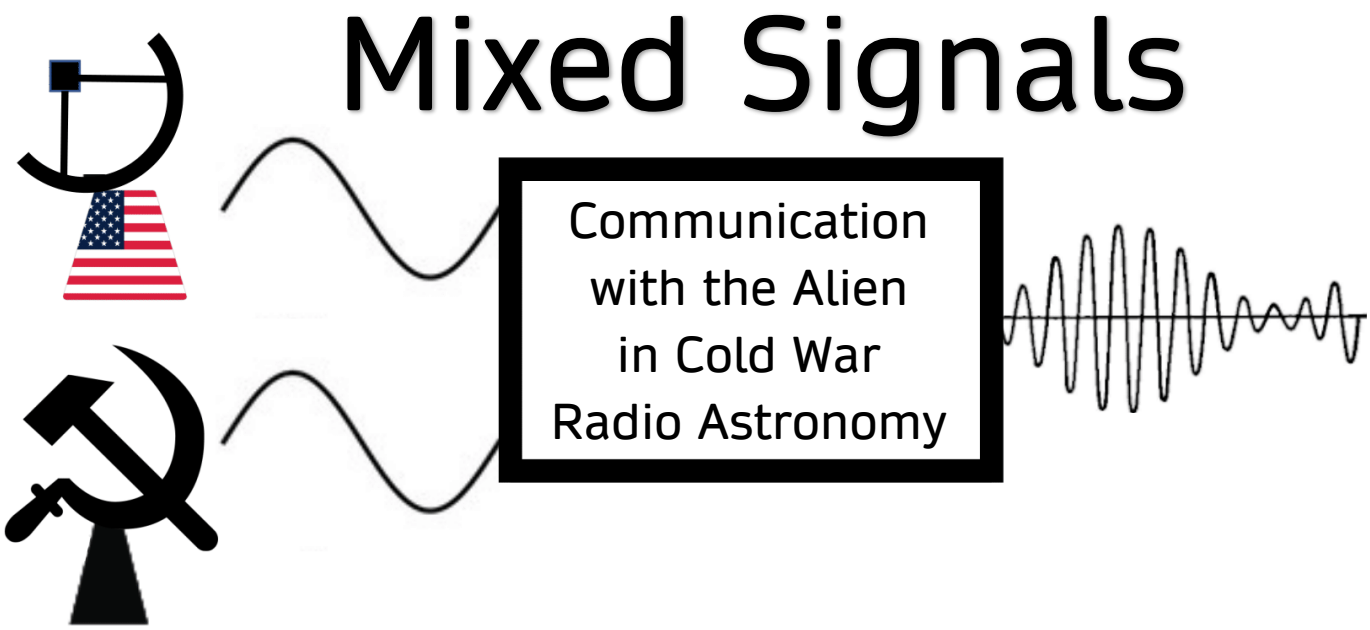

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Preface

This thesis is the result of my own work and includes nothing which is the outcome of work done in collaboration except as declared in the preface and specified in the text.

It is not substantially the same as any work that has already been submitted before for any degree or other qualification except as declared in the preface and specified in the text.

It does not exceed the prescribed word limit for the History and Philosophy of Science Degree Committee.

Abstract

Rebecca A. Charbonneau

"Mixed Signals: Communication with the Alien in Cold War Radio Astronomy"

This dissertation examines the development of radio astronomy and the search for and communication with extraterrestrial intelligence (CETI) from the 1950s through to the early 1980s, with the aim of understanding how these fields reflected the tensions, successes, and anxieties of Cold War science. In the mid-20th century, some radio astronomers in the US and USSR believed CETI would bring about global unity by reminding humans we are one species in a vast, possibly populated cosmos. Using a combination of oral history and archival research, this dissertation demonstrates that the belief in CETI's peace making possibilities encouraged scientific internationalism, helped spark anti-nuclear activist movements, prompted successful scientific exchanges between nations locked in the Cold War, and contributed to the development of breakthrough scientific techniques still utilized today. Radio astronomy infrastructures also enabled those successes; the tools and techniques utilized by radio astronomers required the use of telescopes scattered around the world, demanding global cooperation and communication to achieve the best possible scientific results.

Yet radio astronomy and CETI also benefited from the military and imperialism. The technical requirements of radio telescopes necessitated the construction of government-funded facilities in remote places, and developing remote sites nearly always required dealing with vulnerable populations and, often, colonized land. Therefore, while US and Soviet astronomers were preoccupied with fighting political barriers that impeded their freedom to conduct scientific research, they were simultaneously treading upon the rights and desires of the communities where their instruments were deployed. Furthermore, CETI radio astronomers became adept at developing tools and techniques to identify intelligent extraterrestrial signals from space. That focus made the field significant for the intelligence community, which used CETI's signals-intelligence techniques to improve space listening capabilities. This dissertation ultimately argues that radio astronomy and CETI are particularly valuable disciplines through which to analyse many of the major characteristics of Cold War science and geopolitics, because their infrastructure, instruments, and ideologies reveal the dualities and contradictions of the era by promoting communication and internationalism while simultaneously depending on the military, espionage, and imperial hegemony.

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Acknowledgments

They say it takes a village to raise a child, and that may be so. But it also seems true to me that it takes a village to raise a PhD student. I would like to take full credit for earning my PhD, but that would be entirely dishonest. The last five years have been a journey on which I have been supported, encouraged, and loved by many people, to whom this message of thanks is entirely insufficient. The support of a wide variety of people was perhaps of particular importance for this specific dissertation, given that the last year and a half of my PhD was conducted under the circumstances of a global pandemic. Right before the start of the pandemic, I flew from London to Washington, D.C. with the intent of conducting archival research at the Library of Congress and NASA Headquarters. It was poor timing—I ended up stuck in the US, which resulted in a struggle to find appropriate housing while paying off my flat lease in the UK, having to orchestrate a remote international move, and being subjected to a brand of isolation I had never before experienced. Like the historical figures I researched, I had suddenly found myself in a world that was truly alien to me. During this time, countless people offered me all manner of support—physical, material, temporal, and emotional. Given this enormous debt, I refuse to be brief in my acknowledgements. I would like to offer my sincerest gratitude and appreciation to the following individuals and institutions:

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To Friends.

Abbreviations

CBAT: Central Bureau for Astronomical Telegrams

CETI: Communication with Extraterrestrial Intelligence

ETI: Extraterrestrial Intelligence

GBO: The Green Bank Observatory*

HRMS: The High-Resolution Microwave Survey

IAU: International Astronomical Union

JPL: The Jet Propulsion Laboratory of the National Aeronautics and Space Administration

METI: Messaging Extraterrestrial Intelligence

NAS: National Academy of Sciences

NASA: The National Aeronautics and Space Administration

NRAO: The National Radio Astronomy Observatory

NSA: The National Security Agency

NSF: The National Science Foundation

MHz/GHz: Megahertz and Gigahertz, measurements of the frequency of radio transmissions

RFI: Radio Frequency Interference

SETI: The Search for Extraterrestrial Intelligence

SIGINT: Signals Intelligence

VLBI: Very Long Baseline Interferometry

* The headquarters of the National Radio Astronomy Observatory was originally sited in Green Bank, West Virginia, in 1956 before moving to Charlottesville, Virginia in 1965. The telescopes and facilities at Green Bank were still operated by NRAO until 2016, when the NSF modified the contract for the site and it became an independent observatory, the Green Bank Observatory. GBO still maintains a close relationship with NRAO. Since this dissertation only spans the 20th century, Green Bank will sometimes be used synonymously with NRAO.

Introduction

October 27, 1962—the Soviet Foxtrot-class submarine B-59 cuts quietly through the depths of the Caribbean ocean, armed with a nuclear-tipped torpedo. Above the surface, the Cuban Missile Crisis is reaching its height.

Suddenly, explosions. Left and right, the submarine is shaken by depth charges dropped by a US ship overhead. Concerned they are under attack, and perhaps that nuclear war has broken out above the surface, the captain, Valentin Grigorievitch Savitsky, decides to fire the sub's nuclear torpedo. To do so, there must first be unanimous support from two other officers, the political officer and the deputy.

US President Kennedy had earlier declared a blockade of sea traffic between Cuba and the United States. US Secretary of Defense Robert McNamara sent radio messages to Moscow and Soviet submarines regarding "Submarine Surfacing and Identification Procedures", which stated that the US Navy would take action to "induce [submarines] to surface and identify themselves" if found violating the blockade. The US Navy had orders not to attack Soviets, but to drop warning charges to prompt submarines to surface.[1]

B-59 did not hear McNamara's message—it was too deep to receive radio communications.

The political officer, Ivan Semonovich Maslennikov, gave his authorization to fire. The final officer, Deputy Vasili Arkhipov, however, refused to authorize.

According to the ship's communications intelligence officer, Arkhipov did not see the charges, dropped only to the sides of the submarine, as a hostile act of war.

This is not an attack, he argued. This is a signal.[2*]

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[1]Blanton, T. S. and Burr, W. "The Submarines of October: U.S. and Soviet Naval Encounters During the Cuban Missile Crisis", *National Security Archive Electronic Briefing Book* no. 75, (October 2002), National Security Archive, https://nsarchive2.gwu.edu/NSAEBB/NSAEBB75/.

[2] Kikoy, H. "Vasili Arkhipov – Soviet Hero that Prevented WW 3", 4 July 2004, War History Online. https://www.warhistoryonline.com/cold-war/vasili-cuban-missile-crisis.html.

[*] The details of this event were not revealed in full until early in the 21st century. For example, see: Lloyd, Marion. "Soviets Close to Using A-Bomb in 1962 Crisis, Forum is Told", *The Boston Globe*, 13 October 2002.

The history of the Cold War is in large part a history of signals: signals from the ocean, from the Earth, and from outer space. Unlike the two previous World Wars—which were fought in trenches, boats, and airplanes, using toxic gases, guns, and bombs—many of the most significant features of the Cold War were battled through adherence to a set of signalling and listening practices and variations on them, including intelligence-gathering masked as diplomacy, satellites peeping from overhead, and scientific progress disguising threats of destruction. Fundamentally, signalling is a form of communication and communication was one of the prime weapons of the Cold War. The above episode demonstrates also that communication is rarely straightforward, especially between cultures foreign—or alien—to one another. Cold War communication often relied on these signals and codes and was rife with the potential for miscommunication. After all, if not for Deputy Arkhipov's[*] understanding that the US charges were attempting to communicate a desire they come to the surface, and not a hostile act of war, the Soviets might have somewhat reasonably decided to retaliate with their nuclear arsenal, potentially igniting a "cold" war into a conflict that could lead to global annihilation.

In addition to signals, the history of the Cold War also concerns aliens. Cold War era science fiction, spurred by the Space Race and fears of attack from above prompted by the launch of Sputnik (and the *beep-beep* of the signal it transmitted) and the rise of atomic weaponry, foretold alien invasions and first contact scenarios with a combination of delight and terror. As with the Cold War, these science fiction stories of extraterrestrials fundamentally concerned communication with foreign cultures—the act of sending, listening to, and interpreting signals. Take, for example, Gene Roddenberry's television show *Star Trek*, which first aired in 1966. *Star Trek* is set in the 23rd century on the star ship Enterprise, a military-

[*] Note on transliteration of Russian names and words: I have chosen to transliterate Russian in a way that reflects the original Cyrillic spelling. For example, for the name Геннадий Шоломицкий, I would choose to transliterate as Gennadii Sholomitskii, representing the ий with a double i, as opposed to a singly y, and a double n instead of a single n, even though this does not alter the pronunciation. I have chosen this transliteration style to aid future scholars in this field, who may want to search Russian sources and be able to easily reverse engineer my English spellings into Russian. An exception to this rule will be Iosif Samuelovich Shklovsky, who under my style guide would normally be transliterated "Shklovskii", but who personally preferred his name transliterated with a "y". Because this dissertation owes a great deal to Shklovsky, I have decided to deviate from my style to honour his wishes.

scientific vessel operated under the auspices of the United Federation of Planets, tasked with both "exploring strange new worlds" from a scientific-technical perspective and maintaining peace throughout the galaxy with military power. Take away the rubber costumes and planet-hopping and *Star Trek* is simply a show about Cold War international relations and the scientific-military-industrial complex.[3] And as with the Cold War, much of the show concerned signals. Enterprise was constantly in communication with alien civilizations, picking up distress signals, and tasked with the difficult challenge of making first contact.

A spin-off to the original series, *Star Trek: The Next Generation*, had an episode which focused entirely on the challenges of communication with the alien. The episode, "Darmok", began with the captain of the Enterprise, Jean-Luc Picard, becoming marooned on an alien planet with a species who could only communicate in metaphors drawn from their own complex mythology.[4] The entire 40-minute episode is dedicated to Picard's frustration in trying to conduct meaningful communication with a people whose culture and way of signalling significantly differed from his own. The act of communication with the "other" is a major theme of Cold War and post-Cold War science fiction precisely because it parallels the attempts of communicating with the "alien" on our own planet—those nations and peoples whose languages, cultures, and ontologies differ drastically from the familiar ones.

There was also an underlying sense of anxiety during the Cold War, similarly evoked in alien science fiction. Film theorist Susan Sontag, in her essay on science fiction, "The Imagination of Disaster", famously wrote:

> Here is a historically specifiable twist which intensifies the anxiety. I mean, the trauma suffered by everyone in the middle of the 20th century when it became clear that, from now on to the end of human history, every person would spend his individual life under the threat not only of individual death, which is certain,

[3] Buzan, Berry. "America in Space: The International Relations of Star Trek and Battlestar Galactica." *Millennium: Journal of International Studies* 39, no. 1 (2010).
[4] *Star Trek: The Next Generation*. "Darmok." Episode Two, Season Five. Directed by Winrich Kolbe. Written by Joe Menosky. Paramount Domestic Television, 30 September 1991.

> but of something almost insupportable psychologically—collective incineration and extinction which could come at any time, virtually without warning.[5]

But why was science fiction so prominent a genre in the US and USSR during the Cold War period? It likely is because of the apotheosis of science in the post-war period. The Cold War's scientific-technical competition, arms race, and Space Race elevated the status of science and technology in both the US and USSR. Furthermore, one of the primary battlefields of the Cold War was outer space, not only in the Space Race, but in the less-public race to gather intelligence using satellites and signals intelligence techniques. Furthermore, as seen in *Star Trek*, aliens were a convenient stand-in for foreign civilizations with whom we struggled to understand and communicate. Considering this combination of science-adulation, xenophobia, and newfound public consciousness of outer space, it is no wonder science fiction became a primary medium through which to express Cold War anxiety and aliens the mode. This dissertation is not on the subject of science fiction, yet I begin with this brief analysis to highlight the interconnected nature of science, warfare, anxiety, and aliens in the Cold War mindset. Recognizing these connections, this dissertation will focus on the development of two sciences which arose in the early Cold War period: radio astronomy and the communication with (and search for) extraterrestrial intelligence (CETI/SETI).

Dealing with the World

Radio astronomy is a subdiscipline of astronomy that observes the Universe in the radio part of the electromagnetic spectrum. Instead of the mirrors and lenses that optical telescopes use to observe the 'visible' part of the spectrum, meaning those wavelengths of light which human eyes can perceive, radio telescopes use receivers, parabolic dishes, feed horns, and antennas to explore the 'invisible' universe, meaning light in the cosmos which has a wavelength too long for the human eye to detect. The rise of radio astronomy as a scientific discipline was also a significant diplomatic development in the Cold War—integral to the facilitation of international scientific collaboration and citizen diplomacy during an otherwise geopolitically contentious period. This dissertation will demonstrate that not only was radio

[5] Sontag, S. "The Imagination of Disaster," *Commentary Magazine,* October 1965.

astronomy an intrinsic part of mid-20th century scientific research in both the US and USSR, but it helped promote a philosophy of scientific internationalism and facilitated successful scientific exchanges between nations locked in conflict. The reasons for these successes are twofold.

First, Cold War radio astronomers developed scientific techniques, such as Very Long Baseline Interferometry (VLBI), which necessitated the placement of telescopes on different continents, incentivizing scientists in the US and USSR to circumnavigate political barriers to achieve their science goals. Their 'science first' approach resulted in many successful collaborative experiments in the 1960s and 70s, which led to the development of long-standing partnerships between research groups in the US and USSR/Russia, culminating in cooperation on contemporary projects and missions such as RadioAstron, the first space radio interferometer, which will be discussed in further detail in Chapter One. In field work for this dissertation, I travelled to Moscow to conduct oral history interviews with scientists in attendance at the final RadioAstron International Science Council, held at Russia's AstroSpace Centre in October 2019. As an example of a more recent large collaborative project between US and former-Soviet astronomers, I was interested to see if the internationalist mentalities of 1960s VLBI still held true in the present day. One astronomer who had worked on early VLBI experiments in the US, Dave Jauncey, told me:

> This is one of the major strengths of an area like radio astronomy, and in particular VLBI, because you don't just deal with your own country, you're literally dealing with the world.... The Cold War was going on but the scientists were still collaborating... these things are separate from politics, and I think that's a very powerful phenomenon.[6]

Interestingly, that interview was conducted on October 4, 2019—the 62nd anniversary of the launch of Sputnik, the Soviet satellite that became the first human-made object to orbit the planet and gave the space race an extraordinary public profile.

[6] Interview with David Jauncey on 4 October 2019 in Moscow, Russia, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.

Sputnik and the subsequent Space Race are key examples of how science and technology can be politically charged and subject to interference by non-scientific motivations, and in this dissertation I will demonstrate that, fervent internationalism and cooperation aside, radio astronomy was no exception to this. In other words, despite best efforts when "dealing with the world," as Jauncey put it, it was impossible to avoid worldly challenges. Cold War era radio astronomers collaborating with one another from either side of the Iron Curtain faced many problems stemming from geopolitical conflict, including travel bans, mail interference, inconsistency in data-sharing, and obtrusion from the intelligence community. This leads to the second reason for the unusual collaborative success of radio astronomy during the Cold War period: internationalist philosophies that prompted astronomers to push back against political interference.

In investigating the challenges to scientific cooperation during this period, my research will also address the development of the search for and communication with extraterrestrial intelligence. Today, many radio astronomers consider CETI largely peripheral to science, yet this dissertation will demonstrate that not only was CETI an intrinsic part of 1960s radio astronomy, especially in the Soviet Union, but its scientific philosophy also promoted internationalism which drove innovation and collaboration in other areas, including VLBI. Chapter One will establish, for example, that the first-ever published scientific paper proposing VLBI as a technique was co-authored by Soviet astrophysicists Nikolai Kardashev and Gennadii Sholomitskii as part of their attempts to observe small, bright, and periodic sources, some of which Kardashev speculated might be artificial.

CETI's unique collaborative success resulted from the general philosophy of the community. In considering the potential cultural impact of discovering extraterrestrial intelligence (ETI), prominent CETI scientists such as Carl Sagan and Frank Drake argued that the discovery of life on other worlds could possibly bring about global unity and ergo strove to cooperate with their global peers as 'earthlings', not national citizens.[7] Because of this cosmopolitan perspective, CETI assisted in the formation of networks of contact and

[7] Drake, Frank, *Is Anyone Out There?* (New York: Delacorte Press, 1992): 115.

communication between Soviet and American* astrophysicists, which led to collaboration in other areas of radio astronomy, despite the political challenges. Yet regardless of its success in promoting international collaboration and camaraderie, my research also addresses another aspect of Cold War radio astronomy and CETI—their roles in supporting, and sometimes co-optation by, the military.

During the Cold War, the United States considered scientific freedom an instrument of warfare.[8] This framing was due in part to the ideological campaigns waged by the US and USSR in their fight for global hegemony. In the Soviet Union, the demand that science serve the interests of the people (and State) involved censorship of scientific literature[9], state-mandated theories,[10] adherence to dialectical materialism[11], and in extreme cases[12], the murder and imprisonment of scientists whose actions or beliefs did not align with the politics of the day. In the US, the ideological campaign was far more subtle and arguably more insidious. To present itself as a foil to the USSR, the United States concocted an ideology of "scientific freedom", which was in practice synonymous with its brand of free-market capitalism, democracy, and individual liberty.[13] American science was presented as apolitical; unlike their Soviet peers, American scientists did not have shadowy government censors like Glavlit reviewing their work; nor did they face travel bans for not joining a given political party, and American scientists were free to disagree with each other's theories in independently published scientific journals, mostly without fear of imprisonment. Yet this presentation of "scientific freedom" as a tool to promote democratic values to 'unaligned' countries masked another side of American

* The use of the term "American" to refer to citizens of the United States is sometimes contested, with some arguing it erases the identities of people who live in 'the Americas', meaning the continents of North and South America, but not the United States. That said, given that the vast majority of this dissertation focuses on the period between 1950-1980, when the hegemonic use of "American" primarily referred to citizens of the United States, I have chosen to use the term in this dissertation in the same manner the historical figures I write about would have done, to avoid confusion.

[8] Wolfe, Audra. *Freedom's Laboratory: The Cold War Struggle for the Soul of Science*. Baltimore: Johns Hopkins University Press, 2018.

[9] Vladimirov, L. "Glavlit: How the Soviet Censor Works." *Index on Censorship* 1, no. 3-4 (1971): 31-43.

[10] Gordin, Michael D. "Lysenko Unemployed: Soviet Genetics after the Aftermath." *Isis* 109, no. 1 (2018): 56-78.

[11] Graham, Loren. *Science and Philosophy in the Soviet Union*. New York: Knopf, 1972.

[12] McCutcheon, R.A. "The 1936-1937 Purge of Soviet Astronomers." *Slavic Review* 50, no. 1 (1991): 100-117.

[13] Wolfe, Audra. *Freedom's Laboratory: The Cold War Struggle for the Soul of Science*. Baltimore: Johns Hopkins University Press, 2018.

science—a side that was not apolitical, but deeply entrenched in politics, the military, and imperialism. The notion that science promoted democracy by providing a rational framework for the pursuit of truth was undermined by the reality that science in the US was co-opted by the military-industrial complex; there was essentially no field of science in the mid-20th century that was untouched by the influence of the US military. Furthermore, US scientific freedom disguised US imperialism, which directly benefited the construction of scientific facilities and instruments on settled land as part of its scientific-technical competition with the USSR. With this understanding, science and its institutions seem both central agents of democracy and yet potentially exploitative and tyrannical.

This dissertation will examine radio astronomy and CETI as revealing case studies within the large historiography of Cold War science because of the manner in which these specific sciences embodied the dual tensions of Cold War scientific institutions—playing pivotal roles in promoting internationalism and scientific freedom while simultaneously being implicated in two central ills of the Cold War: espionage and imperialism. For example, as we shall see, the technical requirements of radio telescopes necessitated the construction of government-funded facilities in remote places, away from radio-noisy cities, and developing remote sites nearly always required dealing with vulnerable populations and, often, colonized land. The conflict between astronomical observatories and indigenous communities has sparked many protests over the decades, leading to another dimension of mixed signals: While astronomers were preoccupied with fighting political barriers that impeded their freedom to conduct scientific research, they were simultaneously treading upon the rights and desires of the communities where their instruments were deployed. This reality was at odds with the internationalist rhetoric utilized by the astronomical community, yet commensurate with the needs of the expanding and increasingly globalized nature of the discipline.

Furthermore, by virtue of their science goals, CETI radio astronomers became adept at developing tools and techniques which aimed to target and identify intelligent extraterrestrial signals from space. This made the field rife for exploitation by the intelligence community, which used the signals-intelligence techniques developed by CETI to improve deep-space

listening capabilities.[14] This brief overview of my research has indicated that the technical requirements and internationalist perspectives of mid-20th century radio astronomy exemplified the duality of the US approach to using science as both a tool for diplomacy and imperialistic warfare, focused particularly on its engagement with the USSR. Several significant historical studies of radio astronomers have been written.[15] Yet there is essentially no history on international collaboration in radio astronomy between the US and USSR during the height of the Cold War period, with previous histories focusing largely on interactions between astronomers in the US, Britain, Australia, and the Netherlands. Clearly, historical investigations into the political and social hurdles faced by radio astronomers and their international and regional communities during the Cold War undermine Jauncey's claims that science was separate from politics and demonstrate that internationally cooperative sciences bear worldly challenges in addition to scientific ones.

New Technologies and the Possibility of Strange and Exotic Beings

In some sciences, the ideas precede the technology. In the history of radio astronomy, it has often been the opposite case—new developments in technology drive science questions. This idea will be explored in detail in the first chapter, in my analysis of how radio astronomy developed out of World War II radar equipment and thrived due to the military intelligence applications of its technology. The idea that some sciences stem from technological developments similarly applies to CETI. This becomes clear when one questions why CETI was established out of the development of radio astronomy, rather than optical astronomy. After all, both sciences do essentially the same thing: observe light in the Universe. Yet although humans have speculated on the existence of extraterrestrial intelligence for millennia, rigorous scientific attempts to make contact did not arise until the 20th century. Historians call the human preoccupation with the idea of extraterrestrial life, intelligent or otherwise, the

[14] "The Longest Search: The Story of the Twenty-One Year Portrait of The Soviet Deep Space Data Link and How It Was Helped by the Search for Extraterrestrial Intelligence." National Security Archives (Undated, but produced after 1983, Declassified Sept. 2011).

[15] For examples of previous literature, see: Sullivan III, Woodruff. *Cosmic Noise: A History of Early Radio Astronomy*. Cambridge: Cambridge University Press, 2009.; Munn, D.P.D. *A Single Sky: How an International Community Forged the Science of Radio Astronomy*. Cambridge: MIT Press, 2012.

extraterrestrial life debate, which has preceded CETI by thousands of years.[16] Yet scientific CETI did not arise until the late 1950s and early 1960s, at the onset of radio astronomy's transformation into a scientific discipline. The rise of radio technology allowed the extraterrestrial life debate to transition into a science—a theme which will be analysed in the third chapter, when assessing why CETI developed in the US and USSR, and practically nowhere else.[17] But even more importantly than recognising the development of radar and radio technology leading to the development of CETI, I will argue that CETI's development out of radio astronomy, as opposed to optical astronomy, was due to the close association of radio technology with communication, intelligence gathering, and warfare. In other words, it was the detection of unknown signals in space—initially unexpected because they originated from the military—that led scientists to speculate about the possibility that truly alien signals might also exist.

As I will expand on in the first chapter, many early radio astronomers began their careers as radio technicians who served in the military. This was true for Frank Drake, a radio engineer for the Navy, who pursued a doctoral degree in astronomy at Harvard University in 1955, after having completed his service.[18] Given his background, Drake became one of the first graduate students to complete the new program in radio astronomy at the University. On one night during his studies, Drake was observing the Pleiades star cluster using the University's 60 foot radio telescope. During this observation, Drake detected "what appeared [to him] to be an intelligent signal from an extraterrestrial civilization" coming from the cluster. He assumed its artificiality on account of its striking regularity, something that, at that time, had not been observed in the natural radio.[19] In his autobiography, Drake recalled the event being so

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[16] Crowe, Michael. *The Extraterrestrial Life Debate, 1750-1900*. New York: Dover Publications, 2011.

[17] This is not to say there has not been any involvement in CETI by the rest of the world. In fact, I gave a talk at the European Space Agency in 2017 on this exact subject—the European origins of CETI. Furthermore, interest in the search for technosignatures is presently growing in countries such as Italy, Australia, and South Africa. These caveats aside, it is absolutely accurate to say that Cold War-era CETI is undeniably predominantly product of the US and USSR.

[18] For more on Frank Drake, see Dick, Stephen J. *The Biological Universe: The Twentieth Century Extraterrestrial Life Debate and the Limits of Science* (Cambridge: Cambridge University Press, 1999), 419-431.

[19] Interestingly, about a decade later in 1967, University of Cambridge graduate student Jocelyn Bell Burnell would discover what she called "LGMs"—little green men—later called "Pulsars". Pulsars are highly magnetised neutron stars which emit beams of radio emission while spinning on their axis, resulting in a strikingly regular "pulse" signal

shocking to him that it must have been the explanation for why his hair turned prematurely white shortly after, despite being in his 20s (Figure 1). He tested the signal's location by moving the telescope off the cluster—if the signal disappeared and then reappeared when he returned the telescope to the cluster, it would verify that the signal was indeed coming from the Pleiades. Unfortunately, Drake recalled that to his "great disappointment", the steady, artificial signal continued to broadcast even when he moved the telescope off the cluster, which Drake assumed meant "it had to be some form of terrestrial interference, probably military".[20] The detection of military signals by CETI scientists will become an important theme in this study.

Figure 1. Young Frank Drake with already greying hair, in 1962. From NRAO Archives.

The event lit a fire under Drake, and he became obsessed with the idea of using radio telescopes to seek out artificial signals from extraterrestrial intelligence. Immediately after completing his PhD, Drake was hired at the newly established National Radio Astronomy Observatory (NRAO). In April 1960, shortly after beginning his position at NRAO, Drake designed a receiver to fit the observatory's 85-1 telescope and conducted what is generally considered the first scientific radio search for extraterrestrial intelligence. His search targeted two nearby star systems, Tau Ceti and Epsilon Eridani, in the hopes of detecting another artificial signal—though this time, extraterrestrial in origin. He named his search "Project Ozma", after the Princess Ozma from L. Frank Baum's "Oz" novels. His justification for the name was that Oz was "a land far away, difficult to reach, and populated by strange and exotic beings", perhaps not terribly different from the worlds he was trying to communicate with.[21] Interestingly, the same

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if observed from Earth. Mistaking new, previously unobserved phenomena for evidence of extraterrestrial intelligence is a long-standing pattern in the history of astronomy.

[20] Drake, Frank, *Is Anyone Out There?* (New York: Delacorte Press, 1992): 19.

[21] Ibid, xi-xii.

series of events that happened to him at Harvard took place again. After observing Tau Ceti inconclusively, Drake and his two student assistants, Margaret Hurley and Ellen Gunderman, moved the beam of the 85-1 telescope towards the direction of Epsilon Eridani, where they immediately detected an artificial signal.[22] After a few minutes of excitement, Drake once again realized the signal was of Earth origin, which he speculated was perhaps again military in origin.

When historians discuss Project Ozma, it is usually in the context of the shift in the status of the extraterrestrial life debate. As will be discussed further in Chapter Three, humans have long imagined other worlds populated by other beings. Christiaan Huygens, for example, famously published his treatise *Cosmotheoros: or, Conjectures Concerning the Inhabitants of the Planets* in 1698, in which he speculated on the existence of other worlds inhabited by people just like Earth was.[23] Up until the mid-twentieth century, however, there were few attempts at communicating with these other beings, and none that were systematically scientific in nature, conducted by a professional scientist at a scientific institution. Therefore, much attention has been given to Drake's Ozma on account of its novelty, but also because it set off a buzz of interest within the scientific community, inspiring many subsequent searches.[24] Project Ozma and the start of scientific CETI was also clearly the result of technology driving innovation, because the idea of using radio telescopes to search for extraterrestrial intelligence was a case of simultaneous invention.

Around the time Drake was planning Ozma in 1959, two physicists at Cornell University, Giuseppe Cocconi and Philip Morrison, published a paper titled "Searching for Interstellar Communications" in *Nature*.[25] Like Drake, they too had realized that the electromagnetic spectrum, and in particular, the radio wavelengths, could potentially be used for interstellar communication. Drake, Morrison, and Cocconi all came to the independent conclusion that

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[22] List of Summer Students. Archives of the National Radio Astronomy Observatory, Student Programs Series, Summer Student Programs Unit.

[23] Huygens, C. *ΚΟΣΜΟΘΕΩΡΟΣ* (English translation of Latin: *Cosmotheoros: The Celestial Worlds Discover'd: or, Conjectures Concerning the Inhabitants, Plants and Productions of the Worlds in the Planets*). London: Timothy Childe, 1698.

[24] Dick, Stephen J. *The Biological Universe: The Twentieth Century Extraterrestrial Life Debate and the Limits of Science* (Cambridge: Cambridge University Press, 1999): 418.

[25] Morrison, Philip and Cocconi, Giuseppe. "Searching for Interstellar Communication." *Nature* 184, no. 4690 (1959): 844-846.

searching the radio spectrum at the frequency of 1420 MHz, the line of the transition of neutral hydrogen, would be the best choice for making intelligent contact; the significance of this "magic frequency" will be explained in Chapter Three.[26] Like Drake, Morrison and Cocconi also wanted to conduct a search using a radio telescope, and reached out to Sir Bernard Lovell, a British radio astronomer and Director of the Jodrell Bank Observatory in England, hoping to use the observatory's large Mark I telescope, now known as the Lovell telescope. Cocconi sent Lovell an itemized list of arguments in favour of CETI research, ending on a humble note, stating: "As I said before, all this is most probably fiction, but it would be most interesting if it were not."[27] Cocconi's choice to tie CETI to fiction was likely a poor one—while of course, as already touched upon in this introduction, there were significant links between CETI, science fiction, and the Cold War, this relationship often came to the detriment of CETI's legitimacy as a scientific pursuit. Unfortunately for Cocconi, Lovell was not an advocate for CETI and rejected his proposal, resulting in Drake, not Morrison and Cocconi, conducting the first scientific CETI observations.

Nevertheless, Drake, Morrison, and Cocconi had developed the techniques and theories which would drive the search for the next half century. In fact, even today, contemporary SETI projects such as Breakthrough Listen, launched in 2016, follow essentially the same methods as Project Ozma, although with far more sensitive and powerful instruments. Historians of the extraterrestrial life debate, such as Steven J. Dick, have argued for the significance of Project Ozma as launching a transformation in the way humans have approached extraterrestrial communication, one that has lasted up to the present day.[28] That being said, what few historians have taken note of is the specific connection between CETI and the Cold War. Nor has there been a comprehensive historical study of CETI, and especially not one that carefully examines its development in the USSR.

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[26] Dick, Stephen J. *The Biological Universe: The Twentieth Century Extraterrestrial Life Debate and the Limits of Science* (Cambridge: Cambridge University Press, 1999): 418.
[27] Bernard Lovell, *The Exploration of Outer Space* (1962), Appendix.
[28] Dick, Stephen J. *The Biological Universe: The Twentieth Century Extraterrestrial Life Debate and the Limits of Science.* Cambridge: Cambridge University Press, 1999.

Instead, the existing literature on the history of CETI focuses largely on how CETI shifted the nature of the extraterrestrial life debate. In his book *The Biological Universe: The Twentieth Century Extraterrestrial Life Debate and the Limits of Science* (1999), Dick briefly but correctly notes that the rise of CETI was the result of the development of radio astronomy, part of what he calls the "new astronomy" which recognised that observing the Universe at wavelengths other than the optical was important for a holistic understanding of the cosmos.[29] Yet Dick did not rigorously examine the role of the Cold War in facilitating this development, choosing instead to describe Morrison and Cocconi as having "stumbled" into CETI "almost as an aside to their primary research".[30] Historians of radio astronomy, on the other hand, have certainly made the connection between the development of the science and the Cold War, especially Jon Agar, Woodruff Sullivan, and Ken Kellermann.[31] And of course, as outlined above, there is extensive literature on aliens as a metaphor in fiction during the Cold War. Finally, there is a light yet impressive literature on the development of CETI in the mid-20th century, especially as it relates to philosophical issues. As Dick has pointed out, there is a "metahistoric issue of the cognitive status" of the extraterrestrial life debate.[32] For example, historian Michael Crowe believes that philosophy was the main driver of the extraterrestrial life debate and argues that historical studies of the human preoccupation with extraterrestrial life should largely concern the human mind. He asserts:

> …Although studying the history of ideas of extraterrestrial life may not shed light on such beings, it gives promise of telling humanity about itself. Just as inkblot tests are not about inkblots but rather tell us about their interpreters, just as a study of the paintings of saints may tell us little about those saints but much about the artists and the era in which they painted, so also learning about how humans

[29] Ibid, 414.
[30] Ibid, 415.
[31] For sample works see: Kellermann, Kenneth, Bouton, Ellen, and Brandt, Sierra. *Open Skies: The National Radio Astronomy Observatory and Its Impact on US Radio Astronomy*. New York: Springer International Publishing, 2020.; Sullivan III, Woodruff. *Cosmic Noise: A History of Early Radio Astronomy*. Cambridge: Cambridge University Press, 2009; Agar, Jon. "Making a Meal of the Big Dish: The Construction of the Jodrell Bank Mark I Radio Telescope as a Stable Edifice, 1946-57." *British Journal for the History of Science* 27, no. 1 (1994): 3-21.
[32] Dick, Stephen J. *The Biological Universe: The Twentieth Century Extraterrestrial Life Debate and the Limits of Science (*Cambridge: Cambridge University Press, 1999), 5.

> have thought of extraterrestrials can be deeply revealing of the fears and hopes of persons from the past as well as the images they have of the universe…[33]

Dicks' study, on the other hand, shows how the extraterrestrial life debate was more than simply philosophy, but intimately connected to a wide span of scientific traditions, which he defines as an enterprise "composed of both philosophical and empirical elements" and encompassing atomist, Aristotelian, Copernican, and Newtonian worldviews.[34] Dick believes that just as "the whole thrust of physical science since the seventeenth century scientific revolution has been to demonstrate the role of physical law in the universe", the extraterrestrial life debate within the scientific community has been driven by the desire to see if "an analogous biological law" exists in the universe.[35] Dick therefore situates the extraterrestrial life debate within the scientific community, seeing CETI as stemming out of 20th century scientific ideas and technologies, whereas Crowe situates it within the history of ideas, not neglecting the role of science, but principally believing the pursuit was driven by philosophy.

My own approach certainly borrows from the history of ideas, especially in Chapter Two's discussion of rhetoric and determinism, but will develop a more strongly materialist perspective that focuses on the infrastructures that influenced the development of CETI philosophies. In other words, rather than arguing that the philosophy influences the science, I will argue that scientific and political infrastructures influenced the philosophies. In his essay "The Politics and Poetics of Infrastructure", Anthropologist Brian Larkin defines infrastructure as "material forms that allow for the possibility of exchange over space", a definition which suitably fits Cold War CETI, as its infrastructures aimed to create exchange both over physical spaces on Earth, as well as cosmic space.[36] With Larkin's interpretation of infrastructure in mind, I will show how radio astronomers and CETI scientists interacted with Cold War infrastructures, especially infrastructures of communication, including conferences,

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[33] Crowe, Michael. *The Extraterrestrial Life Debate, 1750-1900* (New York: Dover Publications, 2011), 524.
[34] Dick, Stephen J. *The Biological Universe: The Twentieth Century Extraterrestrial Life Debate and the Limits of Science (*Cambridge: Cambridge University Press, 1999), 5.
[35] Ibid, 2.
[36] Larkin, Brian. "The Politics and Poetics of Infrastructure." *Annual Review of Anthropology* 42 (2013): 327-343.

international correspondence via telegrams and the post office, and surreptitious communication through relationships with intelligence gathering communities.

Furthermore, while the studies of Dick and Crowe discuss the development of CETI as part of the on-going tradition of the extraterrestrial life debate, my study gives CETI its full attention, firmly placing its development in the Cold War. As noted above, while historians of radio astronomy have situated radio astronomy within Cold War historiography, historians of CETI have not, and there is therefore a great need to bridge this gap in the literature and provide a comprehensive study of how CETI was influenced not only by the history of the extraterrestrial life debate, but by Cold War anxieties, globalism, and the onset of military radio intelligence, as there is ample evidence these were significant in its development. For example, both of Drake's first experiences with radio CETI, the accidental detection at Harvard and his deliberately planned Project Ozma, made detections of signals which were likely military in origin. The early 1960s, when Ozma was conducted, was also a period when the US was investing in launching satellites for military and intelligence-gathering purposes—just as the search for extraterrestrial artificial signals began, there was a large increase in extraterrestrial signals that were of Earth-origin. Therefore, the first major point I wish to make is that radio astronomy and the search for and communication with extraterrestrial intelligence are particularly valuable disciplines through which to analyse many of the major characteristics of Cold War science and geopolitics, because their infrastructure, instruments, and ideologies reveal the dualities and contradictions of the era by promoting communication and internationalism while simultaneously depending on the military, espionage, and imperial hegemony.

The Cosmic Mirror and the Alien Other

The languages and terminology with which these dualities were pursued—more or less consciously and deliberately—are important. Before proceeding, it will be helpful to register an important note on the historicity of what one might think of as the euphemism treadmill. Today, the science concerned with seeking out artificial signals from extraterrestrial intelligence is often called the search for "technosignatures"—riding off the rising support for exoplanetary studies, which often purports to search for "biosignatures" in exoplanetary atmospheres. From

the mid-1970s through the early 21st century, however, the term in favour was "SETI", the *search* for extraterrestrial intelligence. But when the first radio astronomers began to use radio astronomy equipment to conduct searches for evidence of extraterrestrial signals in the 1960s, they tellingly preferred the term "CETI"—*communication* with extraterrestrial intelligence. This dissertation will span decades in its analysis of radio astronomy and the search for extraterrestrial intelligence, but is primarily located in the 1950s, 1960s, and 1970s, when CETI was the preferred term. I will therefore primarily use that term but will refer to "SETI" and "technosignatures" when period-appropriate, such as when, for example, I discuss a SETI project which occurred in the 1980s at the end of Chapter One.

It is also important to define disciplinary boundaries, which presents a rather difficult challenge given the disciplinary shifts of the science over the last half century. In this dissertation, I will use the term "CETI" to describe the systematic and scientific search for and attempts at communication with extraterrestrial intelligence within the astronomy community from the late 1950s through the early 1970s, distinguishing it from the extraterrestrial life debate and early attempts to use radio equipment to locate extraterrestrial intelligence, themes which will be further discussed in Chapter Three. When scientific CETI developed in the late 1950s, it was initially a subfield of astronomy with strong ties to radio astronomy. Scientists involved in CETI projects came from a variety of disciplinary backgrounds, but much of the early work in the field came from radio astronomers and their observatories and was published in traditional astronomical journals. Today, the science involved in seeking out intelligent extraterrestrial signals has undergone a shift in its disciplinary grounding—for example, the Ad Hoc Committee on SETI Nomenclature, convened in March 2018, defined SETI as:

> n. A subfield of astrobiology focused on searching for signs of non-human technology or technological life beyond Earth. The theory and practice of searching for extraterrestrial technology or technosignatures.[37]

[37] Wright, Jason T., Sheikh, Sofia, Almár, Iván, Denning, Kathryn, Dick, Steven, and Tarter, Jill. "Recommendations from the Ad Hoc Committee on SETI Nomenclature." https://arxiv.org/ftp/arxiv/papers/1809/1809.06857.pdf.

In the mid-20th century, CETI certainly had some relationship to the newly developing discipline of astrobiology but remained largely rooted in the radio astronomy community.

My preference for the term CETI does not stem from a wish for temporal accuracy alone, however, but also reflects this dissertation's main theme of communication, both with the alien in space and on Earth. Furthermore, as I will explain below, I will use the term "alien" as a rhetorical tool, to highlight how US astronomers' attempts to communicate with their Soviet peers paralleled their attempts at communicating with extraterrestrial civilizations, in a sense both communicating extra and inter-terrestrially with an unknown "other". I am aware the term "alien", when used to describe human beings and human cultures, has sometimes been used to marginalize foreign communities and promote xenophobic beliefs, and I will be cognizant of not repeating those harmful uses of the term, except when critically analysing the history of their use, as I do in Chapter Two. The goal is not to "alienate" real humans and civilizations, but rather to highlight the distinctly human nature of the attempt to communicate with aliens. After all, for a dissertation fundamentally concerned with the search for and communication with extraterrestrials, I will devote considerable attention to analysing the military, scientific infrastructure, and the frameworks of international relations. In fact, for the first half of Chapter One, CETI will hardly be discussed at all. This is because, like Crowe, I believe the history of CETI can be best understood as a history of "humanness": revealing what defines human culture and nature and, more significantly, *who* defines these purportedly universal characteristics.

These are questions which have had many answers throughout history. Human beings have a tendency to alienate one another, to create what the philosopher G.W.F. Hegel called the "Other".[38] Hegel defined the Other as that which differs from the Self. He did so by presenting what is known as the Master-Slave dialectic. Put simply, Hegel's thought experiment presented two independent, conscious minds engaged in conflict with one another. Before they met, each mind was only aware of its own perceptions—its thoughts, feelings, experiences were the universal objective. Since its perceptions were all it knew, they were the standard

[38] Hegel, G.W.F. *System of Science: First Part: The Phenomenology of Spirit*. 1807.

against which all else was measured. But when presented with another mind, with its own thoughts, feelings, and perspectives, there was a new objective standard presented, different from its own. Since there cannot be two objective, universal realities, a conflict was created. The independent consciousness wrestled with identifying the Other—it was not the same as itself, and the Other's own independent consciousness invalidated the veracity of the first's objective measure of existence. It was inherently threatening and uncomfortable.

In a struggle to establish an objective truth, Hegel asserted that the minds would battle to establish the dominance of their own perspective, not only for themselves, but to be imposed upon the other. The "winner" of this conflict, "the Master", would succeed in forcing its perspective on the Other, remaining the arbiter of objective reality. The "loser", the "Slave", would be forced to relativise its perspective and recognize its reality and point of view is not an objective measure of existence. Here, Hegel presented an ironic twist: while the "winner" might have succeeded in its goal of establishing its dominant perspective, it lost the ability to recognize its own limitations, falsely believing in its own God-like power. The "loser", on the other hand, would become fully aware of its place in the universe—being just one of many subjective viewpoints. In presenting the synthesis of his dialectic, Hegel argued for a concept of mutual recognition. Instead of viewing the Other and its subjective reality as conflicting with (and therefore threatening) our own, mutual recognition allows us to learn more about ourselves in comparison to others, realizing both what we are and what they are not. Understanding the Other allows us to test our own measure of reality and come closer to obtaining a true recognition of our place, actions, and perceptions in the Universe.

Hegel's dialectic and use of the Other has some uses in analysing the Cold War and the search for extraterrestrial intelligence. Interpreting the Cold War through the Master-Slave dialectic allows for an interpretation of the struggle for power between the US and USSR. In the Cold War, the Hegelian ideological battle played out as a struggle for global dominance, as each nation redefined itself in opposition to the other. Each nation was convinced of their objective measure of the world, which conflicted with the Other's, leading to a sense of alienation between individuals from the respective nations. Yet Hegel's framework also has some limitations in this context. His depiction seems to presume a basic similarity between the minds

and rests on ideas of subjection and service, imagining the result of the contest being slavery and submission, something that does not have a ready analogue in Cold War relations and is still more distant from extraterrestrial Others. Furthermore, although some historians such as Jared Diamond have experimented with applying psychological interpretive frameworks to interactions between nation-states, ultimately, nations are not "minds" in the way Hegel conceptualised them. [39] Jill Tarter, a SETI scientist and prominent public advocate for the search, has therefore presented her own version of Hegel's theory, which she called the "Cosmic Mirror".[40] Tarter argued that the pursuit of SETI is a tool with which individuals and nations might attain mutual recognition, describing the Cosmic Mirror as:

> the mirror in which all humans can see themselves as the same, when compared to the extraterrestrial 'other'. It's the mirror that allows us to alter our daily perspectives and see ourselves in a more cosmic setting. It is the mirror that reminds us of our common origins in stardust.[41]

In other words, Tarter argued that the pursuit of SETI, which inevitably includes speculation on the consciousness of the "Other", leads to greater reflection and introspection on our own humanity and civilization, and critically, across earthly divisions such as nationality. This introspection is necessary, for as Hegel alludes, much of the conflict in the world stems from the alienation of the Other. The phenomenon that Tarter described as the Cosmic Mirror was commonly held in CETI (as well as the space sciences more broadly) and drove much of the rhetoric of the community. For example, CETI pioneer Carl Sagan once noted:

> The nations that had instituted spaceflight had done so largely for nationalistic reasons; it was a small irony that almost everyone who entered space received a startling glimpse of a transnational perspective, of the Earth as one world.[42]

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[39] Diamond, Jared. *Upheaval: How Nations Cope with Crisis and Change*. Boston: Little, Brown and Company, 2019.
[40] Tarter, Jill. "What if there's somebody else out there?" *CNN*, 20 April 2010, http://www.cnn.com/2010/OPINION/04/20/tarter.TED.SETI/index.html.
[41] Ibid.
[42] Sagan, C. *Contact*. (New York: Simon and Schuster, New York, 1986): 280.

The psychology of spaceflight is well-studied; in 2012 the NASA History Office published a book, *Psychology of Space Exploration: Contemporary Research in Historical Perspective*, which argued that space travel is driven by both sectarian international rivalry and an innately human desire to explore, leading to what they call "national embodiments of a universal human drive".[43] This "universal" and internationalist rhetoric, which will be further analysed in Chapters Two and Three, often obscured the sometimes-hostile nationalistic aspects of spaceflight. Internationalist quotes from astronauts make headlines, such as this one from Apollo astronaut Edgar Mitchell:

> In outer space you develop an instant global consciousness, a people orientation, an intense dissatisfaction with the state of the world, and a compulsion to do something about it. From out there on the Moon, international politics look so petty. You want to grab a politician by the scruff of the neck and drag him a quarter of a million miles out and say, 'Look at that, you son of a bitch'.[44]

Such a statement upholds Tarter's belief in a Cosmic Mirror—that reflection on human civilization in its cosmic situatedness inevitably leads to internationalist, apolitical perspectives. But as the NASA History Office study showed, this rosy picture sometimes masked the other complex reality of national conflict in space exploration. Astro/cosmonauts flying joint missions such as that on Apollo-Soyuz in 1975, for example, had to balance their nationalistic images (as a symbol of communism or democratic capitalism) with internationalist, scientific collaboration rhetoric, along with the natural intercultural discomfort that might arise when sharing a small space with a stranger with different values and habits.[45] A similar conflict can be found in CETI; while scientists touted internationalist rhetoric and anti-national perspectives, they faced many conflicts stemming from national tensions.

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[43] eds. Vakoch, Douglas A. *Psychology of Space Exploration: Contemporary Research in Historical Perspective*. Washington, D.C.: NASA History Office, 2012.
[44] People Staff. "Edgar Mitchell's Strange Voyage." *People Magazine*, 8 April 1974.
[45] Suedfeld, Peter, Wilk, Kasia E., and Cassel, Lindi. "Flying with Strangers: Postmission Reflections of Multinational Space Crews." in eds. Vakoch, Douglas A. *Psychology of Space Exploration: Contemporary Research in Historical Perspective*. Washington, D.C.: NASA History Office, 2012.

It is certainly true that during the Cold War, the Soviet Union and the United States created aliens of one another—it is no coincidence they represented their Cold War fears in science fiction about alien invasions. For a historical example of this othering, consider the meeting of troops at the start of the Cold War. On April 25, 1945, as World War II was coming to a close, the Soviet Red Army and US Infantry successfully cut the German army in two at the Elbe River, southwest of Berlin. The day is still informally celebrated, and sometimes called "first contact" between the US and Soviet forces.[46] The term first contact is not an inappropriate one, for the soldiers on either side of the river appeared to expect aliens rather than fellow human beings. Luibov Kozinchenko, a Soviet soldier from the Red Army 58th Guards Division, later recalled the day stating, as the Americans crossed the river, "We could see their faces. They looked like ordinary people. We had imagined something different".[47] On the US side, Al Aronson, an American soldier from the US 69th Infantry Division, claimed: "I guess we didn't know what to expect from the Russians. But when you looked at them and examined them, well, you could put an American uniform on them and they could have been American!"[48] Both sides appeared surprised at the familiarity of these people who had until then seemed quite alien.

This episode highlights a key theme in what would become the Cold War—a fear of the unknown, anxiety over the alien. This fear would lead to science undergoing a transformation at the start of the Cold War. Paul Erikson and co-authors noted that the Cold War rationality held an overemphasis on technology to solve problems over human thought.[49] This belief manifested in slightly different ways in the US and the USSR. Historian of science Audra Wolfe has argued that, in the US, "policy makers believed in the power of science to solve problems at home as well as abroad" and, importantly, that an ideology of "scientific freedom [was] essential to winning the global Cold War".[50] In addition to major governmental investment in

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[46] "1945: Russians and Americans link at Elbe," On This Day: 1950-2005*, BBC,* accessed 28 April 2021, http://news.bbc.co.uk/onthisday/hi/dates/stories/april/27/newsid_3563000/3563723.stm.
[47] *The Cold War*. "Comrades." Episode One. Produced by Pat Mitchell and Jeremy Isaacs. *CNN*, 1998.
[48] Ibid.
[49] Erikson, Paul et al. *How Reason Almost Lost Its Mind: The Strange Career of Cold War Rationality*. (Chicago: University of Chicago Press, 2015): 8.
[50] Wolfe, Audra. *Freedom's Laboratory: The Cold War Struggle for the Soul of Science*. (Baltimore: Johns Hopkins University Press, 2018): 5.

the sciences, the US strove to present itself as a foil to the USSR. Where science in the Soviet Union was overtly political, explicitly tied to Marxist ideology, science in the US was covertly political, disguised in a veil of apoliticism. Of course, as this dissertation will show, American science was inextricably tied with politics, and radio astronomy and CETI are no exceptions—on the contrary, they excellently capture the American desire for a veneer of apolitical scientific freedom, while still supporting political and militaristic goals.

Returning briefly to science fiction, it is important to note that the idealism of the Cosmic Mirror and the internationalist philosophies of CETI neglect to acknowledge that contact does not equate with true communication and comprehension of the alien. In the Chinese science fiction novel, *The Three Body Problem* (2008), author Liu Cixin writes about a world in which a Cultural-Revolution-era radar station makes contact with an extraterrestrial civilization which intends to invade the Earth.[51] The catch is that, due to the great distance between Earth and Liu's fictional "Trisolaran" planet, the invasion will not happen for over 400 years. This sets up an interesting premise—the Earthlings in Liu's universe must grapple with the idea of alien contact without truly having to interact with the aliens in question. To address the implications of this situation, Liu invents a fictional sociologist, Bill Mathers, and his book titled *The 100,000-Light-Year Iron Curtain: SETI Sociology*. In this book-within-a-book, Mathers sets up a concept he calls "contact as symbol", which argues that whether or not alien contact is actually achieved is irrelevant—simply the confirmation of the existence of extraterrestrial intelligence (ETI) would have an enormous impact on human psychology and culture. Contact, therefore, might be more significant as a symbol or switch than an actual event. That his book is titled *The 100,000 Light-Year Iron Curtain* betrays the parallels between extraterrestrial contact and the technological contact between the US and USSR, and later China.

Although Mathers' book only exists in the world of *The Three Body Problem*, CETI sociology is indeed a serious field of academic inquiry, with many sociologists taking quite seriously the problem of contact with extraterrestrial intelligence.[7] Indeed, the field of CETI as a whole has long been interested in the humanities perspective on what is often called "the CETI

[51] Liu, Cixin. *The Three Body Problem*. London: Head of Zeus, 2014.

problem"—the problem of how to search for, find, and make contact with extraterrestrial intelligence. For example, at the first US-USSR CETI conference in 1971, which will be assessed in further detail in Chapter Three, historians, anthropologists, linguists, and philosophers were invited to speak alongside astronomers and engineers. This dissertation takes inspiration from Liu's "contact as symbol" but chooses to expand on it in a historical context, arguing that Cold War contact and communication between US and Soviet scientists took on great symbolic internationalist meaning for the scientists who engaged in it, which in turn facilitated future interactions, despite the non-utopian realities of international scientific collaboration during that period. In the Earth of *The Three Body Problem*, humans break into two ideological factions regarding the not-so-imminent alien invasion. The "Adventists" believe humanity is irredeemably evil and deserves to be destroyed by the Trisolarans. The other group, the "Redemptionists", believe that humanity is corrupt, but capable of redemption and unification, with the help of a wiser and more advanced civilization. As I shall show, the actual history of CETI also features splits and bifurcations between better and worse natures of humanity. On the one hand, scientific CETI appears to have had a positive impact on the facilitation of scientific internationalism during the Cold War by emphasizing the potential unifying power of contact-as-symbol. On the other hand, however, the tools and techniques developed for SETI were also co-opted for military tracking and intelligence gathering, and scientists working with their international peers were sometimes asked to spy on one another as Cold War hostilities grew.

Methods and Limitations

The reason this dissertation focuses on radio astronomy and CETI in analysing Cold War scientific international cooperation is because the two disciplines will help reveal significant power dynamics; they demonstrate who controls the land, military, and cultural hegemony. Therefore, a core argument of this dissertation is that CETI is an excellent lens with which to observe systems of ideology, power, and control during the Cold War period. In fact, one of my main methods for collecting data for my dissertation was in itself revealing of these systems. As stated earlier, few historians have afforded close attention to radio astronomy or CETI, and even those who have grant little attention to those disciplines as they have been developed and

practiced in the Soviet Union, which on the surface is surprising since, as I will show, the USSR was tremendously active in radio astronomy and was the only other country during the 20th century that heavily invested in CETI. Upon further investigation, however, this gap in the literature is understandable, given the way that the relationship between astronomy and the military, especially in the former Soviet Union, has shaped access to sources on CETI research.

For example, shortly after I left Russia on my field research trip in 2019, President Putin signed a foreign media amendment which used vague wording to demand that any individual, Russian or foreigner, who published information in the media or online (on a blog, for example) and who also received money from a foreign funding source must declare themselves to be "foreign agents", a loaded term with Cold War-era intelligence implications.[52] The amendment was likely targeting journalists, as part of the Putin administration's crack-down on free press, but inadvertently affected historians such as myself, who have published blogs for overseas scientific institutions such as the Harvard-Smithsonian Center for Astrophysics, and receive funding from non-Russian sources, such as the American Institute of Physics. When I someday return to Russia, obtaining access to secure facilities such as the Russian Space Research Institute will become much more difficult if labelled a foreign agent. Furthermore, many Russian archives are closed to outside visitors—despite my best efforts and attempts to pull strings with the many friends and connections I have within the Russian scientific community, including administrators of institutes, directors of observatories, and even cosmonauts, I was unable to access a single archive during my time in Russia. Instead, I was forced to rely on oral history testimony to complement published sources and establish some elements of the Soviet part of the historical record on radio astronomy, as well as utilise Soviet sources which were preserved by US scientists, such as letters of correspondence with Soviet scientists which were donated to the Library of Congress by Carl Sagan. As this dissertation will show, despite the internationalist rhetoric of CETI, its institutions were so entrenched in Cold War politics and military involvement that this relationship even interfered with historical research taking place decades after the Soviet Union dissolved.

[52] Roth, A. "Putin approves law targeting journalists as 'foreign agents'," *The Guardian* (Moscow, Russia), Dec 3, 2019.

It is important, then, to speak briefly to the limitations of this study. First, given archival restrictions in former-Soviet states and a relatively rich tradition of archival preservation in the US, the historical record is extremely uneven between the two nations. As stated above, I have tried to rectify this by conducting oral history interviews with former Soviet astronomers, supported by funds from the American Institute of Physics and donated to their oral history archive. Nevertheless, oral history is an imperfect source; many of the men and women I interviewed were octogenarians trying to recollect events from 40 or 50 years ago. Where I could, I tried to match oral history claims with documentary evidence, and where I could not, I am sure to state that this is one individual's interpretation or recollection of events. There are, of course, some benefits to using oral history. Soviet historian of technology Michael Gordin has noted that the history of technology in the Soviet Union has too often focused attention on the machinery and technology without giving due attention to the human beings creating, operating, and interpreting said technology. In writing about language and its intersections with technology in his analysis of Soviet machine translation, Gordin emphasized the need for the historiography of Soviet technology to "alienate the machine… and return the human… to our narratives of Soviet technology".[53] My approach to Soviet history of technology takes Gordin's sentiments to heart; this dissertation will show how the technology shaped the science, but highlight how both the militaristic and internationalist goals of humans shaped the technology. Utilizing oral history interviews makes this historiographical intervention possible.

Furthermore, regarding traditional documentary evidence, there have been few comprehensive English translations of key documents or papers from Soviet CETI and radio astronomy history. Many of these papers are also inaccessible from British or American libraries. I have been very fortunate to have colleagues with ties to Russia, especially former Soviet Space Research Institute scientist Leonid Gurvits, scan and send me these records which are otherwise challenging to obtain in the West. Over the five years of my graduate research career, I have studied Russian, and done my best to translate several of these documents I consider key pieces of CETI history. It is my hope these translations, especially of two

[53] Gordin, Michael. "The Forgetting and Rediscovery of Soviet Machine Translation." *Critical Inquiry* 46 (2020).

particularly significant documents which I have included in the Appendix of this dissertation, will aid future CETI history scholars who wish to include Soviet contributions in their studies.

Finally, it is important to explain the empiricist historical approach of this research project. Much of this dissertation is based on first-hand research because, as already noted, there is little to no comprehensive historical study on the development of CETI, much less transnational and Soviet CETI. Because there is so little already-documented history, this dissertation sometimes requires extensive exposition of key events in CETI history. I have been fortunate to be welcomed into the CETI and astronomy communities in both the US and former-USSR over the last five years, having conducted research at the National Radio Astronomy Observatory, NASA Headquarters, the AstroSpace Centre of the Lebedev Physical Institute in the Russian Space Research Institute, the Shternberg Astronomical Institute at Moscow State University, Berkeley's SETI Research Center and Breakthrough Listen, Green Bank Observatory, the American Astronomical Society, the European Space Agency, the Square Kilometre Observatory at Jodrell Bank, Harvard-Smithsonian Center for Astrophysics, and others. Through this research and collaboration with scientists, I have been able to build a relatively comprehensive historical record of transnational CETI and radio astronomy history through the collection of letters of correspondence between scientists, oral history interviews, autobiographies and memoirs, scientific papers, and material objects. It is my hope that this preliminary study of these disciplines will open the door for future research on Soviet contributions to CETI, as there is clearly much more to learn about this fascinating and complex part of Cold War history.

Chapter Organisation

I have divided this dissertation into three chapters on major themes within CETI: Intelligence, Civilization, and Life. Even as they engage with their disparate themes, the core of each chapter is communication, and more specifically, miscommunication as caused by the various conflicts between scientific internationalism and scientific imperialism during the Cold War. The first chapter, "Intelligence" will focus on the development of radio astronomy along with military intelligence facilities and show how radio astronomy's relationship with the military caused challenges to early CETI pioneers. The chapter will make a three-pronged argument: First, that

radio astronomy developed in company with its military and intelligence-gathering applications; its development as a discipline relied strongly on governmental and military support and infrastructure. Second, this dual use of the infrastructure and instruments had the consequence of both facilitating and hindering scientific cooperation; military support meant increased funding and support for the sciences, but military interference meant international collaboration was often wrought with challenges and paranoia. And finally, I argue the goals of the US and the USSR during the Cold War period were surprisingly aligned with the goals of CETI; both strove to eavesdrop on alien civilizations: to learn from them, to protect ourselves from them, and to reflect on our own. It is no coincidence, then, that the tools we use to listen to aliens are part of the same infrastructure that we use listen to each other.

The second chapter, “Civilization”, will examine a different consequence of military support for astronomy, one predating the Cold War back to the period of American Imperialism and Tsarist Russia. In this chapter, I will show how one might be tempted to argue that there are two CETIs: the technological and scientific pursuit of the solution to the problem of finding intelligent life in the universe, and the contemplation of the philosophical and ethical implications of such a search. I will argue instead, however, that these two facets are essentially one and the same. The second part of Chapter Two will also shift from studying instruments and infrastructure to examining the disciplinary homes of CETI. As I will demonstrate, the basis of communication with extraterrestrial intelligence in the mid-20th century was a belief in universality, and the scientists engaged in CETI believed they held the ability to convey that universality. In the process, however, CETI scientist’s ideas of universality tended to reveal more about the scientists and their personal ontologies then they did anything about extraterrestrial civilizations, leading to a highly determinist and imperialistic perspective on life in the Universe. The historiography of the Cold War is increasingly taking on a postcolonial perspective and paying attention to how the rest of the world was affected by the battle between the superpowers. “Civilization” will examine how the assumptions we make about other civilizations, messages we send to aliens, and the tools we use to do so reveal much about the inequities of our world, especially as enacted by the US and USSR.

The final chapter, "Life", takes a more individual perspective than the first two chapters. Rather than examining institutions, militaries, rhetoric, and disciplines, it will focus primarily on individual interactions between radio astronomers and CETI scientists, especially those between I.S. Shklovsky and Carl Sagan. I will examine the individual motivations of CETI scientists and the infrastructures they relied on to communicate with one another to argue that without the Cold War, CETI as we know it would not exist. In this chapter, I will show that CETI was a product of the Cold War because the political interference in science and development of technological weapons of mass destruction caused existential anxieties, prompting Soviet and American CETI scientists to reflect on the longevity of technological civilizations. In examining the Cold War origins of CETI, we can begin to understand CETI as a product of Cold War mentalities, explaining why this science was conducted almost exclusively in the US and USSR during this period.

Conclusion

This dissertation pretends to be about aliens, but it fundamentally concerns human beings and two of their primary emotions: hope and fear. As one SETI scientist once put it to me: "science is not only hard because science is hard; it is hard because we live in the world".[54] This is a complex subject—CETI both undermined the geopolitical goals of nation states through international collaboration, as well as actively supported militaries through assistance in intelligence gathering. CETI scientists alienated fellow Earthlings at the same time as they strove to equitably depict our world through messages to extraterrestrials. CETI inspired anti-nuclear activism as well as aided in developing tools and techniques which made nuclear strikes more accurate. In this dissertation, there will be no conclusion that radio astronomy and CETI were definitively forces for either world peace or global oppression.

Instead, this dissertation will find itself sitting within the uncomfortable tensions of the disciplines and use them as a vessel through which to analyse the contradictions and complications of Cold War science and philosophy. Earlier in this introduction I introduced Jill Tarter's concept of the Cosmic Mirror; Tarter argued that contemplating life in the universe

[54] Conversation with Anamaria Berea, Research Investigator at Blue Marble Space Institute of Science, in July 2019.

helps us reflect on our own lives and world. This dissertation takes this general argument a short step further—that the actual process of conducting CETI is revealing of the world and ourselves. It unveils the locality of our instruments of both science and warfare, our cultures and ideologies, and our Earth-bound and orbital systems of communication. Perhaps no other science shows us as much about ourselves, and prompts us to consider: Do we like what we see?

Chapter One:
Intelligence

"I know perfectly well that at this moment the whole universe is listening to us—and that every word we say echoes to the remotest star. To pretend otherwise is the sheerest hypocrisy."

— Jean Giraudoux, *The Madwoman of Chaillot* (1943)[55]

"The successful launching of the Sputnik was a demonstration of one of the highest scientific and technological achievements of man — a tantalizing invitation both to the militarist in search of ever more devastating means of destruction and to the astronomer searching for new means of carrying his instruments away from their earthbound environment."

— Sir Bernard Lovell, on BBC Radio Four in 1958[56]

As noted in the introduction, each chapter of this dissertation will address a different dimension of scientific communication during the Cold War period, especially as it relates to the development of CETI in the US and USSR. This first chapter is dedicated to the overlap between radio astronomy and military intelligence gathering, focusing on the tools and infrastructure of radio astronomy and CETI, and highlighting the interterrestrial communication which occurred secretly and indirectly through espionage and citizen diplomacy. The word "intelligence" plays a dual role in the following chapters, referring to both the intelligent signals from extraterrestrials scientists hoped to communicate with, and the intelligent signals created and captured by militaries conducting surveillance. In analysing these two types of extraterrestrial signals, I will demonstrate that during the Cold War period, searching for signs of extraterrestrial intelligence

[55] Jean Giraudoux, *The Madwoman of Chaillot*. New York: Dramatists Play Service, 1945.
[56] 'Astronomy Breaks Free', *BBC Radio Four*, accessed 10 August 2017, http://www.bbc.co.uk/programmes/p00hg1k5.

(meaning here, signs of intelligence which are not located on the surface of the Earth) was not the exclusive domain of radio astronomy and CETI scientists, but also of global militaries, with their desire to identify enemy radio signals, spacecraft, or satellites.

Linking both Cold War military pursuits and the search for and communication with extraterrestrial intelligence was a desire to identify a strong distinction between artificial and natural signals. Artificiality is a key component of intelligent signals—the artificial is distinct from the natural because it carries intrinsic information and is constructed deliberately and with intention, rather than occurring accidentally or coincidently. Instead of creating a distinction between the pursuits of CETI and the military, this chapter will argue that they were often essentially one and the same. Radio astronomy and CETI benefited from the military, and the military benefited from CETI and radio astronomy; these sciences were inextricably tied up in the military-industrial complex, and in particular, intelligence gathering. Often the same astronomers who cooperated with their international peers also constructed the tools they used to spy on their colleagues.[57] The evidence presented in this chapter and the rest of the dissertation will prove that watching and being watched were intrinsic parts of collaborative scientific work during the Cold War, and CETI is a particularly revealing example of this fusion of scientific and geopolitical aims.

A core argument of this dissertation is that radio astronomy and CETI as we know them would not exist without the Cold War; as we shall see, the Cold War provided funding, technological innovation, political incentive, and philosophical motivation. Yet it would be too simple and bombastic to argue that radio astronomers and CETI scientists were military sciences; the reality is far more nuanced, and many radio astronomers and CETI scientists would rightfully protest being labelled military scientists. It is certainly true that much of the infrastructure supporting radio astronomy and CETI is either military in origin or used at least in part to support military activities. Yet while some radio astronomers and CETI scientists willingly cooperated with the military, others were outraged at military interference in what they viewed as an apolitical and even peace-making scientific pursuit. Some astronomers, on the

[57] Wolfe, Audra. *Freedom's Laboratory: The Cold War Struggle for the Soul of Science*. Baltimore: Johns Hopkins University Press, 2018.

other hand, had no choice in their military involvement; in the case of the Soviet Union especially, there was no flimsy distinction between civilian and military facilities as there was in the United States, and Soviet scientists who wished to cooperate with their international peers and travel abroad had to adhere to political and militaristic agendas and were often compelled to work on military projects alongside their science. This chapter will also argue that CETI has long been a part of the infrastructure and scholarship of radio astronomy. This is a perspective many contemporary radio astronomers are resistant to, as CETI has been viewed by some as existing on the fringe of radio astronomy, at best a waste of telescope time, at worst a damaging pseudoscience; scientists who became involved in CETI sometimes did so at the risk of their careers. But this dissertation will unequivocally demonstrate that CETI was, and remains, a foundational subfield within astronomy, and in fact supported the creation of many of the major tools and techniques utilized by radio astronomy today, including Very Long Baseline Interferometry, which I will show here had origins in CETI.

I will begin by exploring the many ways in which radio astronomy, and therefore CETI, was affected by the relationship between the applicability of radio technology for the purpose of both science and military intelligence gathering. To demonstrate the endurance of this phenomenon over the decades, and therefore prove its central role in the infrastructure and culture of radio astronomy and CETI, I have developed a loosely chronological framing of this chapter, beginning in the 1950s and ending in the early 1980s. Fundamentally, like all the chapters in this dissertation, this is a chapter about communication and, critically, miscommunication. The case studies I examine below will highlight this theme, and further our understanding of the interconnectedness of Cold War astronomy and the military. After first establishing the link between military infrastructure and the development of radio astronomy as a discipline, I will show how a radio astronomy observatory in Britain became the primary source of information on space tracking during the early Space Race, prompting a decades long obsession with gathering radio intelligence from the Soviet Union. Next, I will highlight how the development of radio astronomy infrastructure in the US occurred simultaneously with the development of signals intelligence facilities and argue that the dual use of radio astronomy created a tense and paranoid atmosphere for international cooperation. I will then show how

the restrictions on scientific communication in radio astronomy led to miscommunication between US and Soviet scientists, resulting in the first 'false alarm' in CETI. This false alarm and miscommunication, however, ended up prompting the development of a new technique and fostered relationships between a group of scientists in the US and USSR. Finally, I will conclude the chapter by examining two case studies, one in the US and one in the Soviet Union, which show how CETI efforts were sometimes subject to deliberate and concealed co-optation by the intelligence community, much to the ire of the scientists involved. In examining these episodes in the history of radio astronomy, CETI, and Cold War intelligence, I will demonstrate that the development of the search for and communication with extraterrestrial intelligence was inextricable from the Cold War, an entanglement that both aided and hindered the science.

The Soldier-Scientist

The first US government observatory for radio astronomy, the National Radio Astronomy Observatory, was established on 17 November 1956.[58] The establishment of NRAO in Green Bank, West Virginia was a direct response to the newfound scientific-technical competition between the US and USSR, due to a growing sense that the United States was 'falling behind' in the field of radio astronomy, which as we shall see had greater implications for the United States' warfare capabilities at the start of the Cold War. As noted by historian Paul Forman, US physics in the 1950s "underwent a qualitative change in its purposes and character", with increased government intervention and a new emphasis "in the nation's pursuit of security through ever more advanced military technologies."[59] This government intervention in the sciences occurred in response to the growing military threat from the Soviet Union which, like the US, was expanding its nuclear capabilities. The investment in radio astronomy, however, was also tied to earlier military activities during World War II, and in particular, the development of radar.

Radio astronomy historian Woodruff Sullivan noted in his book on early radio astronomy, *Cosmic Noise: A History of Early Radio Astronomy* (2009), that the first operational

[58] Balser, Dana S., Ghigo, Frank D., and Lockman, Felix J., *But It Was Fun. (*Green Bank, Green Bank Observatory, 2016): xi.

[59] Forman, Paul. "Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, 1940–1960", *Historical Studies in the Physical Sciences* 18, no. 1 (1987): 150.

radar system was developed by Robert Watson Watt from 1935-1938, as the UK was on the cusp of war with Germany. Watt's work was supported by the British Air Ministry because of a recognition that Britain was vulnerable to the growing threat of an air attack by the German Luftwaffe.[60] Radar worked by using a transmitter to bounce radio waves off distant objects to receive accurate information on said object's position and speed, even when it was not optically visible (for example, at night, when most airstrikes occurred). As the War expanded across the world, most countries involved, especially the UK, Germany, the Netherlands, Australia, the United States, the Soviet Union, and Japan, had developed radar systems. These nations recruited physicists and radio engineers, often from universities, in an early example of what is popularly known as the "military-industrial complex", a term coined by US President Eisenhower in his final public speech in 1961.[61] Since many of these military systems developers were trained as academic scientists and engineers, they sometimes made serendipitous scientific discoveries related to their military activities. One prominent example would be the observations of James Stanley Hey, a British physicist who joined the British Army Operational Research Group (AORG), which aimed to improve the capabilities of anti-aircraft radar systems.

Because of the efficacy of radar as a defence system, it should be noted that, during the War, countries often tried to 'jam' their enemy's radar systems—in other words, to send out radio signals that interfered with radar systems by flooding them with noise or other false information. The AORG aimed to study both how to conduct and fend off radar jamming. On two days in February 1942, they discovered that ten radar systems were being 'jammed' by overwhelming noise interference in the 55-85 MHz range, which Hey observed "came almost continuously and exclusively between dawn and sunset".[62] Upon further investigation, Hey noted:

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[60] Sullivan III, Woodruff. *Cosmic Noise: A History of Early Radio Astronomy* (Cambridge: Cambridge University Press, 2009), 79.
[61] "Transcript of President Dwight D. Eisenhower's Farewell Address (1961)", Our Documents. https://www.ourdocuments.gov/doc.php?flash=false&doc=90&page=transcript.
[62] Sullivan III, Woodruff. *Cosmic Noise: A History of Early Radio Astronomy* (Cambridge: Cambridge University Press, 2009), 81.

> Although no explanation of how the interference was caused can be given, it does not appear possible to arrive at any other conclusion… than that the interference was associated with the sun and the recent occurrence of sun spots.[63]

As the war came to a close, Hey published his findings about the radio emissions from the Sun in the scientific journal *Nature*, one of the earliest examples of military radar operators transitioning into radio astronomy researchers in the post-war period.[64]

Another notable example of a wartime radio physicist transitioning into radio astronomy research at the end of the War would be Sir Bernard Lovell. Lovell was a British physicist working in cosmic ray research at the University of Manchester. At the start of the war in 1939, he joined the Telecommunication Research Establishment (TRE) to conduct research into H2S radar systems.[65] While working on one of these radar systems, Lovell noticed background "echoes" when trying to observe aircraft signals, and hypothesized the echoes might be caused by cosmic ray "showers".[66] At the end of the War in 1945, he returned to Manchester and used ex-military radar equipment to continue his studies of cosmic rays in the hopes of identifying the source of the echoes. Instead of finding cosmic rays, however, Lovell discovered that the radio signals were caused by meteors, which ionized small parts of the atmosphere during their descent.[67] This observation by Lovell in 1945 was the start of one of the world's earliest and most distinguished radio astronomy observatories, Britain's Jodrell Bank Observatory.

Historian of science Jon Agar has written extensively on the establishment of Jodrell Bank and argued that the development of radio astronomy in Britain benefited from the trend in nuclear physics to establish centralised research facilities, disconnected from traditional university settings. The United States' own centralised radio astronomy facility, NRAO, however, would not be established until over a decade later, despite the United States'

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[63] Hey, J. "Notes on G. L. interference on 27th and 28th February." 1942 (Secret), file AVIA 7/3544 (6486), Public Record Office, Kew, England, as cited by Sullivan III, Woodruff. *Cosmic Noise: A History of Early Radio Astronomy* (Cambridge: Cambridge University Press, 2009), 81.
[64] Hey, J. "Solar Radiations in the 4–6 Metre Radio Wave-Length Band." *Nature* 157, No. 47–48 (1946).
[65] Hodgson, John. "Sir Bernard Lovell (1913-2012)". The John Rylands Collection Blog. https://rylandscollections.com/2012/09/24/sir-bernard-lovell-1913-2012/.
[66] Smith, F., Davies, R. & Lyne, A. "Bernard Lovell (1913–2012)", *Nature* 488, no. 592 (2012).
[67] Lovell, A. "Electron Density in Meteor Trails". *Nature* 160, no. 670–671 (1947).

prominent role in the War. While Agar noted that radio astronomy in Britain grew "disproportionately quickly" because of its wartime activities, shifting scientific organizational structures, and interest in prestigious symbols of scientific-national power, similar arguments could certainly be made for the US. Nevertheless, the US lagged slightly behind Britain in its interest in radio astronomy—why?[68]

NASA Senior Economic Advisor and historian of astronomy Alexander MacDonald wrote a history on what he called "the long space age", which charted the enormous financial investment in optical astronomical observatories in the United States during the 19th century and argued that "the driving motivation for the provision of funds was a desire to signal status and capability through monumental achievement".[69] There was then, in the US, a strong connection between prestigious optical astronomical observatories and elite status. In *Cosmic Noise*, Sullivan argued that the United States' eminence in optical astronomy "acted as a deterrent to the fledgling specialty" of radio astronomy.[70] This was partly due to two facts: First, the optical astronomy community received little federal funding during the War and early post-war period, especially as compared to other areas of physics. Secondly, optical astronomers did not view radio astronomers as 'real astronomers' because of their different disciplinary backgrounds—at that time, radio astronomers tended to begin their careers as radio engineers or physicists, not traditional astronomy programs. In a view from across the pond, British radio astronomer and later Nobel prize winner Martin Ryle observed:

> The gulf between radio and astronomy was probably worse in America. …I think it's probably fair to say that the [American] optical astronomers weren't particularly welcoming. There was a bit of a closed shop, [the radio people]

[68] Agar, Jon. "The New Price and Place of University Research: Jodrell Bank, NIRNS and the Context of Post-War British Academic Science." Contemporary British History 11, no. 1 (1997): 1-30.
[69] MacDonald, Alexander. *The Long Space Age: The Economic Origins of Space Exploration from Colonial American to the Cold War.* (New Haven: Yale University Press, 2017), 6.
[70] Sullivan III, Woodruff. *Cosmic Noise: A History of Early Radio Astronomy*. Cambridge: Cambridge University Press, 2009.

> weren't real astronomers. They hadn't been brought up properly at all…they didn't know what Oort's constant was, they didn't know Hubble's constant.[71]

Furthermore, many US astronomers believed radio astronomy would be an empty and meaningless pursuit—they did not believe there was anything interesting to observe in the radio, and that much more was to be gained by studying the optical. In fact, even NRAO's first director, esteemed optical astronomer Otto Struve, believed that the universe was largely radio-quiet, and warned that radio astronomy was probably "barren" in comparison to optical astronomy, and might eventually fail as a discipline.[72]

A third reason for the gap between US and international radio astronomy development stemmed from national institutional frameworks. In countries like Britain, radio research in the pre-War era was situated mainly in Physics departments. This made it easier for researchers to transition to solar studies and eventually extragalactic radio astronomy upon return to their universities after serving in the War effort. In the US, on the other hand, radio and ionospheric research was usually situated either within electrical engineering departments at universities, or specialized institutes such as the Naval Research Laboratory which, as we shall see in the next section, struggled to establish strength in radio astronomy, in part because of its emphasis on practical research, as well as due to its military ties.[73] This gap between radio astronomers and optical astronomers in the US led to a decade-long lapse in radio astronomy research, as researchers in other countries, especially Britain, Australia, and the Soviet Union, blazed ahead.

Before moving on to examine the urgent and rapid expansion of US radio astronomy in the late 1950s, it should be noted that the Soviet Union's early accomplishments in radio astronomy were a different case from both Britain and the United States. First, while it may have been true that early radio astronomy technology

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[71] Ryle, Martin, as cited by Sullivan III, Woodruff. *Cosmic Noise: A History of Early Radio Astronomy*. (Cambridge: Cambridge University Press, 2009), 440.
[72] Drake, Frank, *Is Anyone Out There?* (New York: Delacorte Press, 1992), 25.
[73] Sullivan III, Woodruff. *Cosmic Noise: A History of Early Radio Astronomy*. (Cambridge: Cambridge University Press, 2009), 441.

in the US and Europe was of military origin, the transition from military use to scientific use first occurred largely in universities, when wartime radio operators returned to their civilian lives, bringing formerly military equipment with them. In the Soviet Union, on the other hand, the tools and equipment remained largely in military control. As we shall see later in this chapter, this had major implications for the ability of Soviet radio astronomy results to reach a global audience. And secondly, because there was no transition of radar equipment to civilian and scholarly facilities, the Soviet Union initially became much stronger in the theoretical study of radio astronomy, as opposed to observational. The Soviet emphasis on theory was a feature in both optical and radio astronomy, which perhaps explains why there was less resistance to integrating radio astronomical research at prominent institutions in the USSR, such as Pulkovo Observatory, Shternberg Astronomical Institute, and Lebedev Physical Institute. Early and prominent theorists such as I.S. Shklovsky, who will serve as a major figure of interest in this study, began publishing on radio astronomy topics shortly after the end of the War. From the perspective of the United States, the Soviet Union at this point was largely a closed and mysterious society. Due to the presence of what British Prime Minister Winston Churchill famously called the Iron Curtain, there began to grow a sense of anxiety in the US that the Soviet Union was making great advances in radio astronomy.

This begs a question: Why did the US care? As already noted, the US dominated research in other areas of astronomy and was already establishing its role as a leading scientific superpower. Furthermore, there were some major early accomplishments in US radio astronomy; US radio engineer Karl Jansky is credited with making the first deliberate observation of cosmic radio waves, and US radio enthusiast Grote Reber is credited with building the first parabolic radio telescope.[74] Why would there be so much anxiety about success in this newfound and previously disregarded subdiscipline? I argue there are two main reasons. The first concerns the scientific competition narrative

[74] Kellemann, Kenneth, Bouton, Ellen, and Brandt, Sierra. *Open Skies: The National Radio Astronomy Observatory and Its Impact on US Radio Astronomy*. (New York: Springer International Publishing, 2020), 1, 21.

that has already been well-studied by historians of science and the Cold War.[75] As part of its campaign to achieve global dominance, and to signal to 'unaligned' countries its technological superiority over the Soviet Union, the United States invested heavily in the sciences at the start of the Cold War period. Scientists were not hapless bystanders in this effort; many recognized the political atmosphere as being helpful to their scientific productivity.[76] It is therefore possible some astronomers exaggerated the deficiency of radio astronomy in the US and used the 'falling behind' narrative to extract more resources from the government.

The second reason for the sudden US investment in radio astronomy is what the rest of this chapter will be dedicated to. The start of the Cold War, the establishment of Jodrell Bank, and the launch of Sputnik in 1957 all demonstrated a dual use of radio astronomy facilities: in addition to their scientific capabilities, they could be used to gather intelligence, a technique that would become a defining feature of the "cold" warfare which would span the subsequent decades. Thus radio astronomy in the late 1950s transitioned from a quirky post-war science experiment with discarded military equipment to a titan in government-funded science. As we shall see later in this chapter and in the dissertation as a whole, the interconnected nature of radio astronomy and the military would have major implications for scientific communication and the development of CETI in both the US and USSR.

Two Country Roads[77]

In 1958, silence fell over the border between Virginia and West Virginia. The Federal Communications Commission (FCC) had established an area of about 13,000 square miles as the National Radio Quiet Zone (NRQZ). The NRQZ placed restrictions on radio broadcasting within the area and any existing broadcasting facilities had to operate at reduced power and with

[75] Wolfe, Audra. *Competing with Soviets: Science, Technology, and the State in Cold War America*. Baltimore: John Hopkins University Press, 2013.
[76] Wolfe, Audra. *Freedom's Laboratory: The Cold War Struggle for the Soul of Science*. Baltimore: Johns Hopkins University Press, 2018.
[77] A reference to John Denver's hit song, "Take Me Home, Country Roads" (1971), an homage to the state of West Virginia.

highly directional antennas, reducing overall radio noise.[78] The principal reason given for this large-scale federal intervention in the electromagnetic spectrum was the establishment of NRAO in Green Bank, West Virginia (Figure 2). The choice to site NRAO in Green Bank, a small, rural town deep in the heart of Appalachia, was a technical one; astronomers have long sited their telescopes in remote locations to produce the best observational results. For example, in optical astronomy observatories, light pollution is a primary consideration in choosing an observatory site. 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 and their bright lights. 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 if there is too much radio frequency interference (RFI). RFI (Figure 3) is caused by sources that create a disturbance by generating changing electrical currents that 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 human-made and natural sources, such as cellular networks, lightning, vehicle ignition systems, and radio towers. Green Bank was a good choice for the site of NRAO not only because its overall isolation decreased its exposure to RFI, but because it was situated in a valley in the Allegheny mountain range, which provided natural shielding from RFI in nearby cities. However, to further isolate the observatory from RFI, the FCC established the NRQZ to place strict restrictions on radio broadcasting in the area.

The NRQZ did not serve an exclusively scientific support function, however. In 1958, buried in the last sentence of the fourth line-item of the FCC's Docket No. 11745, amending the commission's rules and regulations to give interference protection to frequencies utilized for radio astronomy was this statement: "additional coordination would be undertaken by the commission with the Department of Navy at Washington, D.C. with respect to the Sugar Grove

[78] "West Virginia Code, Chapter 37A". Green Bank Observatory. https://www.gb.nrao.edu/~cniday/chapter-37a.html.

facility".[79] Although the FCC document goes into no further detail on the purpose of the Sugar Grove facility, and the National Reconnaissance Office still keeps many of the documents from the planning and development of facilities in Sugar Grove classified, it is today relatively well-known from other sources that soon after the establishment of NRAO, the Naval Research Lab began plans to build a 600 foot radio telescope for the purposes of gathering intelligence from the Soviet Union.[80]

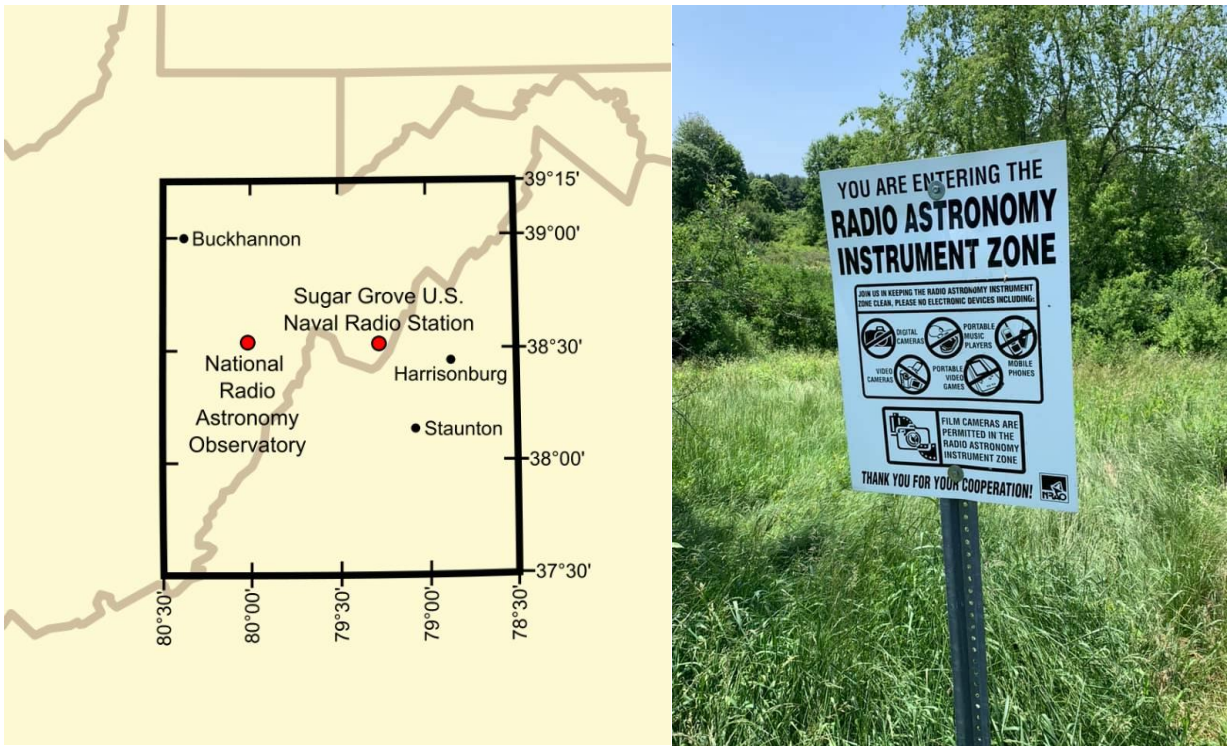

Figure 2. **Left**: The location of the United States National Radio Quiet Zone and major locations within it. Image by Joel Bradshaw.; **Right**: Photo by Rebecca Charbonneau (Green Bank Observatory April 2018). Signs such as these are found around the premises of the Green Bank Observatory, reminding scientists, visitors, and locals that technology that generates RFI is not permitted in the Radio Astronomy Instrument Zone, the most restrictive part of the NRQZ.

[79] "FCC Docket No. 11745" in National Radio Astronomy Observatory Archives, Records of NRAO, Directors Office, Series/Spectrum Management Unit/Box #1.
[80] van Keuren, D.K. "Cold War Science in Black and White: US Intelligence Gathering and Its Scientific Cover at the Naval Research Laboratory, 1948-62." *Social Studies of Science* 31, no. 2 (2001).

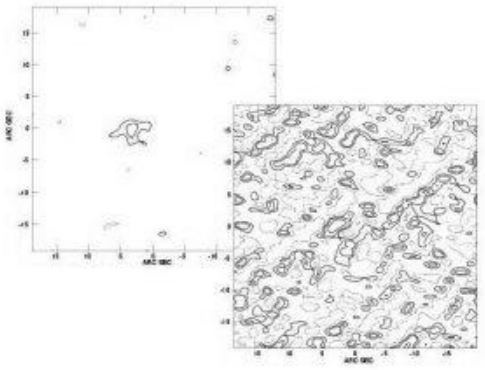

Figure 3. **Left:** Radio Frequency Interference. Photo by Rebecca Charbonneau (Green Bank Observatory, June 2018). This is a microwave used by the GBO staff in their lunchroom. The microwave is locked inside a special RFI-blocking box to prevent the microwaves from escaping and causing disruption to the nearby radio telescopes. The image is grainy and poor in quality because digital cameras are also not allowed on the premises—they too cause RFI and so a disposable film camera was used. **Right:** Image depicting RFI as seen on the Very Large Array (VLA) radio telescope. On the left is a VLA image of a star. On the right is the VLA's image of the same star when a satellite was passing within 25 degrees of the star's position on the sky. Image by G.B. Taylor, NRAO/AUI/NSF.

Therefore, while the US publicly promoted the scientific support function of the NRQZ, there was an undercurrent of military motivation. The brand of intelligence which the new facility at Sugar Grove was interested in conducting was known as signals intelligence. Signals intelligence (SIGINT) is the branch of intelligence gathering which concerns the interception, analysis, and exploitation of foreign communications through the medium of radio emissions. The US Marine Corps manual defines SIGINT as "intelligence gained by exploiting an adversary's use of the electromagnetic spectrum with the aim of gaining undetected first hand intelligence on the adversary's intentions, dispositions, capabilities, and limitations."[81] In the Cold War period, SIGINT was used to target both seemingly benign sources of information, to 'fill in the gaps' of life and activities in the mysterious USSR, as well as its military activities, such as ballistic missile testing, with the hopes of gaining an advantage in understanding (and therefore combating) Soviet weapons and war plans. The trouble with SIGINT, however, was that it was difficult to either ascertain meaning devoid of context, or to know if the source of the

[81] "US Marine Corps, Marine Corps Warfighting Publication (MCWP)." *Signals Intelligence* 2, no. 15 (1999): 1.

information was itself reliable. In an article on the history of signals intelligence and its applications, a CIA officer was quoted as having said "Electronic intercepts are great, but you don't know if you've got two idiots talking on the phone".[82] In other words, the success of SIGINT depended on the ability to understand the subtleties of communication to determine the veracity, reliability, and correct interpretation of the signal.

Despite this obvious potential for misinterpretation and miscommunication, a tremendous amount of governmental funds were sunk into SIGINT during the Cold War period. The authors of the aforementioned paper estimated that

> [the National Security Agency] and its predecessors… spent about $100 billion since 1945, 75 per cent of which was spent on SIGINT and the rest on communications security. More importantly, throughout the Cold War the US government spent four to five times as much money on SIGINT than they did on [traditional human intelligence] collection.[83]

On the Soviet side, it is estimated SIGINT comprised approximately 25% of the KGB's annual budget.[84] This meant the Cold War marked a significant shift from traditional warfare's use of human intelligence gathering to intelligence dependent primarily on technology and the interpretation of technological signals. There was a newfound interest in searching for signals from foreign civilizations.

Sugar Grove is a particularly strange case in the history of signals intelligence, in part because of the transitory period in which it was established. In the late 1950s, as the facility was being designed and constructed, the plan was to collect intelligence from the Soviet Union by searching for their signals which were reflected back to Earth from the surface of the Moon. The idea to use the Moon to capture artificial signals was not an entirely new one. In another case of military radio technology transitioning to scientific use, at the end of World War II, the Director of the US Army's Evans Signal Laboratory, Jack Dewitt, convinced the Army to take

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[82] Aid, M.M. and Cees, W. "Introduction on The Importance of Signals Intelligence in the Cold War", *Intelligence and National Security* 16, no. 1 (2001): 6.
[83] Ibid, 10.
[84] Ibid, 20.

advantage of its equipment no longer being in high demand to conduct an experiment. The experiment, named Project Diana, aimed to use military radar equipment to send a radio signal to the Moon. The signal would then bounce off it, and the team would measure its return, potentially paving the way for new modes of communication. In January 1946, the team succeeded. As one article put it, "the Project Diana team had [became] the first to send a signal into space and receive an answer back". [85]

Over a decade later, the Sugar Grove facility hoped to conduct a similar experiment. This time, however, it planned to build a 600 foot steerable telescope, the largest in existence at that time, to monitor Soviet radio signals which were unintentionally reflected off the surface of the Moon, as part of its SIGINT program. It is important to note here, that several astronomers, and in particular NRAO's former chief scientist Ken Kellermann, have expressed doubt to me that capturing Soviet Moon signals was the true objective of the Sugar Grove project.[86] It seemed strange to them that the US government would invest so much energy and money into a project of this scale that would only be functional for a fraction of the day, when the Moon was visible in both the Soviet and American skies at the same time. These suspicions may be correct—there are certainly examples from the historiography of the Cold War in which false stories were planted to obscure true ones; one of these cases will be addressed in the conclusion of this chapter. Yet I do not share the scepticism of the astronomers I spoke with about Sugar Grove. As we shall see, there were many examples of 'absurd', or even pseudo-scientific Cold-War era scientific projects funded or proposed by various governments. Both this chapter and the third chapter will address the intense anxiety and paranoia of the Cold War period—this atmosphere would lead to several scientific projects with rationales that were unclear to at least some (and sometimes a considerable portion) of the scientific community. Historian Audra Wolfe, for example, has charted how during the Cold War period, science and technology were often seen as offering "the best solutions to the nations problems, whether

[85] Oberhaus, David. "The Cold War Plan to Build Earth's Largest Telescope." *Supercluster*, 13 January 2020, https://www.supercluster.com/editorial/the-biggest-telescope-never-built.
[86] Interview with Kenneth I. Kellermann on 4 August 2020 in Charlottesville, Virginia, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.

those problems might involve infrastructure of foreign policy".[87] This resulted in hundreds of millions of dollars spent on high-tech interventions that, from a contemporary perspective, seem ridiculous. In her book *Competing with Soviets: Science, Technology, and the State in Cold War America* (2013), Wolfe gives the example of physicist Edward Teller's proposal of using nuclear explosives as a "convenient [tool] for mining operations, oil and gas exploration, and… earthmoving projects" as "a symbol of everything that was wrong with science and technology in the Cold War".[88]

Sugar Grove is perhaps another apt example of Cold War science gone wrong. The Naval Research Laboratory's plans for a 600 foot telescope never materialised. Due to poor planning and engineering, it was discovered the base of the telescope was insufficient to support the enormous parabolic dish. Many parts of the dish would have to be replaced with different materials, and part of the telescope redesigned altogether. Congress had already spent tens of millions on the project, but its redesign and reconstruction would cost even more, as well as lead to large delays in the eventual operation of the site. Finally, in 1962, the project was cancelled.[89] By 1962, the United States was becoming successful at regularly launching artificial satellites, some of which were capable of being used for reconnaissance purposes. A satellite would be able to collect signals from the Soviet Union from directly above the country in low Earth orbit; no need for waiting for brief windows of time when the Moon was overhead in both countries. The Naval Research Laboratory nonetheless continued to operate out of Sugar Grove, and the site was later purchased by the National Security Agency (NSA) for use as a listening post.[90]

Clearly, the establishment and maintenance of the NRQZ had a military motivation in its use for intelligence gathering, even though it was largely promoted as an action taken for the success of civilian science. Yet although the facility at Sugar Grove was explicitly military, both

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[87] Wolfe, Audra. *Competing with Soviets: Science, Technology, and the State in Cold War America* (Baltimore: John Hopkins University Press, 2013): 1.
[88] Ibid.
[89] van Keuren, D.K. "Cold War Science in Black and White: US Intelligence Gathering and Its Scientific Cover at the Naval Research Laboratory, 1948-62." *Social Studies of Science* 31, no. 2 (2001).
[90] Bamford, James. "The Agency That Could Be Big Brother." *The New York Times* (New York, NY), 25 December 2005.

the development of the National Radio Astronomy Observatory and the Sugar Grove facility should be understood as contributing to US military aims. That is because while NRAO was (and still is) a civilian organization, its foundation was part of the larger federal investment in science and the creation of scientific institutions as a response to the earlier Cold War. Additionally, while NRAO's main goal was conducting astronomical research, many of the tools and techniques developed by NRAO had military applications, and vice versa; military facilities sometimes benefited NRAO.

For example, the introduction to this dissertation described one of the earliest observations conducted at NRAO: Frank Drake's Project Ozma, which used NRAO's 85-1 telescope to search two nearby star systems for signs of extraterrestrial intelligence. The advent of radio astronomy and CETI science during the early Cold War is particularly interesting because of the use of its technology for spying on both the unknown intelligence of the cosmos and unknown intelligence here on Earth. Shortly after Drake arrived at NRAO, around the time he was planning and executing Project Ozma, he and the other scientists at NRAO were invited to visit the Naval Communication Station in Sugar Grove, which was still actively building the planned 600 foot telescope.[91] Later, in recollecting the experience in an editorial for the *SETI League* publication, Drake highlighted the mystery surrounding Sugar Grove, jokingly calling it "a major radio observatory almost no one has ever heard of!", run by the Navy even though, as Drake cheekily put it, "where is the ocean"?[92] After all, Sugar Grove is hundreds of miles inland, in the mountains. Drake did not describe the exact nature of the visit, or why NRAO scientists might have been invited, but described seeing "a bee hive of little rooms, all underground, protected from RFI by overhead imported charcoal and soil, with each room having a linguist with headphones on listening to conversations in far away Russian (sic)".[93] It is not difficult to speculate on why NRAO scientists might have been invited to visit the facilities. The 600 foot telescope project was underway and already facing challenges; it is possible NRAO's new radio

[91] Drake, Frank. "Quantifying Earth's Electromagnetic Leakage." The SETI League, Accessed 15 April 2021, http://www.setileague.org/editor/leakage.htm.
[92] Ibid.
[93] Ibid.

astronomers were asked for their expertise in telescope design, or some other aspect of collecting radio signals.

Drake's invitation to and fascination with Sugar Grove unveiled a growing link between the early days of military intelligence gathering and CETI. Drake wrote about Sugar Grove to the *SETI League* specifically because his visit many years prior had sparked an idea. CETI scientists were interested in gaining an understanding of what Earth's technosignature might look like; for example, its 'radio leakage', the signals from television, satellites, warfare, and any sort of radio-emission activity which might be detectable to an alien radio astronomer pointing their telescope at our planet from their own. Understanding Earth's technosignature could aid CETI scientists in figuring out what 'non-targeted' signals from other planets might look like (in other words, what to look for if not a direct and deliberately constructed message from another world to our own), and to understand how 'noisy' Earth might be to other civilizations who might be looking to say hello. If the facility at Sugar Grove was interested in 'Moon bounce' signals, they would have had to have an understanding of the radio noise atmosphere of the planet, and so Drake argued "there must be a huge collection of well-calibrated data on the radio signature of Earth as seen from interstellar distances".[94] Therefore, Drake argued, "maybe there is no need to design space missions to gather data about Earth's electromagnetic leakage. The data already exists somewhere in Sugar Grove".[95] Drake's comment, though speculative, demonstrates the overlap between the aims of CETI and SIGINT—both striving, during the Cold War period, to detect artificial signals in space, and in doing so, developing tools and techniques which benefited both communities. He was not the only person to find the 600 foot useful for CETI—the first scientific CETI paper, Morrison and Cocconi's "Searching for Interstellar Communications", proposed the use of the 600 foot telescope for the first CETI observations, given that it was designed for the purpose of seeking artificial extraterrestrial signals.[96] In the next section, I will show how this intersection between radio astronomy

[94] Ibid.
[95] Ibid.
[96] Morrison, Philip and Cocconi, Giuseppe. "Searching for Interstellar Communication." *Nature* 184, no. 4690 (1959): 845.

(including CETI) and military infrastructure created difficult and paranoid interactions between Western and Soviet scientists, hindering interterrestrial scientific communication.

Death by Telescope?

After the War, Sir Bernard Lovell's fascination with using military radar to make atmospheric and astronomical observations led to a desire to build better equipment—after all, the ex-military tools he had been using had not been designed with exclusively scientific pursuits in mind. He initially had a 66 metre parabolic dish built out of wire, which Robert Hanbury Brown, another British radar-technician-turned-scientist, would use to discover radio waves emanating from the Andromeda Galaxy.[97] But because the 66 metre telescope's dish was fixed, meaning it could only face upwards and was not steerable, it relied on the rotation of the Earth to view new astronomical objects and was therefore limited in the observations it could conduct. Lovell next began planning the construction of a 76 metre steerable dish, funded by the University of Manchester and the UK government. Unfortunately, Lovell's ambition led the initially £259,000 telescope budget to run approximately £381,000 over budget, leaving the university and government to cover the costs.[98] Shortly before the completion of the telescope in 1956, this project mismanagement led Lovell to face an inquiry from the Public Accounts Committee, which might have resulted in his imprisonment.[99] Fortunately for Lovell, however, in the year after his inquiry the Soviet Union launched Sputnik, the world's first artificial satellite.[100]

Because of its status as a closed nation, there was initially great scepticism from the US and European countries about Soviet claims of its technological accomplishments, a recurrent theme in Cold War sciences. Sputnik itself could by tracked by conventional radio receivers and even amateur radio enthusiast keen on hearing its signature "beep-beep", but these tools were unable to successfully track the staged rocket which launched the satellite. Tracking the rocket was of utmost important to the Western world—after all, a rocket capable of launching objects

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[97] Smith, F., Davies, R. & Lyne, A. "Bernard Lovell (1913–2012)." *Nature* 488, no. 592 (2012).
[98] Ibid.
[99] Ibid.
[100] For more on the construction of the Mark I telescope and the conflicting agendas of Cold War science, see: Agar, Jon. "Making a Meal of the Big Dish: The Construction of the Jodrell Bank Mark I Radio Telescope as a Stable Edifice, 1946-57." *British Journal for the History of Science* 27, no. 1 (1994): 3-21.

into orbit is essentially an intercontinental ballistic missile. At the start of the Cold War's weapons race, it was crucial to state security to have rocket tracking capabilities.

To make matters even more difficult, Lovell was informed by the British Ministry of Supply that there was "no other radar facility in the West able to track the satellite's upper stage rocket", meaning Jodrell Bank was the only facility which would be capable of monitoring this new Soviet technological feat.[101] On orders from the British government, Lovell's newly-built telescope tracked the Soviet rocket as it began its slow descent into the atmosphere, helping Western nations understand what the Soviets had accomplished. The Mark I telescope was featured in headlines all over the world and Jodrell Bank became an instant point of pride for the British. This event marked the start of what would become an important source of Cold War intelligence—space surveillance.

Unfortunately, the Earth rotates. Because of this, as Lovell tracked the satellite's rocket, he reported to the *New York Times* there would be moments it would "not be visible in [the British skies]", and therefore asked the US to "take up the watch."[102] His request revealed an important theme in the history of radio astronomy: because of the nature of the Earth's rotation, continuous observation of an extraterrestrial source with ground-based telescopes is impossible without international cooperation. This fact will become important in understanding the unique internationalism of radio astronomy. However, in 1957, few facilities were able to successfully conduct radio telemetry, particularly in the US, which had only just begun its late entry into radio astronomy. At the time, the US Smithsonian Astrophysical Observatory (SAO) was only able to conduct optical tracking. The *New York Times* noted:

> No US Confirmation: No United States sources were able to confirm the reported speed-up in the circuit of the satellite rocket around the earth. The Smithsonian Astrophysical Observatory in Cambridge, Mass., which is in charge of visual satellite tracking in this country, confirmed receiving the report from Britain".[103]

[101] Phelan, Dominic. "Sir Bernard Lovell and the Soviets." *Spaceflight* 56 (2014): 336.
[102] "Rocket Reported Falling Rapidly: British Astronomer Asserts First." *The New York Times*, 23 November 1957.
[103] Ibid.

Importantly, it was not only the Americans who were unable to keep track of Sputnik's rocket. Leaders in Moscow reached out to Lovell a couple of weeks after the launch, asking him to repeat the tracking to locate the rocket because they too had lost track of it—at the time, the Soviets also did not have the appropriate radio telescope tracking facilities. Because of his verification and promotion of Soviet success to the Western world and aid with spacecraft tracking, Lovell became a figure of great renown in the Soviet Union. A few months after Sputnik's launch, he received a friendly New Year's telegram from the Soviets*, and they later sent him subsequent telegrams listing radio frequencies and predicted impact times for their future space missions, including Luna 1 in 1959. The Soviet Space Program began to view Lovell as an "unofficial 'record keeper'" to verify their accomplishments to the US and Europe, which were, as noted earlier, otherwise sceptical of Soviet achievements.[104]

Lovell's success at radio space tracking initiated Jodrell Bank's role in conducting secret military operations, which included serving as part of the British ballistic missile defence system.[105] This often meant collaborating with defence operations in the United States. For example, the US approached Lovell in 1958, claiming they had "successfully tested their first intercontinental missile… but had no means of tracking it". [106] They requested Jodrell Bank assist in this tracking, and Lovell complied. This set precedence for future military involvement between the US and Jodrell Bank, as will be further addressed at the end of this chapter. Jodrell Bank was put in a strange position—for several years of the early Space Race and Cold War period, Jodrell Bank became the de facto space tracking facility for both Soviet and American missile launches and space missions, since neither had yet developed the ability to track their respective payloads.[107]

* The celebration of the New Year was important in the Soviet Union, and the exchange of New Year's cards, like the exchange of Christmas cards in the US or UK, was a symbol of good wishes and friendliness. During my archival research I spotted several New Years greetings cards from Soviet scientists to their friends and colleagues in the West.

[104] Phelan, Dominic. "Sir Bernard Lovell and the Soviets." *Spaceflight* 56 (2014): 336.

[105] Graham-Smith, Sir Francis and Lovell, Sir Bernard. "Diversions of a Radio Telescope." *Notes and Records of the Royal Society* 62 (2008): 200.

[106] Ibid, 199.

[107] Ibid, 199.

In part due to his popular reputation in the Soviet Union, in 1963 Lovell was invited to visit Moscow to give lectures, as well as to visit the Soviet's new radio facilities in Crimea. In a book he published five years after the trip, *The Story of Jodrell Bank* (1968), Lovell blithely described the visit and background leading up to it in some detail, including the use of Jodrell Bank in aiding Soviet space tracking. Many years later, however, a collection of Lovell's notes, diaries, and other writings was donated to the University of Manchester's John Rylands Archive and released upon Lovell's death in 2012. In his memorandum for the 1963 file, Lovell began forebodingly: "in retrospect I should not have accepted that invitation to visit the USSR from the Academy of Sciences in the summer of 1963 and furthermore the Joint Intelligence Bureau in London should have advised me not to visit Moscow."[108] The jarring disconnect between Lovell's largely positive description in his 1968 book versus his post-mortem memoranda highlights how radio astronomy facilities played dual roles in both science and diplomacy.

Lovell's trip to Crimea included a visit to the recently completed Yevpatoria facilities. This chapter has thus far established a strong connection between the development of radio astronomy facilities and the military—from the radar origins of much radio astronomy equipment, to the potential for military application of radio astronomy techniques and expertise in intelligence gathering and telemetry. There is perhaps no more illustrative an example of the intersections of radio astronomy and warfare than the Yevpatoria Pluton Deep Space Tracking Station's ADU-1000 South Station transmitting array, built in 1961. The telescope array (Figure 4) had dishes welded onto the hulls of decommissioned World War II submarines and bridge trusses, and the array was steerable thanks to being mounted on turrets from former battleship guns.[109] It quite literally embodied the relationship between the military and astronomy. Lovell was likely the first Westerner to ever visit the complex which, as we shall see later in this chapter, became a point of obsession for US and British Intelligence operations.

[108] University of Manchester, John Rylands Archive, Memorandum by Sir Bernard Lovell on the Files Covering Contact with Soviet Scientists and Visits to the Soviet Union, 1963 File.
[109] Phelan, Dominic. "Sir Bernard Lovell and the Soviets." *Spaceflight* 56 (2014): 337.

Figure 4. Telescope array at Yevpatoria. Photo by Rumlin, https://commons.wikimedia.org/wiki/File:ADU-1000_GAZ-51.jpg.

According to his memorandum and diary, Lovell's trip was superficially cordial and pleasant, but there existed an undercurrent of tension and paranoia. At one point, Lovell recounted being approached during a party by a man he did not know. Lovell wrote:

> We moved in the darkness from the blazing light. 'What do you want?', I asked this man whom I have never seen before. 'I must ask you to take immediate action to arrange for Professor Shklovsky to leave the country because he is in great danger' – 'I have no power to do this' – 'Not so, your authority is greatly respected in this Country and I must ask you immediately to return to England to ask the Vice

> Chancellor of your University to write to the President of the University of Moscow to extend a pressing invitation to Shklovsky to visit your Observatory'.[110]

In his memorandum, Lovell noted that he was familiar with Shklovsky, a figure who will become a major point of focus in this dissertation.

In 1963, Iosif Samuelovich Shklovsky was a professor of astrophysics at Moscow State University's Shternberg Astronomical Institute and was at that time attaining fame both within and outside the Soviet Union as a foundational figure in the newly burgeoning field of radio astronomy. Before that, he had trained as physicist at Moscow State University in the late 1930s, before being sent to Ashkhabad during the War.[111] After the War, Shklovsky returned to Moscow, where he led the Soviet effort in the development of post-War astronomy. He published his first radio astronomy paper, "Emission of Radio-Waves by the Galaxy and the Sun", in 1947.[112] According to the obituary written by his colleagues, by 1952, Shklovsky "gave the world's first series of [university] lectures entitled 'Radio Astronomy'" and quickly became the leader of a radio astronomy group at Shternberg, which was a division of the University.[113] As will be discussed in Chapter Three, Shklovsky later became a key figure in the Soviet Space Program, and in 1967 founded the AstroSpace Centre at the Soviet Academy of Sciences Lebedev Physical Institute. Shklovsky had a reputation for ideas and theories which were sometimes ground-breaking, and other times absurd. Of this contradiction in genius, one colleague wrote: "Fifty percent of Shklovsky's ideas are brilliant, but no one can tell which fifty percent they are."[114] To give an example of one of his impressive ideas, after the publication of Henrik van de Hulst's theoretical paper predicting hydrogen emission, Shklovsky independently calculated the intensity of the 21cm hydrogen line—a breakthrough achievement for observational radio astronomy which will also be discussed in further detail in Chapter Three.

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[110] University of Manchester, John Rylands Archive, Memorandum by Sir Bernard Lovell on the Files Covering Contact with Soviet Scientists and Visits to the Soviet Union, 1963 File.
[111] Kardashev, N.S. and Marochnik, L.S. "The Shklovsky Phenomenon." *Astronomical and Astrophysical Transactions* 30, no. 2 (2017): 119.
[112] Shklovsky, I.S. "Emission of Radio-Waves By the Galaxy and the Sun." *Nature* 159, no. 752-3 (1947).
[113] Kardashev, N.S. and Marochnik, L.S. "The Shklovsky Phenomenon." *Astronomical and Astrophysical Transactions* 30, no. 2 (2017): 120.
[114] Friedman, Herbert. "Introduction" in Shklovsky, I.S. *Five Billion Vodka Bottles to the Moon* (New York: W.W. Norton & Co Inc, 1991): 29.

To give an example of a perhaps-lesser idea, Shklovsky repeatedly published theories that one of Mars's moons, Phobos, was an artificial and hollow satellite placed in Martian orbit by extraterrestrials.[115] This latter example illuminates another facet of Shklovsky's personality which will be further explored in subsequent sections—his interest in CETI.

After the publication of the Morrison and Cocconi paper in 1959, which proposed the use of the 21cm hydrogen line that Shklovsky had a role in calculating for the purpose of communicating with extraterrestrial intelligence, Shklovsky had begun to harbour an intense interest in the subject and supported his students in pursuing CETI projects. According to his diary, Lovell's relationship with Shklovsky at this point largely consisted of "conversations about the problems then facing astronomy about the nature of the distant radio emitting objects in the Universe", which would later be identified as 'quasars'.[116] As we shall see in the next section, at that time in the Soviet Union those objects were considered candidates for CETI searches, though it is unlikely Lovell knew this at that time.[117] Despite his familiarity with Shklovsky and his interests, however, Lovell recorded in his memorandum that he did not know why Shklovsky's life might be threatened.

The interaction with the unknown figure who pleaded for help saving Shklovsky's life clearly impacted Lovell's state of mind, and as the trip wore on, he grew paranoid. At the end of his visit, the President of the Soviet Academy of Sciences, Mstislav Keldysh, told Lovell he knew about his efforts to build a larger telescope at Jodrell Bank and inquired about the cost. When Lovell remarked it would be a challenge to obtain the £4 million required, Lovell recorded that Keldysh proposed: "but that is only a very small sum in my budget. We would be very glad if you would stay in Russia and we will build the telescope for you'".[118] This offer was a clear indication of the level of respect afford to Lovell by the Soviet Union, and perhaps also an attempt to appropriate talent from US access, since the US also considered Lovell and his telescopes valuable for conducting telemetry.

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[115] Sagan, Carl and Shklovsky, I.S. *Intelligent Life in the Universe* (San Francisco: Holden-Day, 1966), 362.
[116] University of Manchester, John Rylands Archive, Memorandum by Sir Bernard Lovell on the Files Covering Contact with Soviet Scientists and Visits to the Soviet Union, 1963 File.
[117] Ibid.
[118] Ibid.

Lovell refused and returned to England. In his memorandum, Lovell revealed that he became "mysteriously ill" shortly after his return and though he did not expand on his symptoms, he noted that the "intelligence agents" thought that the Soviets had used "some means (probably radiation)", perhaps from the radar beam of the telescope, to brainwash him or erase his memories of Yevpatoria.[119] The reason for doing so? Lovell speculated that the Soviet Academy had expected that he would accept their offer to build him a telescope and relocate to the USSR, and upon failing, attempted to prevent Lovell from returning to the West and sharing news about their new radio facilities in Yevpatoria.[120]

Lovell's assertion of assassination or brainwash by telescope was a bold claim, and the Rylands Archive snidely noted in its special collections blog that "already the diary has attracted a lot of interest from the media, who never allow the absence of hard facts to get in the way of a good story".[121] Lovell's claims certainly sound like a tag-line from a Cold War science fiction film: did the Soviets attempt to irradiate Sir Bernard Lovell's brain using their radar beam? To give his claim due diligence, it is certainly *possible*, and the World Health Organization has information on the detrimental effects of radar to the human body.[122] I believe, however, that an attempted brainwash-by-telescope was highly unlikely. Instead, I would argue that this recounted episode is emblematic of a larger trend in Anglo-American relations with the Soviet Union: fear of the technologically advanced unknown. Since the USSR was a closed society, there was much speculation on what technologies they might have developed, and for what purposes. As many science and speculative fiction scholars have noted, 1950s and 1960s literature and film often represented Cold War anxieties about technology and domination by foreign civilizations, reflected in depictions of invasions from ray-gun-armed alien monsters and mind-control weapons.[123] In the introduction, I opened with the recognition that science fiction during the Cold War period was an ideal medium through which to identify particular scientific-

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[119] Ibid.
[120] Ibid.
[121] Hodgson, John. "Sir Bernard Lovell (1913-2012)." John Rylands Blog, 24 September 2012. https://rylandscollections.com/2012/09/24/sir-bernard-lovell-1913-2012/
[122] "Radiation: Radar." World Health Organization. Accessed 3 March 2021. https://www.who.int/news-room/q-a-detail/radiation-radar.
[123] Bryan E. Vizzini. "Cold War Fears, Cold War Passions: Conservatives and Liberals Square Off in 1950s Science Fiction." *Quarterly Review of Film and Video* 26, no. 1 (2008): 28-39.

technical fears and concerns, and this includes brainwashing fears. One classic example comes from the film *The Manchurian Candidate* (1962), starring Frank Sinatra and Laurence Harvey, who plays a US soldier returned from the Korean War having been brainwashed by Communists into becoming a "sleeper agent" who assassinates targets unwittingly, through Communist control.[124]

Yet it was not only science fiction which revealed these fears; paranoid speculation on Soviet technological capabilities infiltrated even the upper echelons of Western governments; their simultaneous development meant government activities fuelled science fiction, and science fiction similarly influenced governments. For example, FBI director J. Edgar Hoover's book *Masters of Deceit: The Story of Communism in America and How to Fight It* (1958) warned of mind control by Communists. In his book, Hoover dramatically cautioned that "many well-meaning citizens, attracted by these words and not seeing behind the communist intentions, have been swept into the communist thought-control net".[125] This line of thinking was not uncommon during the Cold War period; historian of Cold War science Audra Wolfe has unpacked the history of psychological warfare during this period, noting that the Cold War was fought just as much in cultural, informational, and psychological campaigns as it was in military and technological battlegrounds.[126] Of course, Hoover's thought-control net and Wolfe's writing on psychological warfare refer to psychological tactics at mind-control, not quite comparable to the high-tech attempt conjured by Lovell. Fear of possible mind-control/erasure weapons, however, did lead the CIA to test other high-tech psychological interventions themselves, culminating in projects such as "MKUltra", which was operated by the Office of Scientific Intelligence of the CIA, along with the United States Army Biological Warfare Laboratories, from 1953 to 1973.[127] MKUltra studied, among other things, the effects of certain drugs, including LSD, on memory, coercion, and hypnosis. As already stated, it is unlikely Lovell

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[124] Frankenheimer, John. The Manchurian Candidate. 24 October 1962, Santa Monica: M.C. Productions.

[125] Hoover, J. Edgar. *Masters of Deceit: The Story of Communism in America and How to Fight It* (New York: Holt, 1958), 93.

[126] Wolfe, Audra. *Freedom's Laboratory: The Cold War Struggle for the Soul of Science*. Baltimore: Johns Hopkins University Press, 2018.

[127] History.com Editors. "MK-Ultra." *History*, 16 June 2017. https://www.history.com/topics/us-government/history-of-mk-ultra.

was truly the target of brainwashing by telescope radiation. Rather, his fear and the concerns of British Intelligence were representative of a culture of paranoia regarding technology and the unknown alien civilization of the Soviet Union. And this is where we turn our attention back to CETI, where the focus will largely remain for the rest of the dissertation. Understandably, after 1963, the relationship between the Soviet Union and Lovell cooled. The USSR had finally developed their own radar and radio astronomy facilities and were therefore less dependent on Jodrell Bank, and Lovell in turn began a decades-long pursuit of Soviet radio intelligence.

Lighthouse in the Sky

This chapter has thus far demonstrated several ways in which the early history of radio astronomy was deeply entangled with the military. In particular, it has been made clear that radio astronomy during the Cold War period developed in tangent with the new field of signals intelligence, leading to a tense atmosphere of fear and paranoia between scientists in both the US and USSR. These military ties hindered the flow of information between scientists during this period, exacerbating challenges in communication, often to the detriment of scientific efficiency. The tensions between radio astronomy's role in both international collaboration and the military becomes most evident when exploring the history of attribution of discovery in radio astronomy. As noted in the introduction, internationalism and the universality of scientific priorities is a prominent ideology in radio astronomy, and this mentality certainly promoted and facilitated international collaboration even during geopolitically contentious periods. That said, as one delves into the history, it becomes clear that this closely held ideology did not work as well in practice as in theory, with national and military motivations interfering with scientific goals and achievements. Although the aim of this chapter thus far has been to establish how radio astronomy and CETI developed out of and alongside military and intelligence communities, I will now shift the argument slightly to show how the entanglement of radio astronomy and the military often resulted in hindered communication between scientists in the respective countries who, ideally, would cooperate to achieve their science goals. This often led to misattribution of discovery and, as we shall see later in the chapter, international embarrassment.

In his introduction to the English edition of *A Brief History of Radio Astronomy in the USSR*, for example, NRAO astronomer Kenneth Kellermann noted that there were several instances in which Soviets would make a discovery before the rest of the world, but due to communication barriers, Western scientists would often receive credit for making the same discovery at a later date. Miscommunication leading to misattribution can been seen in the case of the discovery of radio recombination lines, which Soviet astronomers at Pulkovo Observatory and Lebedev Physical Institute discovered as early as 1963 or 1964.[128] Due to the lack of clear and consistent communication across borders, however, credit is usually assigned to Bertil Hoglund and Peter Mezger, who reported their own independent discovery in 1965, using observations made at NRAO.[129] In addition, while radio astronomy observatories in the US and most other Western countries were civilian organizations (despite at least some relationship with the military), Soviet radio astronomy facilities were explicitly tied to the military, and therefore many of their publications were heavily redacted or censored, making it difficult for Western scientists to easily verify their scientific validity.[130]

This communication barrier presented a challenge to astronomers because of an inconvenient truth touched upon in the previous section when I described Lovell's desire to have the Americans pick up the tracking of Sputnik's rocket: The Earth rotates. Astronomers who do not possess omnipresence must rely on their colleagues to observe sources when they leave their own field of view if they wish to have continual observation or verification of their observations. It is for that precise reason that astronomical telegrams were established, because when something new was discovered in the sky, that did not mean it would necessarily stick around for long, necessitating quick verification from other observatories, or prolonged observation. Transient astronomical events included a variety of phenomena, such as comets or outbursts from a star. To solve the problem of world-wide communication between astronomers, the Central Bureau for Astronomical Telegrams (CBAT) was founded in 1882, as a direct result of the "crisis" of communication during the Great Comet of 1882, during which

[128] Kellermann, Kenneth. "Preface to the English Edition." in Braude, S.Y. et al. *A Brief History of Radio Astronomy in the USSR (*New York: Springer, 2012), 40.
[129] Ibid, vi.
[130] Ibid, v.

time astronomers tracking the comet realised their informal astronomical news transmission systems were "thoroughly inadequate".[131] In the early 20th century, the International Astronomical Union (IAU) designated that CBAT would be its official telegram bureau and created a commission to oversee its management.[132] A 1968 article in *Physics Today* boasted that over 600 astronomers subscribed to CBAT telegrams, as well as over 100 observatories.[133] In addition to facilitating communication and collaboration between astronomers at great distances, CBAT filled another purpose: allowing astronomers to claim discoveries as their own to the international astronomical community. Comets, for example, are often named after the person who first discovers them. Therefore, if an astronomer was to observe a new comet and quickly send out a telegram to CBAT, they might have a good chance of earning credit as the first discoverer, resulting in the comet being named in their honour.[134] Additionally, astronomers would report their findings so that they could be verified by other astronomers, securing their discovery as a legitimate one. Telegrams often included coordinates, date and time of initial observation, and other such useful information. Sometimes they were very short, with just a few lines of data, and other times included information and citations to contextualise the discovery. CBAT set precedence for this type of communication system, and over the course of the 20th century, more circulars and bulletins were created. By the start of the Cold War period, the IAU "Astronomical Telegram" had become a common form of communication between astronomers around the world during the Cold War period.

Despite these efforts to promote ease of communication between astronomers around the world, however, radio astronomy's ties to the military, especially in the USSR, presented challenges to the efficacy and transparency of this communication system. One such example of this conflict would be the case of the first reported observation of intrinsic, periodic, extragalactic radio variability. Variable stars are stars which have brightness that fluctuates when viewed from Earth, meaning they may appear to 'blink', fade, or grow brighter over time. This might happen, for example, if a star is surrounded by a disc of dust, which blocks some of

[131] Gingerich, Owen. "The Central Bureau for Astronomical Telegrams." *Physics Today* 21, no. 12 (1968): 37.
[132] Ibid, 37.
[133] Ibid, 40.
[134] Ibid, 39.

the light coming from the star, altering its apparent brightness. *Intrinsically* variable sources change not because they are obscured by dust or an orbiting object, but because of changes in the physical properties of the star. This happens in certain circumstances, such as when stars give off flares and mass ejections, or when a star expands or contracts in its evolutionary lifecycle. By the mid-20th century, there were many observations of optically variable sources—in 1961, the IAU even dedicated an entire astronomical telegram bulletin to which astronomers could send their data on new variable stars, the *Information Bulletin on Variable Stars*. Within radio astronomy, however, it was thought that radio sources which were strong enough to be observed by the low-sensitivity instruments of the mid-20th century only existed at great scales and distances. As noted earlier, many optical astronomers considered the radio universe to be far less interesting than the optical; it was not even certain if intrinsic, periodic, variable radio sources existed at all, and if they did, whether they could be observed on human time scales. By the early 1960s, the only variable radio source which had been observed was Cassiopeia A, the remnant of a massive supernova, which slowly faded over time—far less exciting than the periodically variable sources which could be found in the optical wavelengths.[135] As a result, observing radio variability during a human lifespan was regarded by some as impossible.

In August 1964, however, a Soviet graduate student named Gennadii Sholomitskii began to use the deep space tracking antenna in Yevpatoria to observe a source called CTA-102.[136] As a result of this observation, Sholomitskii claimed to have discovered radio variability in the source "at 30 cm wavelength with a period of about 100 days".[137] To put that discovery in context, astronomers would have been stunned at a discovery which varied over a period of years, let alone days. Ergo, Sholomitskii's discovery had the potential to make a great impact on the field, transforming astronomer's understanding of the radio universe. In 1965, he announced his discovery through a telegram submitted to the *Information Bulletin on Variable*

[135] Kellermann, Kenneth, and Pauliny-Toth, I.I.K. "Variable Radio Sources." *Annual Review of Astronomy and Astrophysics* 6 (1968): 417.
[136] Sholomitskii, G. B. "Variability of the Radio Source CTA-102." *Information Bulletin on Variable Stars*, no. 83 (1965).
[137] Kellermann, Kenneth. "Preface to the English Edition." in Braude, S.Y. et al. *A Brief History of Radio Astronomy in the USSR (*New York: Springer, 2012): vii.

Stars, which quickly gained attention from astronomers in the West.[138] He also published a more detailed article on his discovery in the Soviet *Астрономический журнал* [*Journal of Astronomy*], which during the 1960s was translated and republished in the US as *Soviet Astronomy*. Soviets excited by the discovery called the strange blinking source the "lighthouse in the sky".[139]

Given the secret nature of the facilities at Yevpatoria, which as mentioned earlier were also used by the USSR for deep space tracking, many of the details of Sholomitskii's observation were left out of the publication for security reasons, making it difficult for scientists in the West to verify his claimed results.[140] Sholomitskii's telegram was upheld as an example of why Soviet science was untrustworthy, further cementing a culture of distrust between scientists on either side of the Iron Curtain. In fact, the aforementioned American astronomer, Ken Kellermann, was one of those who initially doubted the claims Sholomitskii had made. In a 1968 paper titled "Variable Radio Sources", Kellermann stated that although the "implications of Sholomitskii's discovery were clearly very great", there were many theoretical problems with his discovery.[141] Additionally, no observations of this variability had been made by Western astronomers, despite the fact that CTA-102 was a relatively well-known object.[142] He argued that due to the secretive nature of Soviet observing facilities, "little is known about the antenna or radiometer system used by Sholomitskii" and as a result, "his results have generally not been accepted" by astronomers in the United States.[143] Clearly, radio astronomy's connections with military applications prevented clear and open communication between scientists. It was not until radio variability became generally accepted several years later, due to observations of other sources by Western scientists, that it was confirmed CTA-102 does indeed vary at the scales reported by

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[138] Sholomitskii, G. B. "Variability of the Radio Source CTA-102." *Information Bulletin on Variable Stars*, no. 83 (1965).
[139] *TASS* telegram written by Alexander Midler, 12 April 1965, Records of the Telegraph Agency of the Soviet Union (*TASS*), Centre for Preservation of a Reserve Record, Ialutorovsk, Siberia, Russia. Scans courtesy of Leonid Gurvits (in Russian).
[140] Kellermann, Kenneth, and Pauliny-Toth, I.I.K. "Variable Radio Sources." *Annual Review of Astronomy and Astrophysics* 6 (1968): 421.
[141] Ibid.
[142] Ibid, 420.
[143] Kellermann, Kenneth and Pauliny-Toth, I.I.K. "Variable Radio Sources." *Annual Review of Astronomy and Astrophysics* 6 (1968): 421.

Sholomitskii.[144] By that point, however, the study of radio variability was firmly established within the field, and Sholomitskii had left radio astronomy for infrared astronomy.[145] The situation with CTA-102 highlights the barriers to communication between Soviet and American astronomers during the Cold War, causing frustration to scientists, especially those who did not receive credit for their discoveries due to their limited ability to communicate their full results.

Of course, Sholomitskii's observations are but one of dozens of cases like these that occurred during the Cold War period. What makes this one significant to this dissertation, however, is it demonstrates not only the connection between radio astronomy and the military, but also the connection between CETI and interterrestrial crises of communication. Earlier in this chapter I referenced CTA-102, not by name, but in discussion of Bernard Lovell's relationships with Soviet scientists. I referred to conversations between Lovell and Shklovsky in the early 1960s, in which they discussed "problems then facing astronomy about the nature of the distant radio emitting objects in the Universe".[146] Shklovsky was Sholomitskii's professor, and it was he who had instructed Sholomitskii to observe CTA-102, because it was one of those newly discovered objects, and initially, no one was quite sure what they were.[147] The tentative label these objects were given was "quasi-stellar", or "quasar", because they displayed strong luminosity, like a nearby star, but had other confusing properties that made it difficult to ascertain whether or not they were small and inside our galaxy, or large and terribly far away.[148] The first identification of these objects came in 1960, from the California Institute of Technology's (CalTech) Owens Valley Radio Observatory. The initial aim of the observation which discovered these objects had been to observe faint radio sources, likely in the form of distant galaxies. It seemed unlikely, however, that the resulting sources were extragalactic, due

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[144] Kellermann, Kenneth. "Preface to the English Edition." in Braude, S.Y. et al. *A Brief History of Radio Astronomy in the USSR (*New York: Springer, 2012): viii.

[145] Thronson, H.A., Hawarden, T.G., Davies, J.K., Penny, A.J., Orlowska, A., Sholomitskii, G., Saraceno, P., Vigroux, L., and Thompson, D. "The Edison International Space Observatory and the Future of Infrared Space Astronomy." *Advances in Space Research* 18, no. 11 (1996): 171-83.

[146] University of Manchester, John Rylands Archive, Memorandum by Sir Bernard Lovell on the Files Covering Contact with Soviet Scientists and Visits to the Soviet Union, 1963 File.

[147] Kellermann, Kenneth "The Discovery of Quasars and its Aftermath", *Journal of Astronomical History and Heritage* 17, no. 3 (2014).

[148] Heidmann, Jean. "SETI False Alerts as 'Laboratory' Tests for an International Protocol Formulation." *Acta Astronautica* 21, no. 2 (1990): 74.

to their "unrealistically-high" luminosity.[149] But in 1963, just a year before Sholomitskii's observations of CTA-102 began, CalTech's Maarten Schmidt realised that one of these so-called quasi-stellar objects, 3C 273, had an enormous redshift of 0.16.[150] With further confirmation, this would come to mean that the sources in question were not star-like objects within our galaxy, but some of the brightest and most distant objects in our universe, a discovery with important implications for radio astronomy. Yet, as we shall see, Schmidt's observations were not easily communicated to the USSR, leading to speculation in the USSR that the source was a sign of extraterrestrial intelligence. In the next section, I will show how the discovery of variability in CTA-102 led to one of the earliest 'false alarms' in the history of the search for extraterrestrial intelligence. I will also argue that while the reputation of Soviet CETI was harmed by its use of military facilities, the discovery of variability in CTA-102 also led to the development of important radio astronomy techniques and facilitated international cooperation during the Cold War period.

A Friendly Civilization

There has been little historical research into the development of CETI in the USSR. The most comprehensive study of Soviet CETI/SETI to date is a paper published by two former-Soviet astronomers, Leonid Gurvits and Lev Gindilis, titled "SETI in Russia, USSR and the post-Soviet Space: A Century of Research".[151] The article, written in the style of an astronomical review paper, charts the major CETI, SETI, and technosignature projects from the turn of the century to the present day. Gurvits and Gindilis credit a journal article from another former student of Shklovsky, Nikolai Kardashev, as having "set the stage for [CETI] studies in the USSR".[152] This paper was titled "The Communication of Information by Civilizations On Other Worlds" and

[149] Kellermann, Kenneth "The Discovery of Quasars and its Aftermath", *Journal of Astronomical History and Heritage* 17, no. 3 (2014): 267.
[150] Ibid, 267.
[151] Gindilis, L.M. and Gurvits, L.I. "SETI in Russia, USSR, and the Post-Soviet Space: A Century of Research." *Acta Astronautica* 162 (2019).
[152] Gindilis, L.M. and Gurvits, L.I. "SETI in Russia, USSR, and the Post-Soviet Space: A Century of Research." *Acta Astronautica* 162 (2019): 6.

published in *Astronomicheskii Zhurnal [Journal of Astronomy]* in 1964.[153] Kardashev was then a young scientist working at the Shternberg Astronomical Institute in Moscow, in a research group under the leadership of Shklovsky. In his seminal paper, Kardashev was preoccupied with the idea of how to identify an artificial extraterrestrial source, should one be detected. He began by attempting to identify which wavelength range would be most suitable for interstellar communication. He did so by calculating the noise spectrum of our Milky Way Galaxy and found a deep minimum at the decimetre and centimetre wavelengths (Figure 5, left). This was significant because a search conducted in the minimum meant the observer would get a greater signal to noise ratio for any faint signals. A similar approach was taken by Drake during Project Ozma and CETI scientists would continue to debate which wavelengths were ideal for searching for extraterrestrial signals (Figure 5, right).

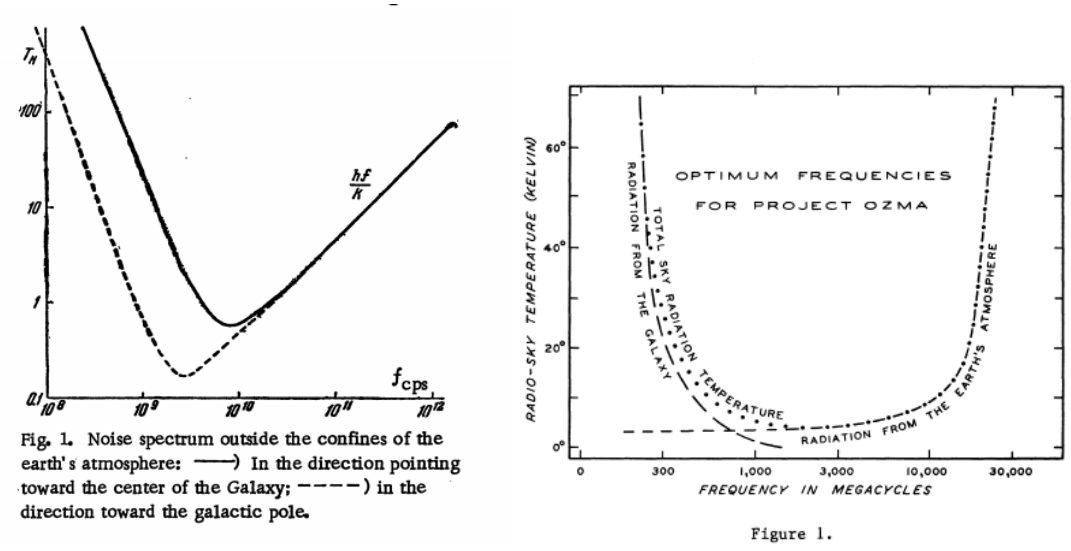

Figure 5. **Left:** A graph from Kardashev's "The Communication Of Information By Civilizations On Other Worlds", page 217. **Right:** A graph from Drake's "Project Ozma" talk at the 25th Anniversary Green Bank conference, page 20.

[153] Kardashev, N.S. "The Communication of Information by Civilizations on Other Worlds", Astron. Zhurnal 41 (1964) (in Russian). Translation note: Some translate the word "Передача" in the title to mean "Transmission" or Broadcast". Передача can be interpreted several ways depending on context—I believe either interpretation is correct, but given that the subject of this dissertation is communication, I chose that specific translation.

The next issue Kardashev tackled was the issue of transmission power. In any given civilization, Kardashev posited, the rate of transmission of signals would be dependent on the amount of power available to said civilization.[154] To address this matter, he introduced his now-famous scale of technological civilizations, sometimes referred to as the "Kardashev Scale".[155] The Kardashev Scale outlined three types of civilizations which might exist in the galaxy, designated by their levels of energy consumption, a choice which, as we shall see in Chapter Two, had great implications for CETI conceptions of civilization. In his scale, Type I was described as a civilization with a "technological level close to the level presently attained on the Earth".[156] Type II was a "civilization capable of harnessing the energy radiated by its own star".[157] In this part of the description, Kardashev made a reference to a "Dyson sphere", which was a theoretical technological concept envisioned by British physicist Freeman Dyson. In postulating upon the "largest feasible technology" CETI scientists could look for, Dyson had imagined a technosphere built around a star, designed to exploit the star's entire energy output.[158] The concept became popular with CETI scientists interested in searches for passive signals, as the Soviets primarily were. Passive signal searches looked for extraterrestrial signals which were unintentionally observable from Earth—they did not contain a targeted message trying to make deliberate contact. Those who advocated for 'passive searches' were primarily interested in looking for incidental evidence of technological civilizations, as opposed to signals directed towards the Earth as a direct attempt at communication ('active searches'). Soviet CETI astronomers believed looking for intentional signals would be a massive waste of time, like looking for a needle in a haystack. In creating this scale, Kardashev attempted to argue that CETI searches should be dedicated to looking for 'super civilizations', whose signals would be easily noticeable. He criticized attempts made in the US, such as "the 'OZMA*' (sic) project",

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[154] Ibid, 218.
[155] Wikipedia. "Kardashev Scale." Last modified 13 May 2021, https://en.wikipedia.org/wiki/Kardashev_scale.
[156] Kardashev, N.S. "The Communication of Information by Civilizations on Other Worlds", *Astron. Zhurnal* 41 (1964): 219. (in Russian).
[157] Ibid, 219.
[158] "Interview with Freeman Dyson" in Swift, David W. *SETI Pioneers: Scientists Talk about Their Search for Extraterrestrial Intelligence* (Tucson: University of Arizona Press, 1990), 325.
* Many in the Soviet Union did not understand Drake's reference to the character in L. Frank Baum's novels, and thought Ozma was an acronym (OZMA), as is usually the case with many other US astronomical projects.

which searched for Type I civilizations, arguing that the possibility of detecting such civilizations was much lower than the detection of Type II and III civilizations.[159] Kardashev took Dyson's concept of large-scale technology a step further with his Type III description: "a civilization in possession of energy on the scale of its own galaxy". Kardashev believed such a civilization would be much easier to detect than an Earth-like one.

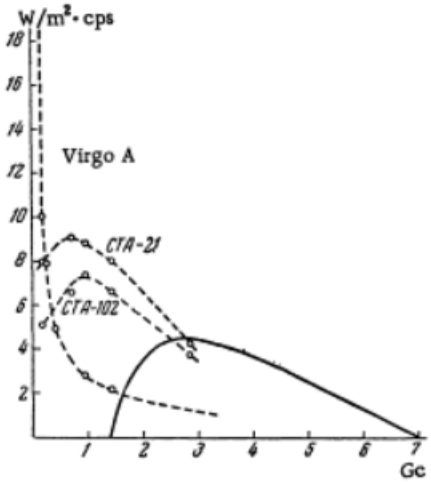

Figure 6. A graph of the spectra of CTA-21 and 102 as compared to Virgo A, in Kardashev, N.S. "Communication of Information by Extraterrestrial Civilizations", 220.

After establishing this scale, Kardashev noted that the power outputs discussed in his paper (especially those of Type II and III civilizations) were "very close to the power of synchrotron radiation from nebulas formed in supernova explosions, or from radio galaxies".[160] Therefore, he argued, it was of utmost importance to distinguish between artificial and natural radio sources. Some of the criteria he outlined for potential artificial sources included those with a "very small angular [dimension]… less than 0".001 [milliarcsecond]" and those which display variability.[161] As already noted, in 1963 no variable radio sources had yet been identified, with the exception of Cassiopeia A, which was only variable in that its flux density decreased over time, as the supernova aged and cooled. An artificial source, on the other hand, might be irregularly or periodically variable due to intelligent activity or transmission of information by way of modulated signal. Periodic variability, Kardashev therefore noted, was "obviously a criterion of outstanding importance" for determining if a signal was artificial.[162] Before concluding, Kardashev briefly mentioned that two sources which had been recently discovered in the US at CalTech fit some of the criteria he had outlined. These sources, CTA-21

[159] Kardashev, N.S. "The Communication of Information by Civilizations on Other Worlds", *Astron. Zhurnal* 41 (1964): 219. (in Russian).
[160] Ibid, 220.
[161] Ibid, 220.
[162] Ibid, 220.

and CTA-102, displayed small angular dimensions* and "[exhibited] a spectrum highly similar to the anticipated artificial spectrum."[163] At that time, cosmic radio sources were known to have a spectrum with lower flux density at high frequencies, leading to a steep spectrum; an artificial source might look differently, as seen in a graph from Kardashev's paper showing how CTA-102 and CTA-21's spectra differed from natural source Virgo A (Figure 6).

In May 1964, the Soviets held their first CETI conference, the All-Union Conference on Extraterrestrial Civilizations at the Byurakan Astrophysical Observatory in Armenia. It was at this conference that Kardashev first presented the ideas from his paper, along with other Soviet CETI pioneers such as his professor I.S. Shklovsky, V.S. Troitsky, V.A. Kotel'nikov, and others. Following the success of the conference, the Soviet Council on Radio Astronomy of the USSR Academy of Sciences formed a section called "Search for Extraterrestrial Civilizations", signalling state support for the newly established field of research.[164] Achieving state support was crucial for the survival of the field, and to achieve said support, the astronomers had to establish a link between Soviet ideology and CETI. In writing on the organization features of Soviet science, historian Loren Graham notes that "the first characteristic of science in the Soviet Union…was the uncommonly large role played by the central government".[165] Crucially, Graham notes, Soviet scientists were compelled to align their work with Marxist dialectical materialism to gain political support.[166]

Debate on the fit of extraterrestrial life in Soviet ideology slightly predated the development of CETI in the USSR. In the 1950s, for example, scientists at the Soviet Institute of Astrobotany argued that according to the principles of dialectic materialism, extraterrestrial life

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* It is important to note that in the original Russian article, Kardashev writes "СТА 21 и СТА 102 имеют угловые размеры менее 20 угловые секунды" which means "CTA 21 and CTA 102 have angular sizes of less than 20 seconds of arc". In a serious translation error, the English version reads that CTA 21 and 102, "display angular [dimensions] not less than 20 [seconds of arc]", which reverses the intended meaning. Clearly, language barriers were yet another inhibitor of Soviet and American communication, and historians need to be alert for these issues when reading texts in either language.

[163] Kardashev, N.S. "The Communication of Information by Civilizations on Other Worlds", *Astron. Zhurnal* 41 (1964): 220. (in Russian).

[164] Gindilis, L.M. and Gurvits, L.I. "SETI in Russia, USSR, and the Post-Soviet Space: A Century of Research." *Acta Astronautica* 162 (2019).

[165] Graham, Loren. *Science in Russia and the Soviet Union*. (Cambridge: Cambridge University Press, 1994): 100.

[166] Ibid.

must exist, and that not finding evidence of it on nearby planets such as Mars or Venus would be a "clear disproof of the philosophical basis of Communism."[167] Such a bold claim demonstrated the importance of establishing compatibility between scientific disciplines and ideology in the Soviet Union during the mid-20th century. Given this significance, the astronomers at the 1964 Soviet CETI conference penned a document titled "Resolution of the All-Union Conference on Extraterrestrial Civilizations".[168] The document was published after the conclusion of the conference and stated that CETI was of "enormous scientific and philosophical significance", and that Marxist "materialistic philosophy has firmly rejected the concept of anthropocentrism", ergo supporting the notion that extraterrestrial intelligence may exist.[169] After having successfully established both the need for further study, as well as the subject's adherence to state ideology, Kardashev became Vice-chairman of the newly-established section, tasked with developing a formal research program on the problem of the search for and communication with extraterrestrial intelligence in the USSR and launching scientific searches. In Chapter Two, I will extend my analysis of Kardashev's paper in a philosophical context and demonstrate how his ideas fit in a greater context of how CETI pioneers conceptualised the future of civilizations and the Soviet worldview. In this section, however, I will show how Kardashev's paper led to one of the Soviet Union's earliest CETI searches on the Yevpatoria array. The subsequent entanglement between military facilities and CETI would result in a major scandal in 1960s Soviet science.

On Kardashev's prompting, astronomers at the Pulkovo Observatory in Leningrad decided to investigate Kardashev's hypothesis regarding CTA-21 and CTA-102. They also presented their results at the 1964 Soviet CETI conference.[170] The primary investigator, Yuri Pariiskii, another former student of Shklovsky's, explained that their observations showed the "expected dependence for artificial radio spectra on account of the linear variation of the quantum fluctuation power with frequency", which seemingly lent credence to Kardashev's

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[167] Sagan, Carl and Shklovsky, I.S. *Intelligent Life in the Universe* (San Francisco: Holden-Day, 1966), viii.
[168] Tovmasyan, G.M., ed. *Extraterrestrial Civilizations (Vnezemnye tsivilizatsii): Proceedings of the First All-Union Conference on Extraterrestrial Civilizations and Interstellar Communication*, (Jerusalem: Israel Program for Scientific Translations, 1967), 97.
[169] Ibid, 97.
[170] Ibid, 30.

suggestion.[171] Pariiskii pointed out, however, that Kellermann had just recently interpreted the spectra as "within the framework of the synchrotron radiation mechanism", and he was inclined to agree with him, since the agreement between the calculated and observed spectra was "astonishing".[172] Put simply, if there was a credible natural explanation, Pariiskii believed that it was a preferable conclusion to ETI.

This episode demonstrated how even in the first few years of CETI, distinguishing between natural and artificial signals was of utmost importance. Pariiskii's consultation of Kellermann's work and Kardashev's dependence on the CalTech catalogue also demonstrate how important international communication and information sharing was in radio astronomy and the development of CETI. Pariiskii's observations might have been the end of the CETI fascination with CTA-102, but in the following year, Sholomitskii was asked by Kardashev and Shklovsky to also observe CTA-102. His subsequent discovery of radio variability would set off a chain of events that gave CETI international attention, brought Soviet science embarrassment, and eventually led to the development of a successful new technique in radio astronomy.

At this point in the analysis, I must pause to discuss primary sources. As I mentioned in the introduction, researching Soviet history can present great challenges due to a lack of archival culture and state censorship. In piecing together the events of the CTA-102 affair, I relied on oral history interviews with the parties involved, newspaper articles from both the USSR and the US/Britain, telegrams from *TASS* Archives Siberia, and an essay of recollections from a *TASS* journalist published in Russia in 2019. As is often the case when one uses documentation which relies on memory, some accounts mildly contradict one another. Yet as I will show, even these contradictions help us understand the nature of scientific communication during this period.

Less than a year after the Soviet CETI conference, Sholomitskii's telegram was published in February 1965, which as previously noted faced disbelief in the Western scientific community. Shortly after, according to the recollections of his colleagues at Shternberg,

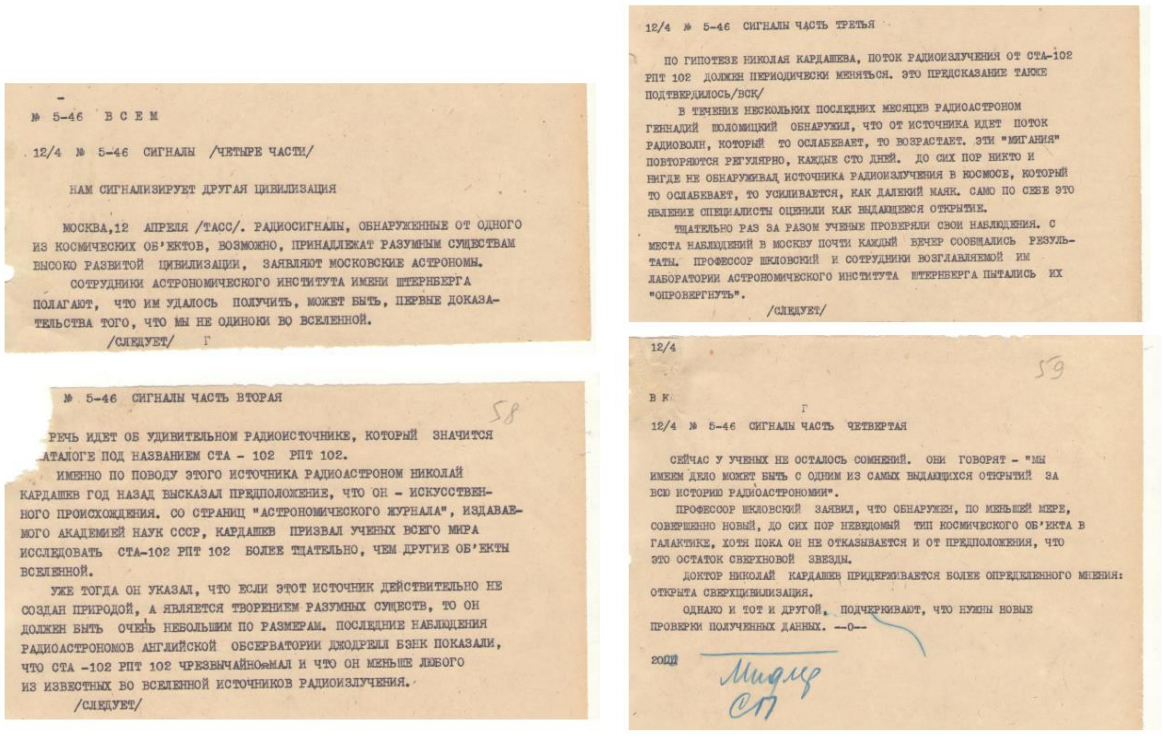
[171] Ibid, 32.
[172] Ibid, 32.

Kardashev made a remark about CTA-102 possibly being the product of an extraterrestrial civilization during a colloquium at the Institute. According to Lev Gindilis, a friend and colleague of Kardashev's at Shternberg, a Telegraph Agency of Soviet Union (*TASS*) reporter named Alexander Midler attended the colloquium and overheard Kardashev's remarks.[173] *TASS* was the central state-run news agency which provided news collection for both national news outlets such as *Pravda, Izvestiya*, and *CT USSR*, as well as international news outlets who wished to report on Soviet subjects.

On 12 April 1962, *TASS* issued a telegram regarding the discovery of an artificial extraterrestrial signal by Soviet astronomers (Figure 7).[174] The telegram was headlined: "We are Signalled by a Friendly Civilization".[175] It began with the stunning claim: "Radio signals, detected from an object in space, might belong to the technology of a highly developed extraterrestrial civilization, declare Moscow astronomers." The telegram, which is broken into four parts, then went on to explain Kardashev's hypothesis from his "Communications" paper. Midler paid particular attention to the size of CTA-102, quoting Kardashev as having said that "if this source is not really created by nature, but is indeed the creation of reasonable creatures, then it should be very small in size".[176] He then noted that Western astronomers, most notably those at Jodrell Bank in England, had recently measured the size of CTA-102, and reported that it was "extremely small".[177] In the third part of the telegram, Midler explained the significance of discovering radio variability, claiming that "until Sholomitskii, no one anywhere had detected a source of radio emission in space which weakened and then strengthened, like a distant lighthouse", using the lighthouse imagery to further suggest an artificial origin.[178] The discovery of variability alone was "an enormous discovery", argued Midler.[179] Because of the high stakes

[173] Interview with Lev Gindilis on 3 October 2019 in Moscow, Russia, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.
[174] *TASS* telegram written by Alexander Midler, 12 April 1965, Records of the Telegraph Agency of the Soviet Union (*TASS*), Centre for Preservation of a Reserve Record, Ialutorovsk, Siberia, Russia. Scans courtesy of Leonid Gurvits (in Russian).
[175] Ibid.
[176] Ibid.
[177] Ibid.
[178] Ibid.
[179] Ibid.

in such a ground-breaking discovery, Midler made sure to emphasize the fact that the astronomers had heavily vetted their results, and that "Shklovsky and employees of the laboratory of the Shternberg Astronomical Institute [had] been testing ways to 'disprove'" the data. In the fourth part, the telegram took a radical shift, beginning by stating: "Now, the scientists have no doubt. They say—'We have a matter which may be one of the most outstanding discoveries in the history of radio astronomy'".[180] The final part of the telegram also included a measured statement from Shklovsky, in which he expressed excitement for a new discovery, but cautioned that there was still work to do in order to determine what the signal was. The telegram concluded with a claim to counter Shklovsky's restrained response, stating "Dr Nikolai Kardashev holds a more defined opinion: a supercivilization is discovered".[181]



№ 5-46 В С Е М

12/4 № 5-46 СИГНАЛЫ /ЧЕТЫРЕ ЧАСТИ/

НАМ СИГНАЛИЗИРУЕТ ДРУГАЯ ЦИВИЛИЗАЦИЯ

МОСКВА,12 АПРЕЛЯ /ТАСС/. РАДИОСИГНАЛЫ, ОБНАРУЖЕННЫЕ ОТ ОДНОГО ИЗ КОСМИЧЕСКИХ ОБ'ЕКТОВ, ВОЗМОЖНО, ПРИНАДЛЕЖАТ РАЗУМНЫМ СУЩЕСТВАМ ВЫСОКО РАЗВИТОЙ ЦИВИЛИЗАЦИИ, ЗАЯВЛЯЮТ МОСКОВСКИЕ АСТРОНОМЫ.

СОТРУДНИКИ АСТРОНОМИЧЕСКОГО ИНСТИТУТА ИМЕНИ ШТЕРНБЕРГА ПОЛАГАЮТ, ЧТО ИМ УДАЛОСЬ ПОЛУЧИТЬ, МОЖЕТ БЫТЬ, ПЕРВЫЕ ДОКАЗАТЕЛЬСТВА ТОГО, ЧТО МЫ НЕ ОДИНОКИ ВО ВСЕЛЕННОЙ.

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№ 5-46 СИГНАЛЫ ЧАСТЬ ВТОРАЯ 58

РЕЧЬ ИДЕТ ОБ УДИВИТЕЛЬНОМ РАДИОИСТОЧНИКЕ, КОТОРЫЙ ЗНАЧИТСЯ АТАЛОГЕ ПОД НАЗВАНИЕМ СТА - 102 РПТ 102.

ИМЕННО ПО ПОВОДУ ЭТОГО ИСТОЧНИКА РАДИОАСТРОНОМ НИКОЛАЙ КАРДАШЕВ ГОД НАЗАД ВЫСКАЗАЛ ПРЕДПОЛОЖЕНИЕ, ЧТО ОН - ИСКУССТВЕННОГО ПРОИСХОЖДЕНИЯ. СО СТРАНИЦ "АСТРОНОМИЧЕСКОГО ЖУРНАЛА", ИЗДАВАЕМОГО АКАДЕМИЕЙ НАУК СССР, КАРДАШЕВ ПРИЗВАЛ УЧЕНЫХ ВСЕГО МИРА ИССЛЕДОВАТЬ СТА-102 РПТ 102 БОЛЕЕ ТЩАТЕЛЬНО, ЧЕМ ДРУГИЕ ОБ'ЕКТЫ ВСЕЛЕННОЙ.

УЖЕ ТОГДА ОН УКАЗАЛ, ЧТО ЕСЛИ ЭТОТ ИСТОЧНИК ДЕЙСТВИТЕЛЬНО НЕ СОЗДАН ПРИРОДОЙ, А ЯВЛЯЕТСЯ ТВОРЕНИЕМ РАЗУМНЫХ СУЩЕСТВ, ТО ОН ДОЛЖЕН БЫТЬ ОЧЕНЬ НЕБОЛЬШИМ ПО РАЗМЕРАМ. ПОСЛЕДНИЕ НАБЛЮДЕНИЯ РАДИОАСТРОНОМОВ АНГЛИЙСКОЙ ОБСЕРВАТОРИИ ДЖОДРЕЛЛ БЭНК ПОКАЗАЛИ, ЧТО СТА -102 РПТ 102 ЧРЕЗВЫЧАЙНО МАЛ И ЧТО ОН МЕНЬШЕ ЛЮБОГО ИЗ ИЗВЕСТНЫХ ВО ВСЕЛЕННОЙ ИСТОЧНИКОВ РАДИОИЗЛУЧЕНИЯ.

/СЛЕДУЕТ/

12/4 № 5-46 СИГНАЛЫ ЧАСТЬ ТРЕТЬЯ

ПО ГИПОТЕЗЕ НИКОЛАЯ КАРДАШЕВА, ПОТОК РАДИОИЗЛУЧЕНИЯ ОТ СТА-102 РПТ 102 ДОЛЖЕН ПЕРИОДИЧЕСКИ МЕНЯТЬСЯ. ЭТО ПРЕДСКАЗАНИЕ ТАКЖЕ ПОДТВЕРДИЛОСЬ/ВСК/

В ТЕЧЕНИЕ НЕСКОЛЬКИХ ПОСЛЕДНИХ МЕСЯЦЕВ РАДИОАСТРОНОМ ГЕННАДИЙ ШОЛОМИЦКИЙ ОБНАРУЖИЛ, ЧТО ОТ ИСТОЧНИКА ИДЕТ ПОТОК РАДИОВОЛН, КОТОРЫЙ ТО ОСЛАБЕВАЕТ, ТО ВОЗРАСТАЕТ. ЭТИ "МИГАНИЯ" ПОВТОРЯЮТСЯ РЕГУЛЯРНО, КАЖДЫЕ СТО ДНЕЙ. ДО СИХ ПОР НИКТО И НИГДЕ НЕ ОБНАРУЖИВАЛ ИСТОЧНИКА РАДИОИЗЛУЧЕНИЯ В КОСМОСЕ, КОТОРЫЙ ТО ОСЛАБЕВАЕТ, ТО УСИЛИВАЕТСЯ, КАК ДАЛЕКИЙ МАЯК. САМО ПО СЕБЕ ЭТО ЯВЛЕНИЕ СПЕЦИАЛИСТЫ ОЦЕНИЛИ КАК ВЫДАЮЩЕЕСЯ ОТКРЫТИЕ.

ТЩАТЕЛЬНО РАЗ ЗА РАЗОМ УЧЕНЫЕ ПРОВЕРЯЛИ СВОИ НАБЛЮДЕНИЯ. С МЕСТА НАБЛЮДЕНИЙ В МОСКВУ ПОЧТИ КАЖДЫЙ ВЕЧЕР СООБЩАЛИСЬ РЕЗУЛЬТАТЫ. ПРОФЕССОР ШКЛОВСКИЙ И СОТРУДНИКИ ВОЗГЛАВЛЯЕМОЙ ИМ ЛАБОРАТОРИИ АСТРОНОМИЧЕСКОГО ИНСТИТУТА ИМЕНИ ШТЕРНБЕРГА ПЫТАЛИСЬ ИХ "ОПРОВЕРГНУТЬ".

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12/4 № 5-46 СИГНАЛЫ ЧАСТЬ ЧЕТВЕРТАЯ

СЕЙЧАС У УЧЕНЫХ НЕ ОСТАЛОСЬ СОМНЕНИЙ. ОНИ ГОВОРЯТ - "МЫ ИМЕЕМ ДЕЛО МОЖЕТ БЫТЬ С ОДНИМ ИЗ САМЫХ ВЫДАЮЩИХСЯ ОТКРЫТИЙ ЗА ВСЮ ИСТОРИЮ РАДИОАСТРОНОМИИ".

ПРОФЕССОР ШКЛОВСКИЙ ЗАЯВИЛ, ЧТО ОБНАРУЖЕН, ПО МЕНЬШЕЙ МЕРЕ, СОВЕРШЕННО НОВЫЙ, ДО СИХ ПОР НЕВЕДОМЫЙ ТИП КОСМИЧЕСКОГО ОБ'ЕКТА В ГАЛАКТИКЕ, ХОТЯ ПОКА ОН НЕ ОТКАЗЫВАЕТСЯ И ОТ ПРЕДПОЛОЖЕНИЯ, ЧТО ЭТО ОСТАТОК СВЕРХНОВОЙ ЗВЕЗДЫ.

ДОКТОР НИКОЛАЙ КАРДАШЕВ ПРИДЕРЖИВАЕТСЯ БОЛЕЕ ОПРЕДЕЛЕННОГО МНЕНИЯ: ОТКРЫТА СВЕРХЦИВИЛИЗАЦИЯ.

ОДНАКО И ТОТ И ДРУГОЙ, ПОДЧЕРКИВАЮТ, ЧТО НУЖНЫ НОВЫЕ ПРОВЕРКИ ПОЛУЧЕННЫХ ДАННЫХ. --О--

2ОДП Мидлер СП

Figure 7. A *TASS* Telegram by Alexander Midler, sent on 12 April 1965. *TASS* Archives Siberia. Scan courtesy of Leonid Gurvits. For English translation, see Appendix B.

Since the telegram confusingly conflated radio variability with ETI, it naturally garnered much attention from the media and the following day there was a large press conference held

[180] Ibid.
[181] Ibid.

at Shternberg (Figure 8). The massive response from the media and the public appeared to have caught the scientists of the institute off-guard. In his autobiography, Shklovsky wrote that on the day of the press conference,

> [the] entire courtyard was crammed with luxurious foreign cars belonging to some 150 of the leading accredited correspondents in Moscow. I led off with a few conservative and sceptical principles. Sholomitskii was extremely restrained.[182]

Figure 8. Photograph from the April 1965 press conference at Shternberg. From left to right: Gennadii Sholomitskii, Iosif Shklovsky, and Nikolai Kardashev. From Gindilis, Lev. *SETI: Search for Extraterrestrial Intelligence.* Moscow: Fizmalit, 2004 (in Russian).

Indeed, in recalling the day of the press conference in his autobiography, Shklovsky represented himself as being fairly dismissive of Kardashev's claims, even going as far as to say Kardashev was filled with "adolescent optimism" to believe the variability in CTA-102 was of intelligent origin.[183] At the press conference Shklovsky also derided *TASS* for its hasty publication, stating that "it is our right to ask journalists that they respect their great responsibilities, which does not always happen".[184] Despite attempts by Shklovsky and Sholomitskii to undermine the extraterrestrial hypothesis, however, the narrative quickly spread around the world. Soon after the alleged discovery was reported, Kardashev received a telegram from Frank Drake, congratulating Shternberg and asking for more details—one of the earliest instances of direct communication between Soviet and American astronomers regarding CETI.[185] In his own autobiographical writings, Drake

[182] Shklovsky, I.S. *Five Billion Vodka Bottles to the Moon*. New York: WW Norton & Co. Inc., 1991: 253.
[183] Ibid, 253.
[184] "Russians Temper Report on Space." *The New York Times*, 14 April 1965.
[185] "Interview with Nikolai Kardashev" in Swift, David W. *SETI Pioneers: Scientists Talk about Their Search for Extraterrestrial Intelligence* (Tucson: University of Arizona Press, 1990), 195.

recalled Shklovsky later told him Shternberg had received a second telegram from America, one from Caltech scientists informing them the signal was definitely not a signal from extraterrestrial intelligence. This telegram stated that the source had recently been identified by Caltech scientists as a quasar.[186] Unfortunately, due to "protocol", the results of that identification would not be made public until they were published in a scientific journal, which often were delayed in their dissemination in the Soviet Union, due in part to Soviet Foreign Censorship Committee, a subject which will be addressed in further detail in the third chapter.[187]

International news media nonetheless ran wild with the claim that Soviets had made first contact with extraterrestrials (Figure 9). On 13 April 1965, a newspaper in the United Kingdom interviewed Sir Bernard Lovell about the alleged discovery. In the article, Lovell is quoted as stating the telegram's report was "rather sad" and went on to state that "Russians are in some ways given to extravagant interpretations of their results".[188] Lovell's public condemnation would have had significant impact in the Soviet Union, as he was still recognized there as an elite and renowned member of the international scientific community. Journalists in other countries were similarly patronizing. In the *New York Times*, an article titled "Natural Origin Indicated" noted that Shklovsky was a "long-standing enthusiast" of the idea of extraterrestrial intelligence, and pointed out that American astronomers at CalTech had, just two months earlier, identified CTA-102 as a quasar.[189] In fact, CalTech had even been able to obtain a spectrum of CTA-102 and measured its redshift, but given barriers to communication, this information had also not yet reached the Soviet Union.[190] Newspapers also pointed out that Sholomitskii's observations had been conducted at an undisclosed facility, casting further disbelief on his results. In another *New York Times* article, published the week after the

[186] Drake, Frank, *Is Anyone Out There?* (New York: Delacorte Press, 1992), 103.
[187] Choldin, Marianna Tax. "Access to Foreign Publications in Soviet Libraries." *Libraries & Culture* 26, no. 1 (1991): 135-150.
[188] "Space Claim is 'Sad'." *Coventry Evening Telegraph*, 13 April 1965.
[189] Sullivan, Walter. "Natural Origins Indicated." *The New York Times*, 13 April 1965.
[190] Sullivan, Walter. "Radio Emissions from Space Spur Disagreement Between Soviet and American Astronomers." *The New York Times*, 18 April 1965.

Shternberg press conference, Walter Sullivan, a science editor, pointed out this "curious contradiction" in Soviet and American astronomy:

> The Americans believe that the object…is so distant that it and other such objects may open the way to a deeper understanding of the very nature of the universe. The Russians say it is comparatively close and may be trying to attract our attention.[191]

Why the significant difference in opinion? Sholomitskii believed that, given the strange distribution of its spectrum, CTA-102 must lie "in or near the Milky Way galaxy", because an object that was very large and far away, like a distant galaxy, could not possibly pulsate in the 100-day rhythm he had observed.[192] Such an occurrence, Sullivan noted, would be like observing "an elephant [that] can do the twist".[193] American astronomers, on the other hand, believed the object was an incredibly large and distant object, but agreed that the 100-day pulsation was strange, and therefore were inclined to disregard Sholomitskii's results, especially given the secrecy over the Yevpatoria facilities. If Sholomitskii was right, Sullivan added, "there must be some way, so to speak, to get the elephant to do the twist."[194] Kellermann believed that the variability detected by Sholomitskii was "'theoretically impossible' since light travel time arguments meant that the source would need to be so small, that any radio emission would be self-absorbed".[195] Kellermann later admitted that "we now know that the radio emission from CTA-102 does vary at 30 cm on the time scales reported by Sholomitskii, as do many other quasars, and that this phenomena is now understood to occur as a combination of relativistic beaming and interstellar scattering.".[196] Nevertheless, the Western acknowledgment of Sholomitskii's discovery came too late; the combination of his covert observations using the Yevpatoria array and the claims of ETI contact all but discredited the discovery at the time.

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[191] Ibid.
[192] Ibid.
[193] Ibid.
[194] Ibid.
[195] Kellermann, Kenneth. "Preface to the English Edition." in Braude, S.Y. et al. *A Brief History of Radio Astronomy in the USSR (*New York: Springer, 2012): viii.
[196] Ibid.

SPACE CLAIM IS 'SAD'— LOVELL

SIR BERNARD LOVELL, Director at Jodrell Bank, said today that the chances of CTA-102, a distant source of radio waves, being linked with any super civilisation, as claimed by Russia, were "entirely remote."

He added: "I can think of no means of obtaining scientific proof of this. I think the only sort of proof which would be accepted by scientists would be if there was some specific secret code.

"It is rather sad. The Russians are in some ways given to extravagant interpretations of their results.

"The strange thing is that they are trying to interpret this in a fanciful way instead of in an astronomical way."

Extremely improbable

The interpretation of CTA-102 that it had anything to do with intelligence of any kind was "extremely improbable."

He said it was one of five most exciting objects which astronomers knew about at the present time. It had not been identified but the variability in the strength of the source reported by the Russians was regarded as of extreme importance in the astronomical world.

He said Jodrell Bank had contacted the source last night on two telescopes and they would search through old records and keep a careful check on the intensity from the source in future.

Professor Iosef S. Shklovsky, a Soviet astronomer, said today that the reported radio signal from outer space was "to say the least, an absolutely new, still unknown type of cosmic object."

COVENTR COMMENI MAKING

A MEMBER of the public, named as Mr. Hannon, who "exercised his right" under Common Law, and arrested a man whom he suspected of theft, earned a commendation from

Moscow astronomer Professor Joseph Shklovsky. . . . He said yesterday that the reports about life in Space had been "distorted" by the Russian news agency TASS

Gennady Sholomitsky . . . the Russian astronomer who started yesterday's reports. But later he said: "Nothing has been definitely proved."

Figure 9. **Left**: An article published on 13 April 1965 in the *Coventry Evening Telegraph*. **Right**: Two images from a *Daily Mirror* article published the following day, on 14 April 1965, titled: "Life in Space? Russians Not So Sure".

Soviet science was made to look foolish by the international scientific community and the media. At this point in the analysis, it becomes important to defer to the journalist's perspective. Midler wrote an account of his memory of the CTA-102 events for a Russian book celebrating Shklovsky's life published in 2019, the contents of which highlight yet another dimension of mixed signals in Cold War communication. Aptly titled "! *Или* ?" [! Or ?], Midler's essay explained how a punctuation mishap led to this international scandal for Soviet science. Rather than "overhearing" a conversation, as Gindilis recounted, Midler claimed to have interviewed Shklovsky and Kardashev after a Shternberg colloquium, during which Kardashev made remarks about CTA-102 possibly being of intelligent origin. Importantly, this conversation happened on 12 April, the anniversary of the day Yuri Gagarin became the first human being to journey into space, formally celebrated as "Cosmonautics Day" in the USSR. As will be further explored in Chapter Three, anniversaries were of particular importance in the Soviet Union, and so Midler and his team hurried to get the telegram announcing this discovery out as quickly as possible. In his retrospective, Midler said that he posed the discovery as a question in his

headline: 'Is an extraterrestrial civilization signalling us?' He claimed that the question mark was removed during the editorial and publishing stages, turning it into an assertion. After Shklovsky made disparaging remarks about *TASS* in the subsequent press conference, Midler approached him, distressed, saying "What have you done! I will be fired, and three levels of editors and bosses will also be fired. I have only just started in this job and now Reuters has published an article titled 'Soviet Scientists Refute Soviet Telegraph Agency".[197] This negative international attention had dire implications for *TASS* and Midler. Other sources, including Gurvits and Gindilis, suggested that Midler was even frightened for his life.[198]

Shklovsky, who as discussed earlier in this chapter had also experienced threats on his life from the Soviet bureaucracy, allegedly told Midler that he would take care of the problem and "write an article in *Pravda* in [Midler's] defence".[199] The article, published on the front page, was titled "New in Radio Astronomy: A *Pravda* Interview" and consisted mainly of an interview with Shklovsky. Unlike other *Pravda* interviews, however, there was no interviewer listed as author, nor any back-and-forth questioning. It seems likely that the entirety of the article was written by Shklovsky, as an editorial of sorts posed as an interview. It is not surprising Shklovsky would be granted this much control of the narrative in a state newspaper. In the mid-1960s, Shklovsky was considered an eminent and respected scientist in the Soviet Union, having previously won a prestigious Lenin Prize for his role in the Space Race.[200] As such, Shklovsky was given more leeway than others might have. In the "interview" (Figure 10), Shklovsky began by giving context for the discovery, briefly explaining how the discovery of variability was made, and praising the Soviet technology which helped make the discovery possible. Despite his earlier expressed qualms about CTA-102 being evidence of ETI, in the *Pravda* article Shklovsky was not shy to mention Kardashev's hypothesis. He referred to the paper in which Kardashev predicted that CTA-102 might be artificial, saying that "according to

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[197] Midler, Alexander. "! OR ?" in eds. Gurvits L.I. *I.S. Shklovsky: Mind, Life, Universe.* Moscow, 2019 (in Russian).
[198] Gindilis, L.M. and Gurvits, L.I. "SETI in Russia, USSR, and the Post-Soviet Space: A Century of Research." *Acta Astronautica* 162 (2019).
[199] Interview with Leonid Gurvits on 4 October 2019 in Moscow, Russia, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.
[200] Scheglov, P.V. "Obituary - Shklovsky, Iosif." *Quarterly Journal of the Royal Astronomical Society* 27, no. 4 (1986): 701.

Kardashev's hypothesis, these sources could be radio signals of cosmic civilizations far from us".[201] Although he noted that there could be several different natural explanations for the discovery, he concluded with a remark which was both titillating, yet conservative:

> Of course, one cannot exclude the exciting hypothesis that an artificial signal from an extraterrestrial civilization is being observed. New observations are necessary, however, for the hypothesis to become a scientific fact.[202]

In writing this editorial, Shklovsky was able to downplay the initial claim that CTA-102 was assuredly evidence of ETI, but still allowed for the possible veracity of Midler's claims. He also argued that CETI was a viable outlet for scientific investigation. As Midler later put it, Shklovsky wrote "as if there were no guilty persons" in the whole debacle; both the enthusiasm for the possibility of extraterrestrial civilizations and the exciting discovery of natural radio variability were valid responses.[203] Perhaps due to Shklovsky's article, although this cannot be definitively proved, Midler was neither fired nor imprisoned, and CETI research in the Soviet Union continued to thrive thereafter.

Although much of the international response to the CTA-102 affair was critical of Soviet science, the event did lead to the development of positive relationships between some Soviet and US scientists. For example, at the time of Sholomitskii's announcement of variability in CTA-102 in 1965, Kellermann was completing his postdoctoral fellowship at Australia's Parkes Observatory. Kellermann, who also had an interest in CETI, had just conducted observations of the radio source 1934-63, which he discovered had a "remarkably similar [spectrum] to that predicted by Kardashev for signals transmitted by extraterrestrial 'super civilizations'".[204] In a paper discussing his observations, Kellermann took seriously Kardashev's hypothesis, noting 1934-63 might meet Kardashev's requirements for "the Type I and Type II civilizations respectively".[205] Furthermore, as Kardashev's paper suggested, Kellermann investigated the spectrum of 1934-63 near the 21cm hydrogen line to look for characteristics which might

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[201] "New in Radio Astronomy." *Pravda*, 14 April 1965 (in Russian).
[202] Ibid.
[203] Midler, Alexander. "! OR ?" in eds. Gurvits L.I. *I.S. Shklovsky: Mind, Life, Universe.* Moscow, 2019 (in Russian).
[204] Kellermann, Kenneth I. "The Radio Source 1934-63." *Australian Journal of Physics* 19 (1966): 205.
[205] Ibid.

"emphasize the artificial nature of the sources".[206] In his paper, Kellermann noted that it was likely the unusual spectrum of 1934-63 is likely the result of natural physical phenomena, possibly "[representing] the very early stages of quasi-stellar sources".[207] Nevertheless, the Australian media picked up the story with a headline reading: "Space Mystery for Australia: Scientists Pick Up Signals" (Figure 11).[208] The article claimed that Kellermann detected "mysterious radio signals from an unidentified body….following claims by Russian scientists… that radio signals picked up from a stellar body code-named CTA102 could be evidence of a super civilization in outer space".[209] The newspaper noted that Kellermann would travel from Sydney to Moscow in a few days to "compare notes the Russians".[210] Kellermann travelled to Moscow shortly before returning to the US to begin his staff scientist position at NRAO. His visit to Shternberg was significant because it established ties between the Institute and NRAO, which would, as we shall see in the next section, eventually lead to important collaborative relationships between the two institutions.

[206] Ibid.
[207] Ibid.
[208] "Space Mystery for Aust." *The Sun-Herald,* 18 April 1965.
[209] Ibid.
[210] Ibid.

Новое в радиоастрономии

ИНТЕРВЬЮ «ПРАВДЫ»

RUSSIANS TEMPER REPORT ON SPACE

Idea That 'Rational Beings' Are Signaling Is Challenged

By HENRY TANNER

MODIFY SPACE-SIGNAL REPORT: Prof. Iosif S. Shklovsky, center, of Moscow's Sternberg Astronomical Institute, and associates Gennady Sholomitsky, left, and Dr. Nikolai Kardashev, at news conference yesterday. They said Tass account was premature.

Figure 10. **Left**: Article in *Pravda* on 15 April 1965, titled "New in Radio Astronomy: A *Pravda* Interview". For English translation, see Appendix A. **Right**: Henry Tanner, "Russians Temper Report on Space", The *New York Times*, 13 April 1965. The photograph shows (left to right) Sholomitskii, Shklovsky, and Kardashev at the CTA-102 conference at Shternberg.

SPACE MYSTERY FOR AUST.

Scientists pick up signals

By BOB JOHNSON

Australian scientists have had mysterious radio signals from an unidentified body, billions of miles away in southern skies, under observation since 1962.

This was revealed in Sydney this week following claims by Russian scientists.

The Russians claimed that radio signals picked up from a stellar body code-named CTA102 could be evidence of a super - civilisation in outer space.

OCEAN RACE

NATO TALKS

LOW NOTE'S HIGH SALE

Low notes are making high sales at the Royal Easter Show.

Figure 11. "Space Mystery for Aust." *The Sun-Herald*, 18 April 1965. Scan courtesy of Ken Kellermann.

The CTA-102 affair, as it is now known in both US and Soviet scientific circles, is important for understanding the history of radio astronomy and CETI during the Cold War period.[211] First, it highlights barriers to communication between Soviet and American astronomers, in part caused by the relationship between radio astronomy and the military, given the restrictions on the Yevpatoria facilities. Second, the CTA-102 affair illuminates the burgeoning of a Soviet CETI field in the 1960s and shows how eager scientists were to make first contact with extraterrestrial civilizations. Third, it demonstrated the importance to CETI of distinguishing between natural and artificial sources. And finally, given Midler's telegram and subsequent fallout for the reputation of Soviet science, the CTA-102 affair showed how both personal and international politics imbued scientific research, with great consequences for scientists and journalists.

Very Large Batch of Idiots

After the CTA-102 affair, Kardashev continued to promote his idea that CETI projects were best spent in search of 'supercivilizations', which he believed would, like the quasars, be bright, small, and distant. Typically, observing sources that are small and distant requires telescopes with high sensitivity. The radio telescopes of the 1960s were not terribly sensitive; quasars could only be observed by these low sensitivity telescopes because of their stunning luminosity. To achieve the resolution required to observe other small and distant sources, the astronomers needed a new observing strategy.

There are several components that contribute to the sensitivity of a radio telescope. First, the collecting area of the dish. Many radio telescopes have a parabolic dish that collects incoming radio waves and reflects them towards the focus, where they are then directed into a feed horn (Figure 12). The feed horn funnels these weak radio signals into the receiver. Even with these focused signals, however, radio waves are still very difficult to detect. Therefore, the second thing that contributes to a radio telescope's sensitivity is its receiver, which amplifies

[211] Heidmann, Jean. "SETI False Alerts as 'Laboratory' Tests for an International Protocol Formulation." *Acta Astronautica* 21, no. 2 (1990).

the signals. The receiver measures the waves and converts them into electrical signals which can be distinguished by voltage. These voltages are then recorded, processed, and stored.

Optical telescopes observe the visible part of the electromagnetic spectrum, where wavelengths measure between 380 to 740 nanometres.* Radio telescopes, on the other hand, observe at much longer wavelengths, and therefore need larger telescopes to make observations which have decent resolution. In the 1960s, it was possible to build dish telescopes of a very large diameter. For example, the 1000 foot diameter dish in Arecibo, Puerto Rico was constructed in 1963, and remained the largest radio telescope on earth, until China's Five Hundred Metre Aperture Spherical Telescope (FAST) completed construction in 2016.[212] So while not necessarily limited by size, the radio telescopes of the 1960s were limited by the ability of their receivers.

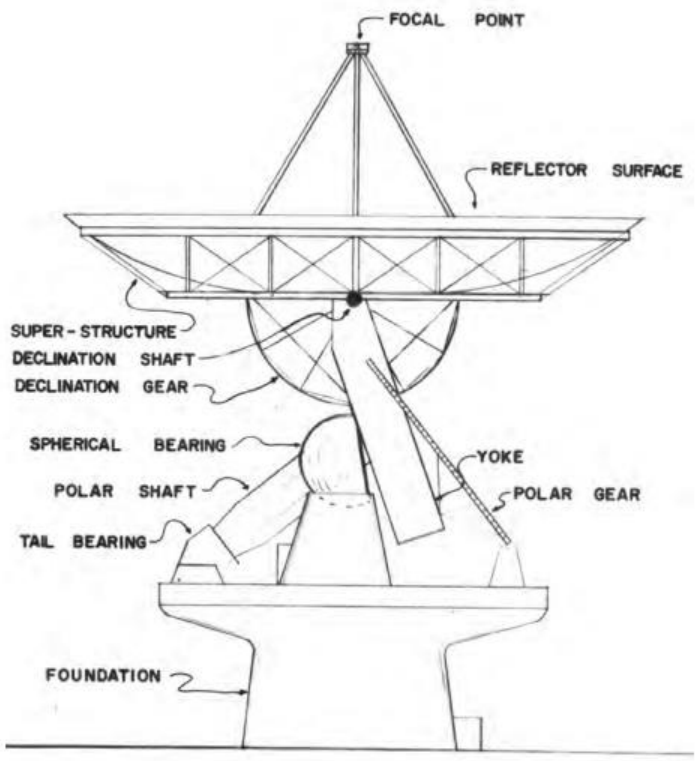

Figure 12. Ashton sketch of NRAO's 140 foot telescope, which began operations in 1965. NRAO Archives.

Nearly everything gives off radio waves. The computer upon which I am currently typing this dissertation gives off radio waves. The hands with which I am typing also give off radio waves (though to a far less degree). Therefore, for a receiver to do an excellent job of recording and amplifying radio waves, it must not receive too much radio frequency interference or noise. This is not possible if the receiver itself is giving off radio waves (which it does). One solution to this problem is to cool the receiver to a point where it gives off

* It should be noted that optical astronomy does also sometimes incorporate the infrared and UV parts of the e/m spectrum.

[212] "History." Arecibo Observatory Puerto Rico. Accessed 20 April 2020. http://www.naic.edu/ao/history.

very little radiation, and indeed, this is what is now done at radio astronomy observatories. The Green Bank Telescope, for example, which completed construction in the year 2000, cools its receivers with helium, so that they stay between 10-20 Kelvin, greatly minimizing the RFI they create. Radio astronomy observatories in the 1960s, however, lacked the sophisticated receivers which would be developed decades later, and they did not have the means to keep them cold enough to keep RFI to a minimum. As a result, 1960s radio astronomers had to find creative ways to increase the resolving capabilities of their telescopes.

One such way of achieving this was through a technique called aperture synthesis, a type of interferometry. Historian and radio astronomer Woodruff Sullivan's book *Cosmic Noise: A History of Early Radio Astronomy* (2009) documents in detail the development of interferometric techniques in radio astronomy from the 'post-war' period up to the early 1950s. Sullivan notes the technique was developed by Martin Ryle and his group at Cambridge, shortly after his time as a radar operator for the Royal Airforce during World War II.[213] Ryle, inspired by radar techniques, proposed combining the signals from multiple telescopes which were spaced at a distance from one another (Figure 13).[214] Once combined, the signals were amplified as if they had been observed by a telescope of a much larger size—as large as the distance between the respective telescopes. This works in part because of interference, and therefore in radio astronomy this technique is often called interferometry. Ryle would go on to win a Nobel Prize for his development of aperture synthesis, and radio interferometry became a popular solution for achieving higher resolution without having to invest in the construction of massive telescopes.

[213] Sullivan III, W. *Cosmic Noise: A History of Early Radio Astronomy* (Cambridge: Cambridge University Press, 2009): 163.
[214] Ryle, M. "A New Radio Interferometer and its Application to the Observation of Weak Radio Stars." *Proceedings of the Royal Society A* 211, no. 1106 (1952).

Figure 13. The Green Bank Interferometer at NRAO in Green Bank, WV. Photo courtesy of NRAO Archives.

One challenge with radio interferometry, however, is that radio waves would arrive at each telescope at slightly different times, depending on the distance between the telescopes (Figure 14). As a result, the signals were slightly out of sync, and there needed to be a way to know when each wave was recorded in exact relation to the arrival of the waves at the other telescope. This was because, after the telescopes were pointed at the same source, the signals observed need to be lined up by a correlator so that they were in phase. This process required immense precision in order to measure the time between each crest of a wave. In interferometers which had telescopes which were not placed too far apart, this could be fairly easily accomplished by connecting the two apertures via coaxial cables. But if astronomers wanted the distance between the telescopes—the baseline—to be too large to connect via cable (for example, across continents or bodies of water), this presented a limitation to the technique.

Spurred by the desire to observe more sources like CTA-102, Kardashev and Sholomitskii joined forces with a colleague at Lebedev Physical Institute, Leonid Matveyenko, and proposed

a method to artificially increase angular resolution by conducting radio interferometry using telescopes which were disconnected, thereby permitting much larger baselines between telescopes. They published their idea in 1965, in the first scholarly paper to propose this new technique, which they called "radio interferometry with a large baseline".[215] The disconnected apertures and long baselines were made possible with the development of the atomic clock. Atomic clocks are extremely accurate clocks that use the natural oscillations of atoms to keep time. The development of the atomic clock enabled interferometric components to be disconnected from one another, thereby allowing interferometry observations to be conducted at much greater distances. In theory, there was no limit to the distance that could be put between the telescopes, meaning very high angular resolution could be possible. Because there was still a lack in collection area, however, this technique only worked well for very small, very bright sources—like quasars, or extraterrestrial supercivilizations.

Although Kardashev, Sholomitskii, and Matveyenko became the first to propose this new technique in a scientific journal, they were not the only ones working on the problem of low angular resolution in radio astronomy. On the other side of the planet, Ken Kellermann and his group at NRAO, as well as a group of radio astronomers in Canada, were independently developing their own versions of this technique, which eventually became known as "Very Long Baseline Interferometry" (VLBI), riffing off of the proposed name for an array NRAO was planning to build, the Very Large Array (VLA).[216] The simultaneous development of this

[215] Matveyenko, L.I, Kardashev, N.S., and Sholomitskii, G.V. "Radio Interferometry with a Large Baseline" *Radiophysics* 8, no 4 (1965) (in Russian).
[216] Correspondence with Ken Kellermann on 5 April 2019 at Jodrell Bank.

technique as a result of the heightened interest in quasars would lead to the first major collaboration in radio astronomy between the US and USSR: a joint US-USSR VLBI experiment.

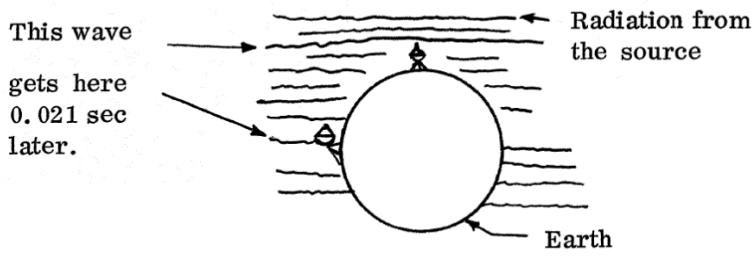

Figure 14. How VLBI works. From John Broderick's article "VLB Interferometry" in NRAO's *The Observer*, vol. 10, no. 1 (Jan 1970). NRAO Archives.

Even with the advances made in time stamping due to the development of atomic clocks, however, conducting VLBI was an enormous challenge. It required astronomers coordinating with one another at great distances, during a time when rapid communication across continents was not easy or reliable, as evidenced by the CTA-102 affair. Furthermore, if the telescopes were in different countries, this could mean dealing with different power systems, language barriers, differences in machinery, and other such challenges. VLBI was so difficult to pull off successfully, that NRAO astronomer David Shaffer jokingly referred to those who participated in such experiments as a "Very Large Batch of Idiots (VLBI)" in a cartoon he published in NRAO's internal newsletter, *The Observer* (Figure 15). As the rest of this section will illuminate, VLBI in the 1960s was riddled with challenges and setbacks and conducting an experiment between two countries locked in a Cold War increased the challenges exponentially.

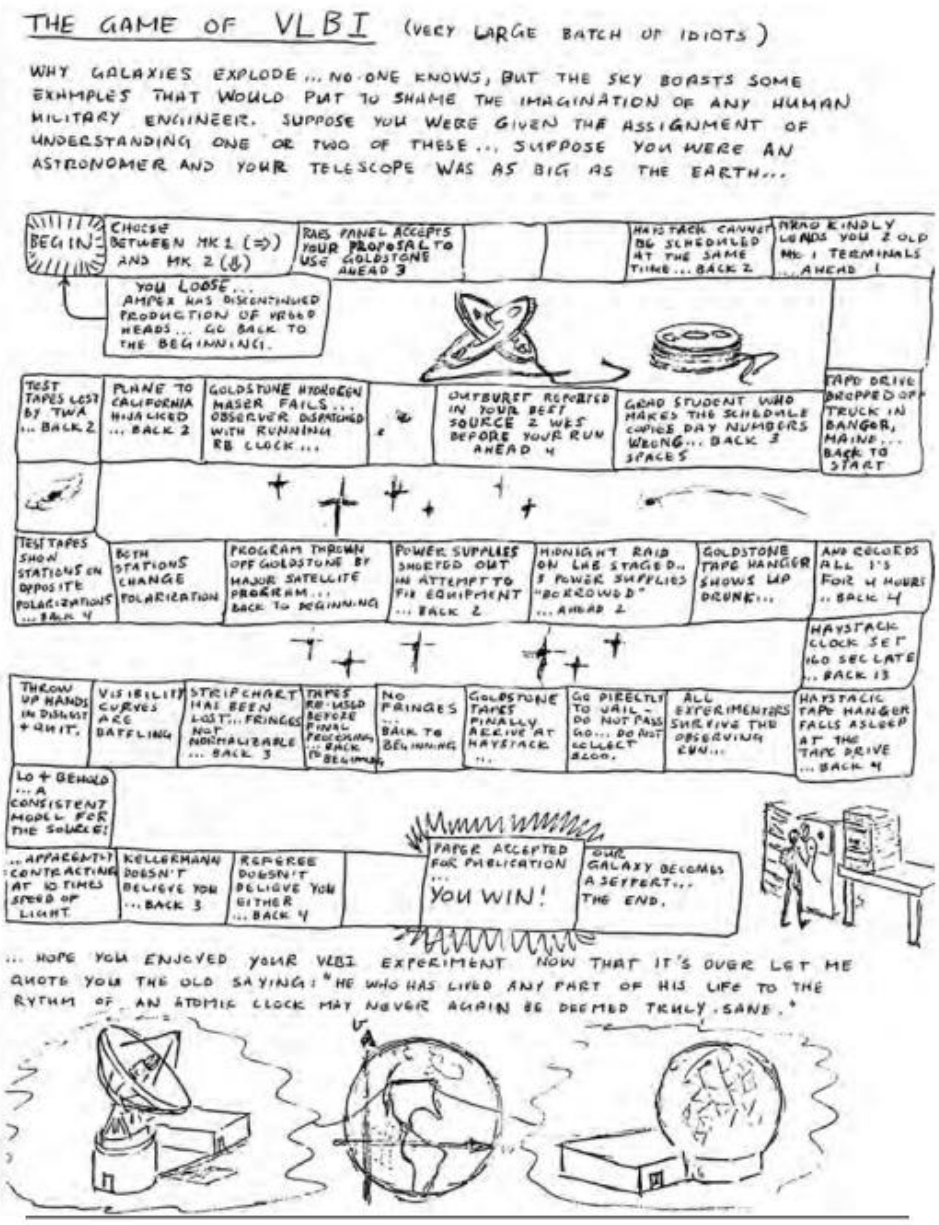

Figure 15. A cartoon titled “The Game of VLBI (Very Large Batch of Idiots)”, created by NRAO scientist David Shaffer and published in *The Observer* in 1974. *The Observer* was an internal publication circulated by NRAO between 1961 through 1981. It was a patchwork of a publication with a wide variety of content, such as short updates on scientific projects, names of babies recently born into NRAO families, satirical articles, photos and summaries of recent events, and hand drawn cartoons. This cartoon highlighted the many different challenges and setbacks early VLBI experiments faces. For example, the sixth and seventh tiles from the end say that “[the model is] apparently contracting at 10 times the speed of light… Kellermann doesn’t believe you… Back 3”.

By the late 1960s, NRAO scientists had conducted a few VLBI experiments with observatories in other countries, most notably a successful one in Sweden, conducted in February 1968.[217] After the completion of that experiment, the astronomers were interested in expanding their baselines as far as possible. They quickly realised the longest "reasonable" baseline from Green Bank, West Virginia was in Australia.[218] There was a problem with this proposal, however: Australia did not have a telescope which was able to observe at short centimetre wavelengths with large enough collecting area—crucial for obtaining the highest possible resolution. After some investigating, it soon became clear that the only telescopes capable of the necessary observations were located in the Soviet Union. Kellermann and a colleague, Marshall Cohen, wrote a letter to Professor Victor Vitkevich, then Director of the Lebedev Physical Institute in the USSR.[219] The letter began by explaining the success of the US-Swedish experiment, and how the result of said experiment indicated that sources of less than 0.001 arc seconds could still be found if they increased the resolution by moving to longer baselines and shorter wavelengths. Kellermann proposed the use of NRAO's 140 foot telescope with the Soviet 22 metre telescope located in Serpukhov for the experiment, arguing that this "would seem to provide nearly the highest resolution obtainable from two antennas located on the surface of the earth".[220]

The NRAO scientists had no response from the Soviet Union for five months.[221] This was due to the fact that acquiring permissions from Soviet officials to conduct a collaboration with the US was a complex process; this chapter has so far concerned communication challenges between the US and USSR, but as many former-Soviet astronomers will attest, communication within the USSR was difficult as well. Matveyenko, who had co-authored the first VLBI paper

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[217] Kellermann, Kenneth I. "How Not to Do a VLBI Experiment." *The Observer* 10, no. 1 (Jan 1970). The Observer Series, National Radio Astronomy Observatory Archives, National Radio Astronomy Observatory, Charlottesville, VA USA.
[218] Ibid.
[219] Letter from Marshall Cohen and Ken Kellermann to Victor Vitkevitch, February 23, 1968. Scans from Matveyenko, L.I. "Early VLBI in the USSR". *Astronomische Nachrichten* 328, no. 5 (2007).
[220] Ibid.
[221] Kellermann, Kenneth I. "How Not to Do a VLBI Experiment." *The Observer* 10, no. 1 (Jan 1970). The Observer Series, National Radio Astronomy Observatory Archives, National Radio Astronomy Observatory, Charlottesville, VA USA.

with Sholomitskii and Kardashev, was working at Lebedev when Kellermann's letter arrived at Vitkevitch's office, on 14 March 1968, about three weeks after it had been sent.[222] In a retrospective article published in 2007, Matveyenko claimed Vitkevitch handed him the letter, and stated: "this is your idea and you should realize it, but the chance [of the experiment actually happening] is very small, because of the Cold War", recognizing the barriers to cooperation during the 1960s.[223] There was a further problem in achieving the collaboration, this time once again rooted in the military-scientific infrastructure of Soviet radio astronomy. The telescope Kellermann proposed to use, the RT-22 in Serpukhov, was located quite close to Moscow, meaning it could not be used in this experiment "for security reasons".[224] In his retrospective article, Matveyenko did not explain what those security reasons were. But as we shall see in the paragraphs below, the US government also had concerns about telescope use and national security, and it is likely both governments shared the same apprehensions. As a result of these "security" concerns, the Soviets proposed instead the use of the RT-22 located in Simeiz, on the Crimean Peninsula, far from any major population centres. Once he gained the support of the Director of the Crimean Astrophysical Observatory, Ivan Moiseyev, Matveyenko sent a letter to the Americans to agree to collaborate on the experiment.[225]

In a letter sent on 27 July 1968, NRAO was told that Vitkevitch was on vacation, and had instructed Matveyenko to respond. The Americans were rather baffled by this—in a memo to NRAO Director Dave Heeschen, Kellermann explained: "Vitkevitch did not answer our letter of February 23 because he has been on vacation!".[226] This, of course, is not what happened, but is an example of the type of miscommunication between the Soviets and Americans which frequently occurred during this experiment. Despite their confusion over alleged Soviet holidays which appeared to last nearly half a year, the Americans were pleased to learn the

[222] Matveyenko, L.I. "Early VLBI in the USSR". *Astronomische Nachrichten* 328, no. 5 (2007): 414.
[223] Ibid.
[224] Ibid.
[225] Letter from Matveyenko to Kellermann on 27 July 1968 NRAO Archives, VLBI Series (in Russian).
[226] Memo from Ken Kellermann to David Heeschen on 30 July 1968, NRAO Archives, VLBI Series.

Academy of Sciences had given their "tentative agreement" of the collaboration.[227] The letter also included the proposed change of telescope, stating:

> We have considered our own possibility and have come to the conclusion that such an experiment would be most appropriate conducted, not with the RT 22 (Serpukhov) radio telescope, but with the more refined radio telescope of similar construction located in the Crimea at Simeiz. This site has more favourable meteorological conditions, and it is more favourable from the standpoint of the baseline orientation.[228]

Nowhere in the letter was there mention of the vague security reasons Matveyenko wrote about in his recollection of the experiment, despite the request for change.

After this positive response, NRAO quickly began to plan out the experiment. In a document titled "Long Baseline Interferometry Between the United States and The Soviet Union: Scientific Background and Potential Problem Areas", they emphasized the importance of the collaboration for the science goals, stating it was "necessary to use the Crimean telescope for this work, because there is no other radio astronomy telescope outside the United States with such large collecting area of sufficient precision to operate at wavelengths shorter than 6 cm".[229] The report set out several potential "problem" areas that needed to be anticipated and, hopefully, minimized through preparation.

One problem listed was already becoming rapidly apparent: "ease of communications".[230] To conduct a successful VLBI experiment, communications would have to be established quickly, sometimes as quickly as within the half hour. Additionally, there would have to be an exchange of personnel. NRAO needed to send scientists to the USSR, and in his letter, Matveyenko had requested that a couple of "specialists" from the USSR be sent to Green Bank, to "obtain a more detailed acquaintance with the equipment and the observational

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[227] Letter from Matveyenko to Kellermann on 27 July 1968 NRAO Archives, VLBI Series (in Russian).
[228] Letter from Matveyenko to Kellermann on 27 July 1968 NRAO Archives, VLBI Series. (in Russian).
[229] Report titled "Long Baseline Interferometry Between the United States and The Soviet Union: Scientific Background and Potential Problem Areas", NRAO Archives, VLBI Series.
[230] Ibid.

procedures".[231] The US and USSR were locked in the Cold War and the Space Race, and the hostility between the two nations meant that quickly and easily exchanging scientific staff would pose a challenge. Related to this concern, the report set out another potential problem in exchanges between the two countries—the transport of technical equipment such as the atomic clock.

With only seven months until the proposed date of the experiment, the astronomers quickly set out to gain the approval for transporting the clock from the Office of Export Control and the Department of Defence, but immediately ran into problems. On 19 June 1969, representatives from the US Department of Defence (DoD) visited Green Bank to discuss their concerns with the experiment. Their problem was not with any one piece of technology, but the technique of VLBI itself. As it so happened, VLBI was not only a technique used by astronomers, but by specialists in a field called geodesy, which was concerned with the measurement of the Earth's surface, orientation in space, and how these properties change over time, through processes such as tectonic shift and polar motion. Scientists interested in geodesy could use VLBI 'in reverse' to observe how the telescope's antennas moved in relation to one another, by determining the location of each antenna in respect to the other with great accuracy. For geodesic purposes, this allowed scientists to track the Earth's rotation, how continents moved, and other such measurable factors. At the time of the US-USSR VLBI experiment, the accuracy could only be determined "to an accuracy of about 100 feet", but that was expected to rapidly improve, with astronomers predicting accuracy of as much as a few centimetres "within 3-4 years".[232] The DOD "[desired] not to have NRAO give a geodetic tie into the two systems", for concern that it might allow the Soviets to "significantly [refine] their grid" of US geography, a form of intelligence-gathering that could potentially allow for more accurate targeting in the event of a nuclear strike.[233] This is likely the same "security concern" that Matveyenko wrote about, in respect to the use of the telescope located near Moscow. Despite these concerns,

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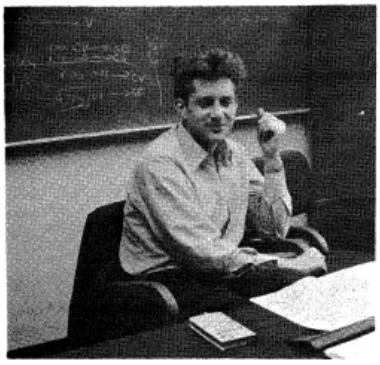
[231] Letter from Matveyenko to Kellermann on 27 July 1968, NRAO Archives, VLBI Series (in Russian).
[232] Kellermann, Kenneth I. "How Not to Do a VLBI Experiment." *The Observer* 10, no. 1 (Jan 1970). The Observer Series, National Radio Astronomy Observatory Archives, National Radio Astronomy Observatory, Charlottesville, VA USA.; Rough Notes of Meeting in Green Bank with DOD Representatives on 19 June 1969, NRAO Archives. VLBI Series.
[233] Rough Notes of Meeting in Green Bank with DOD Representatives on 19 June 1969, NRAO Archives. VLBI Series.

Presently visiting from Moscow are Drs. Kardashev and Matveyenko who participated in the October VLB experiment with the Crimea. While here they have been making observations of pulsars with the 300-ft. telescope and the Crab Nebula with the 140-ft. telescope.

WELCOME TO NRAO



Dr. Kardashev

Dr. Matveyenko

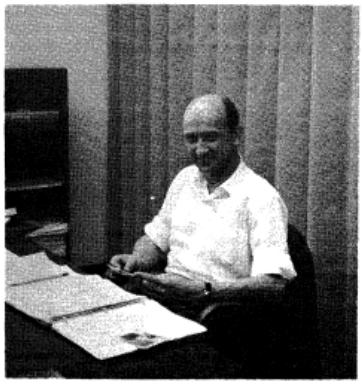


Figure 16. Photos of Kardashev and Matveyenko as published in *The Observer*, 10, no. 1 (Jan 1970). The Observer Series, National Radio Astronomy Observatory Archives, National Radio Astronomy Observatory, Charlottesville, VA USA.

however, the DOD was prepared to give NRAO approval of the experiment, at least until a point where it could become "possible to refine the intergrid geodetic measurements" to a few inches or centimetres.[234]

It is not within the scope of this dissertation to expand on the first US-USSR VLBI experiment, but the events of the experiment were recorded and published in 1970 by Kellermann in the internal NRAO newsletter, *The Observer*.[235] After the experiment successfully concluded, positive relationships between the scientists in the USSR and NRAO remained; in fact, Matveyenko and Kardashev were both invited to visit the US shortly after, and there were many future collaborative project between the groups (Figure 16). Nevertheless, VLBI is clearly another example of how the tools and techniques of radio astronomers and CETI scientists were co-opted by the military during the Cold War.

The Longest Search

This chapter has thus far hinted at the connection between CETI and the intelligence community through its ties to radio astronomy infrastructure such as telemetry and VLBI, as well as by showing how CETI researchers faced challenges due to politically fuelled barriers to

[234] Ibid.

[235] Kellermann, Kenneth I. "How Not to Do a VLBI Experiment." *The Observer* 10, no. 1 (Jan 1970). The Observer Series, National Radio Astronomy Observatory Archives, National Radio Astronomy Observatory, Charlottesville, VA USA.

communication and military interference. In this section, attention will be turned from the challenges faced by astronomers and CETI scientists because of geopolitics and instead show there was also an explicit, symbiotic relationship between radio astronomy, CETI, and intelligence gathering. The introduction to this dissertation discussed the significance of Morrison and Cocconi's paper and explained how they pursued Lovell in the hopes of gaining his support in using the Mark I telescope for an observational CETI project. Lovell declined, "rather coldly" according to Cocconi, and spoke of CETI with contempt.[236] This chapter introduced Lovell as a major figure in early Cold War radio astronomy, one who embodied contradictions—Lovell considered himself and his telescope as aiding the West by providing information on the Soviet Union, yet the Soviet Union saw him as a hero just as much as Britain did—until his role in working with British intelligence emerged. Lovell's disapproval of CETI and disdain for the USSR was also revealed in the section on CTA-102, where he derided the Soviet Union's early claims of contact with extraterrestrial intelligence. This section returns to these themes in greater detail, in order to argue that CETI's relationship with the military extended beyond its peripheral use of radio astronomy infrastructure and instead showing that the tools and techniques developed by CETI also played an explicit role in Cold War intelligence.

In the 1970s and 80s, there was a shift in how CETI was treated by the general scientific community in the United States. Prior to this decade, as we saw in the introduction to this dissertation, US CETI was largely comprised of targeted searches conducted by individual astronomers (as opposed to concerted efforts by research groups or institutions) and there were very few observational studies conducted in the US as opposed to the USSR in the 1960s.[237] The shift from mostly theorizing to planning and organizing a large-scale formal search in the 1970s also marked a departure from the term CETI to SETI: the *search* for extraterrestrial intelligence. As part of this shift to focus on searches in the US, SETI scientist and Hewlett-Packard Vice President Barney Oliver conducted a NASA-funded investigatory study in 1971 titled Project Cyclops, in which he proposed the design of a phased array for

[236] "Interview with Giuseppe Cocconi" in Swift, David W. *SETI Pioneers: Scientists Talk about Their Search for Extraterrestrial Intelligence* (Tucson: University of Arizona Press, 1990), 52.
[237] "Radio List." The SETI Institute. Accessed 21 February 2021. https://technosearch.seti.org/radio-list.

SETI.[238] Jill Tarter, who was mentioned in the introduction as having promoted the concept of a Cosmic Mirror, was then a graduate student. When she read the Project Cyclops report, she was inspired to pursue a career in SETI, and became one of the next generation of scientists pursuing the radio search for extraterrestrial intelligence.

Tarter and her fellow SETI colleagues were successful at integrating SETI not only in radio observatories, where the field had largely remained in the 1960s, but at scientific institutions such as NASA. The involvement of NASA and its comparably large budget made large-scale searches possible, and in the late 1970s they had their first opportunity to plan and design a NASA SETI project. Working at NASA's Ames Research Center, Tarter and her colleagues hoped to use NASA's Deep Space Network, which had a network of 34 metre telescopes primarily designed for tracking deep-space probes, such as those used for the Pioneer and Voyager missions. In order to use the telescopes for the intended purpose, the SETI team had to design and build a prototype for a "multi-channel spectrum analyser" which would be used to conduct a targeted search of stars which had been selected as best candidates for SETI as well as an all-sky survey which would sweep the sky looking for artificial signals.[239] Scientists at another NASA site, the Jet Propulsion Laboratory (JPL), wanted to participate, and so the project created two arms of the program to develop analysers. The Ames prototype was called "Peterson's Left Leg", a humorous reference to Al Peterson, an electrical engineer at Stanford, who provided technical support for the design.[240] The JPL prototype was simply called the MCSA—the Multi-Channel Signal Analyzer.[241] The analysers were designed to search for "obviously engineered" signals, which the SETI group decided might be compressed in frequency to bandwidths that were narrower than whatever would be possible in the natural

[238] Project Cyclops (1971), Papers of Kenneth I. Kellermann, National Radio Astronomy Observatory Archives, National Radio Astronomy Observatory, Charlottesville, VA USA.
[239] Interview with Jill Tarter by Rebecca Charbonneau on 4 September 2019 in Berkeley, CA, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.
[240] Ibid.
[241] Billingham, John. "SETI: The NASA Years." in eds. Vakoch, Douglas. *Archaeology, Anthropology, And Interstellar Communication* (Washington, D.C.: NASA History Office, 2014): 9.

astrophysical environment.* Even when searching for emissions from naturally narrowband astrophysical sources such as masers,* the group did not know of any naturally occurring cosmic structures that were any more narrow than 300Hz, defining the "sandbox" for SETI at signals under 300Hz. The team developed an instrument that could observe about 65,000 individual spectral channels simultaneously, scanning a wide range of frequencies and identifying narrow band signals. Tarter later noted that "this [was] the type of instrument astronomers don't build, because nature doesn't do narrowband. So this was a unique instrument."[242] In other words, the analysers were perfect for finding artificial signals, not natural astrophysical ones.

By the early 1980s, the JPL team was further along in their design than the Ames team. The MCSA fit inside a van, making it relatively transportable. Because of its portability, Sam Gulkis, JPL's project scientist, informed Tarter that he and the JPL team had been invited to field test their equipment at Jodrell Bank. This would be a huge boon for the prestige of SETI— even in the 80s, as it was being overtaken in scientific achievements by the next generation of radio telescopes and arrays, the observatory at Jodrell Bank still carried the prestige from its early role in the Space Race, and Bernard Lovell still helmed the Director's office. In an oral history interview, Tarter recounted her excitement that SETI was being recognized as important science by one of the world's most prestigious radio astronomy observatories, and "invited [herself]" along on the trip.[243] When she arrived in Britain, she learned JPL would be testing the all-sky function, and so she decided to spend her time not with them, but instead testing the MCSA's capabilities for targeted searches by observing OH masers. It was during this time that Tarter, during a private conversation with her JPL colleagues, learned the true nature of the "field test" was to use the MCSA to conduct an intelligence search for a Soviet secret signal.

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* This was a somewhat arbitrary decision. There have been arguments in support of broadband searches as well, and as Ken Kellermann once wryly informed me: "Unfortunately there is no cosmic treaty that specifies bandwidths for communication."

* A cosmic maser is a naturally occurring, single-pass amplifier working at radio wavelengths, based on the mechanism of stimulated emission.

[242] Interview with Jill Tarter by Rebecca Charbonneau on 4 September 2019 in Berkeley, CA, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.

[243] Ibid.

Tarter's frustration with the events was still palpable in her oral history interview nearly 40 years later:

> I was incensed! Here I was, so proud, that Jodrell Bank is allowing us to... ugh! I was so pleased and proud of myself, that here we are doing field tests for SETI at Jodrell Bank, isn't this fabulous, and then indeed it was just a big shill, it was just a cover story. So I was really furious with my colleagues. I just... it was...[Tarter groans]. I can't... I don't know how to express it. I was so... again, very young, very naïve, very full of myself thinking that SETI was so important... and that it would obviously be invited to do a field test at Jodrell Bank, you know? Because we were so special and so good! And, as it turned out, it wasn't like that at all and it took me a while to calm down.[244]

A report from the NSA sheds light on what had occurred. The report, declassified in 2011 and titled "The Longest Search: The Story of the Twenty-One Year Pursuit of the Soviet Deep Space Data Link, and How It Was Helped by the Search for Extraterrestrial Intelligence", was published in the *Cryptologic Almanac*, a classified academic journal published internally by the NSA. The report began by noting the long history of searches for particular signals known to the intelligence community, but not yet found and identified. One of these 'white whales' was the Soviet deep space data link, which was used to, among other things, send images from Mars and Venus to the Earth by the Soviet space probes.

The historiography of signals intelligence has been described by historians Matthew Aid and Cees Weibes as an "inventory of ignorance", given the enormous lack of information and publication on how the US conducted signals intelligence collection during the Cold War era.[245] As seen in the earlier section on the Sugar Grove listening station, SIGINT and communications interception were significant parts of US Cold War efforts to gather information on the Soviet Union. Yet much of the purpose behind SIGINT is often obscured, sometimes even to intelligence officials themselves. Even the "Longest Search" report published by the NSA

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[244] Ibid.

[245] Aid, M.M. and Cees, W. "Introduction on The Importance of Signals Intelligence in the Cold War." *Intelligence and National Security* 16, no. 1 (2001): 1.

questioned the obsession with finding the Soviet deep space data link, noting that though the search for the signal began in 1962, shortly after the first Venera mission launched in 1961, the signal evaded analysts until 1983. Given that most SIGINT searches only last a few years, the report claimed "if this search was not quite a Moby Dick-like obsession, it never entirely left the minds of those analysts who wanted the signal, either".[246] The Soviet deep space data Link consisted nearly exclusively of radar mapping of planets, images from the surface of Venus, and telemetry data. This information was valuable to the scientific community, of course, but the images of Venus' surface and other scientific data was nearly always released by the Soviet Union shortly after they received it, as part of their aim to establish their position as the dominant space power. Therefore, there does not appear to be a clear motivation, either scientific or political, for the effort put towards capturing the signal. The NSA report concluded by acknowledging the futility of the search, concluding "in the final analysis, though, there seems to have been few obvious benefits from this prolonged search for the Soviet deep space data link."[247] Nonetheless, it is clear that if there was not a strategic benefit to the search, there was certainly an emotional one, perhaps especially on the part of Lovell, who as we have seen, prized himself on his role using Jodrell Bank to conduct intelligence searches.

But why did Lovell need to use the SETI van to capture the Soviet deep space data link, as opposed to existing SIGINT tools and techniques? As demonstrated by the CTA-102 section, SETI scientists and engineers had great interest in identifying artificial sources—and this was recognized by the intelligence community. In fact, there had even been some courting on the part of the SETI community; in her oral history interview, Jill Tarter explained that two SETI scientists, Kent Cullers and Carl Sagan, visited the NSA on an "information exchange" to give a presentation on the tools developed by SETI—but also in the hopes that they might learn from the intelligence community as well. As Tarter rightly noted, "we had gotten a lot of technologies that we use in astronomy today out of [the] military, classified development that then gets

[246] "The Longest Search: The Story of the Twenty-One Year Portrait of The Soviet Deep Space Data Link and How It Was Helped by the Search for Extraterrestrial Intelligence." National Security Archives (Undated, but produced after 1983, Declassified Sept. 2011).
[247] Ibid, 3.

unclassified".[248] This has already been shown in the development of radio astronomy out of World War II radar.

This phenomenon is also true in the reverse: intelligence agencies sometimes benefited from the development of scientific instruments. In their pursuit of the Soviet deep space data link, CIA hardware specialists would attend international space exhibitions to investigate waveguides on Soviet equipment and "discovered that the equipment was configured to transmit a signal somewhere between 5.6 and 6.3 GHz", homing in on the frequencies the Link might have used. Furthermore, astronomers themselves got involved, an example of human intelligence which was discussed in the earlier section. According to the NSA report, "Western astronomers who were aware of the search for the missing data signal discreetly queried their Soviet colleagues about the Soviet data link. One was told that is was 5.9 GHz".[249] Still, after decades of searching, these forms of intelligence gathering were clearly insufficient for capturing the link.

The search was further complicated by geopolitical conflict. The NSA report notes that because of geopolitical instability, most notably civil war in Ethiopia, they had lost control of intercept sites in Turkey and Ethiopia, which meant that the United States "could intercept transmissions only during [a] short window".[250] The portability of the RFI van made it a valuable asset, and the NSA report described it as "a system designed specifically for the collection of signals from deep space… it was a unique configuration of receivers, spectrum analysers, and computers" which "included a digital signal analysis subsystem that could monitor 64,000 radio channels, each 205 Hz wide simultaneously."[251] The report does not refer to Lovell by name, and references to Jodrell Bank are redacted in the declassified document. It does, however,

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[248] Interview with Jill Tarter by Rebecca Charbonneau on 4 September 2019 in Berkeley, CA, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.

[249] "The Longest Search: The Story of the Twenty-One Year Portrait of The Soviet Deep Space Data Link and How It Was Helped by the Search for Extraterrestrial Intelligence." National Security Archives (Undated, but produced after 1983, Declassified Sept. 2011): 2.

[250] "Stonehouse: First U.S. Collector of [REDACTED] Signals." *The National Security Agency*. (Undated but declassified Sept. 2007). https://www.nsa.gov/Portals/70/documents/news-features/declassified-documents/cryptologic-spectrum/stonehouse.pdf.; "The Longest Search: The Story of the Twenty-One Year Portrait of The Soviet Deep Space Data Link and How It Was Helped by the Search for Extraterrestrial Intelligence." National Security Archives (Undated, but produced after 1983, Declassified Sept. 2011): 2.

[251] Ibid, 2.

highlight that the use of the SETI technology was a resounding success. By ensuring that "the SETI specialists were given sanitized search parameters and limited feedback on results", the 'true' purpose of the visit was conducted surreptitiously, and "shortly after midnight on 9 November… the 21 year search was over".[252] The document optimistically notes the usefulness of SETI technology, arguing that it "pointed the way to the advanced collection and signal analysis systems", perhaps with "some application to the study of Soviet space communications, especially with its constellation of intelligence satellites that circled the earth".[253]

While the intelligence community was satisfied, Tarter was incensed. In her interview, she recalled that when she learned that the MCSA was being used by Jodrell Bank for intelligence gathering purposes, the young and angry Tarter attempted to confront Lovell in his office. When she arrived, however, she found him standing over a book on his desk and weeping. Tarter described herself as "just overwhelmed" at finding the eminent scientist in such a state and discovered he had been examining pictures of Dresden in World War II. He told her: "My sister tells me that I should be ashamed of myself."[254] The radar he developed during the War had allowed for the successful bombing raids even through bad weather. Such an interaction highlights the complexities of 20th century radio astronomy, having grown out of the tragedy of World War II and cold warfare, but with some practitioners who rejected the field's relationship with militaries. Tarter, who was strictly against use of SETI for militaristic purposes, would later become a major figure in SETI and develop the concept of the Cosmic Mirror, which posited that SETI was a force for peace and global unity. Nevertheless, the notion of a Cosmic Mirror sits uncomfortably against the reality that the tools CETI scientists created could be co-opted for war.

Conclusion

As already noted, the Soviet historical record for astronomy is much more challenging to access than the US one, in part because of the many contemporary barriers, both political and

[252] Ibid, 3.
[253] Ibid, 3.
[254] Interview with Jill Tarter by Rebecca Charbonneau on 4 September 2019 in Berkeley, CA, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.

organizational, to archival access in Russia. In my efforts to fill in the gaps of Soviet contributions to radio astronomy, I stumbled upon information on KRT-10, an alleged space radio interferometer launched in 1979. Despite seeing a few references to the existence of the telescope, including its depiction on a Russian stamp (Figure 18), I could not find any significant scientific publications resulting from data from the telescope, nor any information about the receiver, frequency range, or scientific mission, other than vague references to its alleged ability to conduct VLBI.[255] One *Pravda* article (Figure 17), titled "Radio Astronomy Steps Into Outer Space", highlighted KRT-10 as the first radio interferometer in space, noting that interferometry experts Gennadii Sholomitskii and Leonid Matveyenko were responsible for first proposing VLBI as a method.[256]

I found this claim bizarre, primarily because there is another, more contemporary mission, RadioAstron (launched 2011), that is better known as Russia's first space radio interferometer. RadioAstron is the product of decades of collaboration between scientists in the US, especially NASA and NRAO, and Kardashev's research group in the Soviet Union and Russia after the fall of the Soviet Union in 1991. RadioAstron was a product of the ongoing relationships between the US and USSR stemming from the first joint VLBI experiments conducted in the late 1960s, covered earlier in this chapter. Although not included in promotional or scientific materials, it is the general understanding of scientists at the AstroSpace Centre located in the Russian Space Research Institute in Moscow, which launched RadioAstron, that RadioAstron was in part the culmination of Nikolai Kardashev's dream of using VLBI to identify evidence of extraterrestrial intelligence.[257]

[255] "Radio Astronomy Steps into Outer Space", *Pravda*, 2 September 1980 (in Russian).
[256] Ibid.
[257] Interview with Lev Gindilis on 3 October 2019 in Moscow, Russia, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.

2 сентября 1980 года ● № 246 (22676) ПРАВДА

На соискание Государственной премии СССР

РАДИОАСТРОНОМИЯ ШАГНУЛА В КОСМОС

Взоры ученых издавна прикованы к изучению космического пространства, планет, звезд, галактик и других объектов. За последние десятилетия на этом направлении достигнуты выдающиеся результаты благодаря прогрессу методов исследования Вселенной не только в оптическом, но и в радиодиапазоне.

Радиоастрономия, которой еще нет и пятидесяти лет от роду, совершила подлинную революцию в познании Вселенной. Открыты квазары — компактные радиоисточники, удаленные от нас на миллиарды световых лет и обладающие колоссальной энергией, пульсары — нейтронные звезды с удивительными свойствами, релятивистское радиоизлучение космических мазеров. Эти и многие другие открытия во Вселенной, осуществленные в последние годы, связаны с совершенствованием радиотелескопов — основного инструмента радиоастрономов.

Радиотелескопы ныне обладают лучшими чувствительностью и угловой разрешающей способностью, чем самые современные оптические телескопы, и нашли применение не только в радиоастрономии, но и при решении важных практических задач. Они, например, помогают с фантастической точностью определять движение полюсов Земли, скорость и неравномерность ее вращения, расстояния между континентами.

Радиотелескопы, направленные из космоса на нашу планету, станут мощным средством изучения погодных условий, принесут сведения о зарождении грозных явлений в атмосфере Земли, помогут исследовать ее природные ресурсы. Вот почему создание

...ности и большого мастерства потребовала юстировка антенны, то есть точная ориентация в пространстве всех ее лучей сначала в наземных, а затем и в космических условиях. Это весьма не простая задача, так как на Земле пришлось создать специальные «обезвешивающие» устройства, сохраняющие форму зеркала в условиях земного тяготения. На орбите же было совсем не просто очень точно сориентировать станцию в пространстве при наведении антенны на источник радиоизлучения Кассиопея—А. Впервые удалось создать радиоинтерферометр Земля — космос, состоящий из синхронно работающих десятиметровой антенны КРТ-10 и 70-метровой антенны наземного радиотелескопа

...от частотных ограничений аналоговых наземных устройств. У «земных» радиотелескопов из-за влияния атмосферы «окно прозрачности» простирается от коротковолнового края радиодиапазона (миллиметровые волны) до длинноволнового (декаметровые волны). Ликвидация «окна прозрачности» при наблюдениях с околоземной орбиты многократно расширяет информативность радиоастрономии.

Космические радиотелескопы практически позволяют забыть об ограничениях, с которыми сталкивается наземная радиоастрономия. Основное из них — размеры нашей Земли, так как угловое разрешение интерферометра тем лучше, чем больше расстояние

...решение порядка 0,0001 секунды дуги. Это в шестьсот тысяч раз превышает возможности человеческого глаза (одна минута) и в десять тысяч раз — современных оптических телескопов. С помощью гигантского синтезированного радиотелескопа удалось, в частности, приступить к изучению структуры квазаров и ядер галактик, что существенно расширяет представления о Вселенной.

Космические радиоинтерферометры, антенны которых можно расположить сколь угодно далеко друг от друга, откроют совершенно новые, порой даже непредсказуемые возможности для радиоастрономических исследований — и не только фундаментальных, но и прикладных. Например, изучение земной атмосферы средствами радиоастрономии одновременно на ряде длин волн даст ценную метеорологическую информацию — о температуре, влажности, водности облаков. Радиометеоскопы — многочастотные всепогодные радиотелескопы на околоземной орбите — внесут существенный вклад как в изучение атмосферы, так и в прогнозирование погоды, в охрану окружающей среды (например, контроль загрязненности атмосферы и т. д.). Использование космических остронаправленных антенн, несомненно, сыграет немалую роль также в совершенствовании связи и телевидения, даст возможность проводить весьма точные геодезические измерения.

Figure 17. "Radio Astronomy Steps into Outer Space", *Pravda*, 2 September 1980. Scan courtesy of Leonid Gurvits.

Figure 18. A pair of stamps showing KRT-10 and its launch to Salyut 6 from "ISS and Other Space-Station-Related Sub-Satellites." Regional and Mesoscale Meteorology Branch (RAMMB). https://rammb.cira.colostate.edu/dev/hillger/iss-related_satellites.htm.

In autumn 2019, I was invited to visit the AstroSpace Centre to attend the final RadioAstron International Scientific Council meeting. RadioAstron had been decommissioned that summer after astronomers had lost contact with the spacecraft due to some mechanical failures. During the meeting, I had the opportunity to sit down and conduct an oral history interview with my friend and colleague, Leonid Gurvits, a former-Soviet astronomer and aerospace engineer who began his career in Moscow in the early 1970s and had been a key figure in the RadioAstron mission.[258] At the time of this dissertation's writing, Leonid is a scientist working at the Joint Institute for VLBI ERIC in the Netherlands, as well as a professor in the aerospace department at the Delft University of Technology. Given his expertise in VLBI and employment at the Soviet Space Research Institute in the 1970s, I assumed he would know more details about the mysterious KRT-10. When asked, Gurvits responded with his characteristic blend of humour and frankness:

> The first large antenna deployed on Salut-6 station in 1979, KRT-10, was presented to the public as a radio telescope and there were even some publications about radio astronomy. Even more, [there were claims that] VLBI observations [were made] using KRT and ground base telescopes. And that was complete fake. It was really fake news and much more fake than what is referred to by President Trump. Very different. That was real fake.[259]

When pressed on how he could possibly know this, Gurvits explained that he was a member of the science group tasked with building KRT-10, and he proclaimed, "we didn't do any VLBI, I swear".[260] Gurvits asserted it would have been impossible, as KRT-10 did not have any of the equipment needed for VLBI, like an atomic clock. The true function of KRT-10 was never fully explained to the Space Research Institute team in full. But given their involvement in its construction, they could extrapolate its function. For example, they knew where the dish on KRT was pointing, and it spent much of its mission flying over the oceans, pointed down towards the Earth. And what is the purpose of a radio telescope pointed towards the ocean?

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[258] Interview with Leonid Gurvits on 4 October 2019 in Moscow, Russia, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.
[259] Ibid.
[260] Ibid.

Gurvits explained that it is possible that KRT-10 would have been able to detect the movement of ships or submarines in the ocean, and that it might well have been used to track the movements of adversarial navies. In other words, its status as a radio telescope was meant to conceal its true nature as an intelligence-gathering tool.

I end with this brief story on KRT-10 because I believe it further highlights the connections between radio astronomy tools/techniques and global conflict. Interestingly, Leonid himself is a SETI enthusiast and has done a significant amount of work trying to preserve Soviet and Russian contributions to the field, including by publishing his paper "SETI in Russia, USSR and the post-Soviet space: A Century of Research", as cited earlier in this chapter as one of the few existent papers on Soviet CETI history.[261] It is likely no coincidence that two of Leonid's greatest research interests are VLBI and SETI—as established, the connection between VLBI and CETI in the USSR and Russia was more pronounced than in the US. Furthermore, Leonid, like many of his colleagues, holds internationalist ideas about his science. When I have spoken to Western radio astronomers who engaged in international collaboration during the Cold War era, either in VLBI or CETI, they often spend much time trying to persuade me of the apolitical nature of their pursuits. They tell me of the friendships they made in the Soviet Union, how they were driven to cooperate out of a pure scientific desire to understand the universe. The astronomer I quoted in the introduction, Dave Jauncey, made clear that he believed his work was "separate from politics".[262] Jauncey and others are not being insincere—they did form lifelong friendships and developed exciting techniques in astronomy that have formed the foundation of the science being conducted today. I believe them when they tell me they were not motivated by politics.

But in speaking with Gurvits and the other Soviet astronomers, I recognized the barriers that had to be overcome to facilitate internationally cooperative experiments and meetings. There was also a recognition that things were different for the Soviet side. Today, historians of the Cold War rightfully push back against the US propaganda of apolitical science and note the

[261] Gindilis, L.M. and Gurvits, L.I. "SETI in Russia, USSR, and the Post-Soviet Space: A Century of Research." *Acta Astronautica* 162 (2019).
[262] Interview with David Jauncey on 4 October 2019 in Moscow, Russia, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.

many ways the United States weaponized ideology in its science.[263] Yet the historical literature is sometimes too bombastic in its attempts to convince the reader to correct their perception that the Soviet Union was a more tyrannical society than the United States. Because while it is absolutely true that the United States employed ideology, cultural 'diplomacy', psychological warfare, and undue military influence in its scientific-technical pursuits, when assessing the evidence, it is still clear that science in the Soviet Union was far more restrictive and repressive, often to the detriment of its practitioners. It is my view the important historiographical attempts to reverse the narrative of apolitical US science are sometimes an 'overcorrection'. While politics certainly imbued American science, as has been made apparent in this chapter and will continue to emerge as a theme in this dissertation, it is also clear that astronomers in the USSR faced unique political barriers which impeded their scientific freedom, as evidenced by the lack of credit Sholomitskii received for discovery of radio variability. This is, as we have seen, due in part to the *explicit* connection between Soviet military and scientific infrastructures, as opposed to the *implicit* connections in American ones.

I come to this conclusion not as an American keen on protecting my country's image as a force for 'freedom' and democracy (I will happily critique my nation's history of scientific imperialism in the next chapter), but rather from listening to the perspectives of my former-Soviet friends and colleagues. American astronomers of course affected and were affected by political forces, but the tie between the military and astronomy was more overt in the USSR than in the US, often leading US astronomers to be more ignorant of the political forces behind their scientific labour than their Soviet peers, but also permitting them a greater degree of autonomy that Soviet astronomers lacked. This is a key point to be made: US astronomers were more easily able to hold internationalist ideals because of the covert nature of US scientific politics. When I informed Gurvits of his American colleagues' sunny recollections of their collaborative work in the USSR, he responded:

> Yeah, as just normal human beings, we wanted to be open with our colleagues and friends. And as you certainly know, all [of the American] people you

[263] For a couple of examples of said literature, see: Wolfe, Audra. *Freedom's Laboratory: The Cold War Struggle for the Soul of Science*. Baltimore: Johns Hopkins University Press, 2018. And Wang, Jessica. *American Science in an Age of Anxiety: Scientists, Anticommunism, and the Cold War.* Chapel Hill: University of North Carolina Press, 1999.

> interviewed… they are my good friends and colleagues for many years… [But] when our foreign colleagues tell us 'it was so friendly and lovely!'. Yeah, it was. But what does it cost of them, on the other side? They can hardly imagine… It was very, very difficult. It was so difficult you cannot imagine how difficult it was from this side.[264]

This chapter has demonstrated how scientific internationalism sometimes masked the reality of conducting astronomical and CETI research during the Cold War period, which was often tied to the military. The following Chapter will assess another aspect of CETI rhetoric which stemmed from its internationalism: its belief that a planetary perspective could serve to universalise the human experience. As we shall see, this form of internationalism also masked a different militaristic dimension of Cold War science, one which was decidedly imperialistic in nature.

[264] Interview with Leonid Gurvits on 4 October 2019 in Moscow, Russia, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.

Chapter Two:

Civilization

"The world is nearly all parcelled out, and what there is left of it is being divided up, conquered, and colonised. To think of these stars that you see overhead at night, these vast worlds which we can never reach. I would annex the planets if I could; I often think of that. It makes me sad to see them so clear and yet so far."

– Cecil Rhodes, *Last Will and Testament* (1902).[265]

"The great radio telescopes of the world are constructed in remote locations for the same reason Paul Gauguin sailed to Tahiti: For them to work well they must be far from civilization."

– Carl Sagan, *Contact* (1986).[266]

"If aliens visit us, the outcome would be much as when Columbus landed in America, which didn't turn out well for the Native Americans… We only have to look at ourselves to see how intelligent life might develop into something we wouldn't want to meet."

– Stephen Hawking, 2010.[267]

When NASA launched its first search for extraterrestrial intelligence, the High-Resolution Microwave Survey (HRMS), it chose to do so on the 500th anniversary of Columbus Day, 12 October 1992 (Figure 19). This chapter will show that tying the new endeavour to this celebration of conquest drew on long term tropes in play amongst American scientists and both CETI and SETI researchers, but also that astronomers' simultaneous embrace of this historical projection and unease with its implications illustrates particularly well the complex, socially unsettled nature of the physical 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

[265] eds. Stead, W.T. *The Last Will and Testament of Cecil John Rhodes: With Elucidatory Notes to Which Are Added Some Chapters Describing the Political and Religious Ideas of the Testator (*London: Review of Reviews Office, 1902): 203.
[266] Sagan, C. *Contact*. (New York: Simon and Schuster, New York, 1986): 28.
[267] Heussner, Ki Mae. "Stephen Hawking: Alien Contact Could Be Risky." ABC News, 26 April 2010. https://abcnews.go.com/Technology/Space/stephen-hawking-alien-contact-risky/story?id=10478157

once sailed the high seas, not knowing what lands of peoples awaited us…"[268] Since its origins in the early 1960s, CETI researchers were 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 ETI. As I will show, CETI/CETI scientists typically subscribed to a progressive social evolutionist understanding of alien as well as Earth civilizations and used such ideas to promote the linear 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 Hart, for example, became famous for his CETI paper on "intergalactic colonization" that depicted the universe as necessarily subject to expansionist colonization from technologically progressive beings.[269]

The historiography of the Cold War is increasingly taking on a postcolonial perspective.[270] The history of Cold War science and technology invariably focuses on conflict between the two superpowers. This approach is not a mistake, of course; it would be impossible to fully understand the development of science and technology during the Cold War period without understanding the dynamics between the US and USSR. But to assess this aspect of the Cold War without taking into consideration the colonial heritage of the Cold War, and the imperialistic actions and philosophies of the two superpowers, would be to neglect another important aspect of Cold War history—its impact on the rest of the world. As Marxist historian Vijay Prashad has noted, during the Cold War, nearly two-thirds of the world's people were "thrown between these two major formations… amassed as the Third World".[271] Scholars such as Andrew Hammond have shown that Cold War trope of a "clash of civilizations" has also played out in colonialism, and that, fundamentally, the "underlying ideological struggle

[268] HRMS Promotional Booklet, from National Radio Astronomy Observatory Archives, Papers of Kenneth I. Kellermann, Search for Extraterrestrial Intelligence Series, NASA's High-Resolution Microwave Survey (HRMS) folder.
[269] Swain, Nieli, Swain, Carol M., and Nieli, Russell. "Interview with Michael Hart." in *Contemporary Voices of White Nationalism in America* (Cambridge: Cambridge University Press, 2003): 184-202.
[270] eds. Hammond, Andrew. *Cold War Literature: Writing the Global Conflict*. New York: Routledge, 2006.
[271] Prashad, Vijay. *The Darker Nations: A People's History of the Third World* (New York: The New Press, 2007): xvi.

between the US and Soviet Union was a territorial competition for control of decolonised regions in the wake of European imperial retreat."[272] This novel way of examining the Cold War, which is sometimes described as studying the "Global Cold War", shows there was a strong link between the technological infrastructure of the Cold War and imperialism, a link also reflected in the ideas and perspectives of Soviet and American scientists.

I have thus far focused on links between radio astronomy's tools and techniques and their various military uses that helped sustain what might otherwise have been a rather marginal enterprise. This chapter explores another dimension of Cold War CETI, showing that the search for extraterrestrial intelligence often represented a form of cultural imperialism – writ unusually large, in hugely expansive, even if often speculative, historical and technological timeframes. Chapter One examined how the infrastructure of radio astronomy and CETI—primarily the telescopes and other instruments—facilitated both scientific and military endeavours. This chapter will further analyse the instruments of Cold War radio astronomy and CETI, paying particular attention to their locations on the Earth. Having examined the insubstantial boundaries between science and military interests in the previous

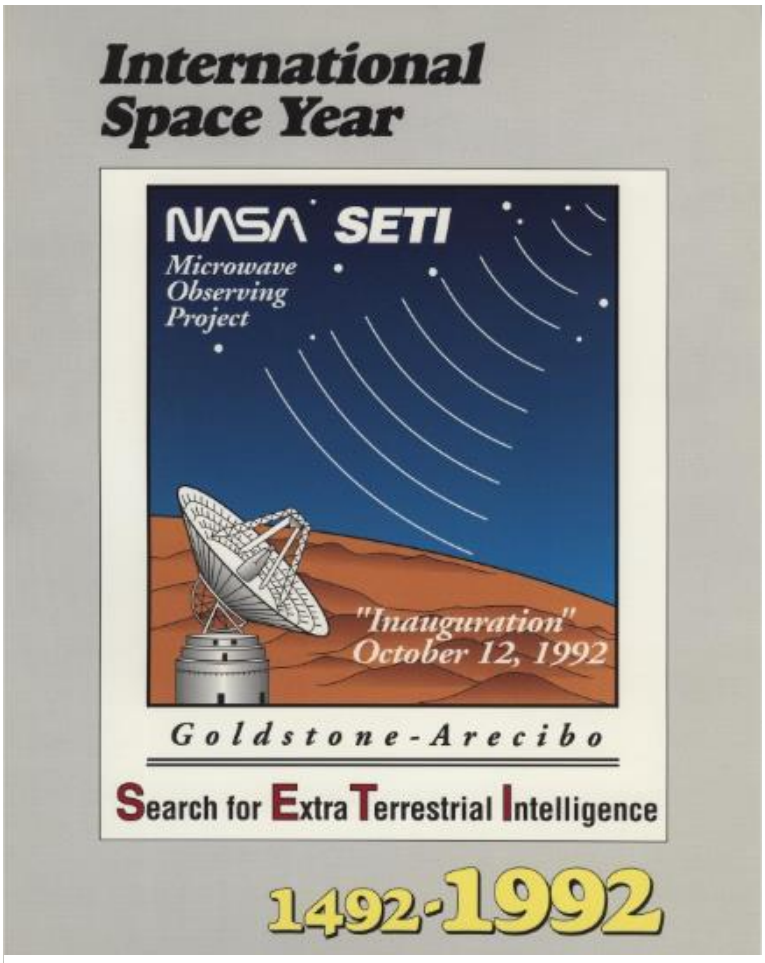

Figure 19. Poster from Inauguration of High Resolution Microwave Survey. From Collection of Kenneth I. Kellerman, NRAO Archives.

[272] eds. Hammond, Andrew. *Cold War Literature: Writing the Global Conflict* (New York: Routledge, 2006): 1-2.

chapter, I will turn my focus to both geographical and ideological boundaries. In doing so, I will reveal a conflict within the CETI community: the desire to define universality while actually remaining dependent on a technologically determinist and colonial framework.

Examining the colonial, sometimes extravagantly Columbian, rhetoric undergirding CETI will help show that even this most future-centered science was importantly historical. But there are two further senses in which treating this branch of radio astronomy as a settler science can help us better recognize the complexity – often insecurity, and sometimes violence – of its foundations. The first is based on the physical locations of CETI sciences, the second on its disciplinary homes. The tools and techniques developed for CETI almost invariably 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."[273] 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 CETI— the scientific and technical requirements necessitate a space that is unsettled (or, more significantly, *nearly* unsettled), and 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[274] or conflict with indigenous peoples.[275] CETI scientists were more concerned about self-conceptualising their

* It is important to note here that I am not claiming that every single observatory occupies settled land. There are of course many European observatories, for example, such as Jodrell Bank, that are not situated on colonised land. Nevertheless, as this chapter will show, many—if not most—astronomical observatories have uncomfortable colonial and/or imperial heritages.

[273] Davis, Donald. "The Opening Ceremony of the High Resolution Microwave Survey on October 12, 1992 at Goldstone, California." *Don Davis*, Accessed 21 June 2020. http://www.donaldedavis.com/2012%20new/HRMSSPEECH.html.

[274] Wong, Edward, "China Telescope to Displace 9000 Villagers in Hunt for Extraterrestrials." *The New York Times.* 17 Feb 2016. https://www.nytimes.com/2016/02/18/world/asia/china-fast-telescope-guizhou-relocation.html.

[275] "Mauna Kea Road Closed, Police At Very Long Baseline Array." *Big Island Video News*, 29 March 2016. https://www.bigislandvideonews.com/2016/03/29/mauna-kea-road-closed-police-respond-to-very-long-baseline-array/.

work by referencing a colonial past, without recognising the irony that their own work was so often dependant on colonised sites in the present.

Yet it would be too simplistic to argue that all CETI scientists uncritically utilized colonial rhetoric or imperial power. As this chapter will highlight, there was instead an on-going struggle within the discipline on how to contextualise this enterprise, with some scientists being deeply critical of others in their comparisons of CETI's mission to colonialism. In trying to combat their situated perspectives, some CETI 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 CETI that aimed to represent a full picture of humanity. Nevertheless, even when attempting to synthesize interdisciplinary perspectives, CETI scientist's 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 to engage with ontologies outside of the dominant Euro-American framework, caused in part by its Cold War militaristic ties, hindered CETI's creative thinking, leading to searches and messages limited by their dependency on technologically deterministic perspectives.

The Cosmic Manifest Destiny

Before addressing the specifics of early CETI 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 CETI developed. It has been well established within historical and sociological literature that colonial rhetoric was utilized in the promotion of science, especially government-funded science, in the mid-20th century. 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 US 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".[276] 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.[277] Bush recognized that the 'post-war' 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.[278] He chose to evoke the frontier myth as justification for US investment in science, maintaining 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.[279]

Bush's arguments parallel those made 52 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".[280] 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.[281] So intrinsic was the frontier to

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[276] Bush, Vannevar. *Science The Endless Frontier: A Report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development, July 1945*. Washington, DC: United States Government Printing Office, 1945.

[277][277] Holden Thorp, H. "Science Has Always Been Political." *Science* 369, no. 6501 (2020): 227.

[278] Ibid.

[279] Bush, Vannevar. *Science The Endless Frontier: A Report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development, July 1945*. Washington, DC: United States Government Printing Office, 1945.

[280] Turner, Frederick Jackson. "The Significance of the Frontier in American History." in *The Frontier in American History.* New York: Henry Holt & Company, 1921.

[281] Ibid.

American identity, Turner argued, that although "the frontier is gone… the American energy will continually demand a wider field for its exercise".[282] 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 20th 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, and Megascience* (2008), historians Hoddeson, Kolb, and Westfall argue that physicists continue to use colonial metaphors in proposals because "government funding bodies still respond well to frontier rhetoric".[283] 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 US against the frontier in its new standoff against the Soviet Union.[284] What began with Bush's call for scientific investment in 1945 led to many further cases of scientists and politicians evoking frontier rhetoric to justify costly endeavours. 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 moon-shot, 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".[285] Within contemporary space discourse, the frontier myth is still particularly effective in aiding those seeking funding. On 15 July 2018, during the US Congress Subcommittee on Space, Science, and Competitiveness, for example, Senator Ted Cruz supported governmental 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

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[282] Ibid.
[283] Hoddeson, Lillian, Kolb, Adrienne, and Westfall, Catherine. *Fermilab: Physics, The Frontier, and Megascience* (Chicago: University of Chicago Press, 2008): 9-10.
[284] Denning, Kathryn. "Social Evolution." In eds Dick, Steven J., and Lupisella, Mark L. *Cosmos and Culture: Cultural Evolution in a Cosmic Context* (Washington, D.C.: NASA History Office, 2009): 109.
[285] "John F. Kennedy Moon Speech - Rice Stadium, September 12, 1962." *NASA Johnson Space Center*. Accessed 21 June 2020. https://er.jsc.nasa.gov/seh/ricetalk.htm.

promising a frontier as the New World was some centuries ago".[286] In December 2020, a new US National Space Policy was released by the Trump administration; on the opening page of the 40 page document a quote from now former-president Trump read: "We are a nation of pioneers. We are the people who crossed the ocean, carved out a foothold on a vast continent, settled a great wilderness, and then set our eyes upon the stars. This is our history, and this is our destiny".[287]

The "pioneer" narrative used in justifying so many scientific and space investments was similarly echoed in CETI funding struggles, of which there were many. Because of its affiliation with science fiction, CETI 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.[288] 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".[289] Proxmire's ire and mockery resulted in lost CETI funding for that fiscal year. In justifying the need for the funding to be reinstated, CETI scientist Frank Drake smartly evoked the frontier myth, claiming, "When Christopher Columbus left Spain, there was no evidence the New World existed", hoping this comparison would demonstrate that some theories only seem ridiculous until there is evidence for them.[290] It was possibly an effective tactic—funding was reinstated

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[286] "Destination Mars – Putting American Boots on the Surface of the Red Planet." US Senate Committee on Commerce, Science, and Transportation. Accessed July 3, 2020. https://www.commerce.senate.gov/2018/7/destination-mars-putting-american-boots-on-the-surface-of-the-red-planet.

[287] "National Space Policy." The White House. Accessed 20 December 2020. https://www.whitehouse.gov/wp-content/uploads/2020/12/National-Space-Policy.pdf.

[288] Wisconsin Historical Society Archives, *Golden Fleece Awards, 1975-1987.* Accessed July 6, 2020. https://content.wisconsinhistory.org/digital/collection/tp/id/70852.

[289] Holden, Constance. "House Chops Sex-Pot Probe." *Science* 30 (1976): 450.; Severo, Richard. "William Proxmire, Maverick Democratic Senator from Wisconsin, is Dead at 90." *The New York Times*, December 16, 2005. https://www.nytimes.com/2005/12/16/us/william-proxmire-maverick-democratic-senator-from-wisconsin-is-dead-at.html.

[290] Drake, Frank. *The Scientist* (1988). NRAO Archives.

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 in a bid to promote its mission and revive investment, the project unwittingly betrayed a significant —but probably unintended—link between CETI and colonialism that I will show was manifest both in the spaces their instruments occupied and the metaphysical tools they employed in their search. The colonialism of Bush's speech was largely metaphorical in contrast to the more explicitly practical engagement with colonial and imperial frontiers in Turner's treatment—in other words, Bush argued that the land frontiers for pioneers had more or less literally disappeared, but CETI showed that was only partly true; the infrastructure for engaging with the cosmos still required pioneering frontiers on Earth. CETI disclosed these issues in a particularly significant framework because colonialism was more directly relevant to CETI than the other sciences pursuing expansionist frontier rhetoric in the mid-20th century. While other historians have described the use of frontier rhetoric in the sciences, my treatment of this rhetoric in CETI will show that mid-20th century CETI both possessed a perspective on alien civilizations influenced by colonial and Orientalist ideals as well as tangibly benefited from their nations' histories of imperialism.

Physical Homes: "Before You Look into Space, You Need to Respect this Place"[291]

As already noted in the introduction, historians generally consider the contemporary search for extraterrestrial intelligence to have begun with the 1960 launch of Drake's Project Ozma, which used NRAO's 85-1 telescope to observe two nearby star-systems, Tau Ceti and Epsilon Eridani.[292] Drake conducted these observations in a staff scientist position at the 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 selected for the observatory, and where

[291] Quote by Joshua Lanakila Mangauil, Kānaka Maoli, a Hawaiian activist speaking out against the telescopes on Mauna Kea. Source: Witze, Alexandra. "The Mountain-Top Battle Over the Thirty Meter Telescope." *Nature* 526, no. 7571 (2015): 24-28.
[292] Project Ozma Logbook 85-1, NRAO Archives.

Project Ozma was undertaken, was Green Bank, West Virginia. The decision to place the first US national radio observatory in Green Bank was made for strategic technical reasons.

Situated in a valley amidst the Allegheny mountain range, the National Radio Astronomy Observatory sat on 2700 acres of land acquired by the US Army Corps of Engineers on behalf of the NSF in 1956.[293] 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" (Figure 20).[294] 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.[295]

[293] Emberson, Richard. "National Radio Astronomy Observatory." *Science* 130, no. 3385 (1959): 1307-1318.
[294] Balser, Dana S., Ghigo, Frank D., and Lockman, Felix J. *But It Was Fun* (Green Bank: Green Bank Observatory, 2016): 7.
[295] Ibid, 8.

Figure 20. Photo by Rebecca Charbonneau. A view of The Green Bank Telescope at Green Bank Observatory, set in a rural valley in the Allegheny mountain range in West Virginia.

The first chapter of this dissertation explained how RFI was an important part of siting a radio astronomy observatory, and part of the motivation for establishing the National Radio Quiet Zone in the area surrounding Green Bank. In part because of this government-enforced radio silence, Green Bank today 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 Wi-Fi Ends."[296] Against the backdrop of a rural country landscape, the people who live in Green Bank sometimes sound like they have time travelled 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

[296] Drash, Wayne and Contreras, Evelio. "America's Quietest Town: Where Cell Phones Are Banned." *CNN*, July 2017. https://www.cnn.com/interactive/2015/07/us/quiet-town-american-story/.; Kennedy, Pagan. "The Land Where the Internet Ends." *The New York Times,* 21 June 2019. https://www.nytimes.com/2019/06/21/opinion/sunday/wifi-wilderness-privacy-reserves.html.

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 20th and 21st century astronomy, from the discovery of compact molecular hydrogen regions to making the first transcontinental observations using very long baseline interferometry, as described in Chapter One.[297] These feats could not have been accomplished without the establishment of the NRQZ and the isolated, radio-quiet environment on which the observatory is sited. Yet this technical reality creates a social problem—developing remote sites nearly always requires dealing with vulnerable populations, and, often, colonized or settled land.

The relationship between aerospace, astronomy, and colonialism has been well established in the historical literature. 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."[298] 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."[299]

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

[297] "History." *Green Bank Observatory*, Accessed July 23, 2020. https://greenbankobservatory.org/about/history/.
[298] Gorman, Alice. "La Terre et l'Espace: Rockets, Prisons, Protests, and Heritage in Australia and French Guiana." *Archaeologies* 3, no. 2 (2007): 154-155.
[299] Ibid.

chief who was later presented in England as an example of a 'civilized savage'.[300] The land was once the hunting grounds of the Iroquois, preserved by a 1758 treaty with Great Britain that forbade settlers from coming there.[301] 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.[302] 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.[303] 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 the top of the mountain.[304] 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'.[305]

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[300] Lewis, Robert. "Wild American Savages and the Civilized English: Catlin's Indian Gallery and the Shows of London" *European Journal of American Studies* 3, no. 1 (2008): 6.
[301] Waugaman, David. "The Great Easton Treaty of 1758: The 'Unknown' Turning Point of the French and Indian War." Master's thesis, (Wichita State University, 2017): 77.
[302] "Native American Tribes of West Virginia." Native Languages, Accessed August 1, 2020. http://www.native-languages.org/wvirginia#:~:text=There%20are%20no%20federally%20recognized,Oklahoma%20or%20other%20western%20states.
[303] "Green Bank Observatory." West Virginia Tourism. Accessed 4 June 2021. https://wvtourism.com/company/national-radio-astronomy-observatory/.
[304] Swanner, Leandra. "Mountains of Controversy: Narrative and the Making of Contested Landscapes in Post-war American Astronomy." Ph.D dissertation (Harvard University, 2013): 269.
[305] Ibid, 269.

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."[306] 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."[307] The "prayer permit" is just one example of the lack of historical insight and respect the observatory held for the beliefs and practices of 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.[308]

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."[309] 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—it regards the perception of prolonged disrespect and lack of communication between the

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[306] Ibid, 269.
[307] Ibid, 1.
[308] After subsequent outrage and negative news coverage, the University of Arizona eventually dropped its "prayer permit" and made no further arrests. For more, see: Swanner, Leandra. "Mountains of Controversy: Narrative and the Making of Contested Landscapes in Post-war American Astronomy." Ph.D dissertation (Harvard University, 2013).
[309] "`A`ole TMT Too Many Telescopes." KAHEA: The Hawaiian-Environmental Alliance, Accessed August 4, 2020. http://kahea.org/images/mauna-kea-inspired-art/a-ole-tmt-too-many-telescopes-1/view.

astronomers and the indigenous population. As one Hawaiian activist, Joshua Lanakila Mangauil, asserted: "Before you look into space, you need to respect this place".[310]

The problem of settled land and community-technical conflict similarly applies to radio astronomy observatories, including those utilized by the CETI community. For example, in the late 1960s NRAO began planning the construction of the Very Large Array (VLA), which would consist of twenty-seven 25 metre dishes, arranged in three arms that would stretch approximately 21 kilometres long. A project such as that required not only the right environment, but an immensely 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. 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.[311] Additionally, New Mexico itself was situated on settled land which historically belonged to several indigenous cultures, including 23 sovereign nations that still today call New Mexico home.[312] Because of this, 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 which "uncovered more than 3,000 artifacts dating back as much as ten thousand years."[313] Nonetheless, the VLA's construction was subsequently approved and the telescope was formally dedicated in 1980.[314] The VLA has been used for CETI, and is perhaps most famous for its appearance in the science fiction film *Contact* (1997), based on the novel by Carl Sagan, in

[310] Witze, Alexandra. "The Mountain-Top Battle Over the Thirty Meter Telescope." *Nature* 526, no. 7571 (2015): 24-28.
[311] Kellemann, Kenneth, Bouton, Ellen, and Brandt, Sierra. *Open Skies: The National Radio Astronomy Observatory and Its Impact on US Radio Astronomy* (New York: Springer International Publishing, 2020): 319-390.
[312] "Pueblos, Tribes and Nations." New Mexico, Accessed August 16, 2020. https://www.newmexico.org/places-to-visit/native-culture/pueblos-tribes-nations/.
[313] Kellemann, Kenneth, Bouton, Ellen, and Brandt, Sierra. *Open Skies: The National Radio Astronomy Observatory and Its Impact on US Radio Astronomy* (New York: Springer International Publishing, 2020): 319-390.
[314] "The Very Large Array." National Radio Astronomy Observatory, Accessed June 18, 2020, https://public.nrao.edu/telescopes/vla/.

which an alien civilization from the Vega star system succeeds in communicating with radio astronomers on Earth.[315]

Other CETI-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.[316] Once a Spanish territory, Puerto Rico came into US possession after its victory in the Spanish-American War in 1898, fuelling 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'".[317] 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.[318] 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.[319] To this day, Puerto Rico has no representation in Congress, even though the nation utilizes their bodies in war.[320]

In part due to this deleterious history, protests against US military are common in Puerto Rico, where the US additionally maintains several bases. There were protests against 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

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[315] "CETI Institute and National Radio Astronomy Observatory Team Up for CETI Science at the Very Large Array." The CETI Institute, Feb 13, 2020. https://www.CETI.org/CETI-institute-and-national-radio-astronomy-observatory-team-up-for-CETI-science-at-very-large-array.
[316] Schimmer, Russel. "Puerto Rico." Yale Genocide Studies Program, Accessed August 12, 2020. https://gsp.yale.edu/case-studies/colonial-genocides-project/puerto-rico.
[317] Little, Becky. "Puerto Rico's Complicated History with the United States." History, 1 September 2018, https://www.history.com/news/puerto-ricos-complicated-history-with-the-united-states.
[318] Ibid.
[319] Ibid.
[320] "Puerto Ricans become U.S. citizens, are recruited for war effort." History, 16 November 2009. https://www.history.com/this-day-in-history/puerto-ricans-become-u-s-citizens-are-recruited-for-war-effort.

site.[321] The observatory denied the claims, but Puerto Rican concerns about military projects in Arecibo were not unfounded. As already addressed in detail in Chapter One, there were significant connections 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 defence against extra-atmospheric offensive vehicles, including space vehicles and ballistic missiles."[322] Given the long history of military occupation of the island, many Puerto Ricans were understandably hostile to all US military activities on their land. Clearly, the siting of telescopes regards not only technical and scientific specifications, but is immersed in politics, cultural tensions, and power.

Of course, this is not to suggest that there exists conflict between all local communities and observatories. As Gorman points out, "space installations involve the creation of technological enclaves, isolated from local life, but promising benefits from participation in the global economy."[323] 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 there are protests by some Puerto

[321] "Protesters in Puerto Rico Picket Giant Observatory." *The Orlando Sentinel*, 3 April 1999. https://www.orlandosentinel.com/news/os-xpm-1999-04-03-9904030352-story.html.
[322] *Defense Advanced Research Projects Agency Technology Transition*. Arlington, VA: DARPA, 1997.
[323] Gorman, Alice. "La Terre et l'Espace: Rockets, Prisons, Protests, and Heritage in Australia and French Guiana." *Archaeologies* 3, no. 2 (2007): 165.

Ricans 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.[324]

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, taking care to note under the "Opportunities and Benefits" section on their website that the "Wajarri Yamaji people" are the title holders for the land the project will occupy.[325] Yet in each of these cases, regardless of positive impact, the observatories are still enshrouded in a legacy of colonialism, and in regard to CETI, that colonial heritage sometimes shaped the character of the search and message. The Arecibo telescope, for example, is best known in the CETI community for the message Drake sent from the telescope in 1974, aimed at globular star cluster M13.[326] 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

Figure 21. The Arecibo message, designed by Frank Drake. Image from The SETI Institute. https://www.seti.org/seti-institute/project/details/arecibo-message.

[324] *Environmental Impact Statement for the Arecibo Observatory* (Washington, DC: National Science Foundation, 2016): 287.
[325] "The Square Kilometre Array," Australian Telescope National Facility, Accessed July 20, 2020. https://www.atnf.csiro.au/projects/ska/index.html.
[326] The Staff at the National Astronomy and Ionosphere Center. "The Arecibo Message of November, 1974." *Icarus* 26, no. 4 (1975): 462-466.

average US man (Figure 21).[327] 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 which defaulted to that of an American man.

Disciplinary Homes: Imaginative Cosmos

As demonstrated by the US-male-centric theme of the Arecibo message, it is clear the connections between CETI and colonialism existed beyond their occupation of settled land or use of frontier rhetoric borrowed from the space race. They were also embedded within the disciplinary homes of CETI 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 19th 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.[328] These imaginative geographies were based "on a very unrigorous idea of what is 'out there,' beyond one's own territory."[329] 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."[330] 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 the Orientalist imaginative geography 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 rumours 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, laying exposed to the viewer, surrounded by items of luxury such as silks

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[327] Ibid.; "Average Height by State." *The World Population Review*, Accessed August 12, 2020. https://worldpopulationreview.com/state-rankings/average-height-by-state.
[328] Said, Edward. "Orientalism." *The Georgia Review* 31, no. 1 (1977): 162.
[329] Ibid, 168.
[330] Ibid, 168.

and a peacock feather duster. It 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 Ingre's part; rather, the fact 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, CETI 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. In a sense, the extraterrestrial is the ultimate Odalisque, a vision of possibilities upon which CETI scientists could project their desires and fantasies, and as we shall see, as with the Odalisque, CETI scientists' strategies often reflected common assumptions about power and gender.

As illustrated earlier in this chapter, many CETI scientists, both implicitly and explicitly, positioned themselves as Columbus-like figures. Yet the Columbus metaphor, although popular in early CETI discourse, was sometimes used in an interestingly inverted sense, imagining the extraterrestrial alien as "supercivilizations" with technological abilities far beyond current human capacities. As we saw in Chapter One, this was especially true in the Soviet Union. The previous sections thus far have focused largely on US history and observatories, arguing that US imperialism led to a scientific culture fascinated with frontier mythology as a metaphor for scientific progress. I argue that much CETI rhetoric borrowed from this ideology, leading to a perspective tainted by Western colonialism and technological determinism. Yet, in spite of the unique national context of CETI science in the US, the colonial perspective also lends itself to examining Soviet CETI to great effect. It would be ridiculous, however, to push a US framework on Soviet science. In the next few paragraphs, I will explain how Soviet CETI embodied a

technologically determinate perspective borrowed from imperialist ideologies, one different yet sharing some similarities with US CETI.

Figure 22. **Left:** V. Briskin, "Imperialism is war!", USSR 1968. **Right:** Kukryniksy, "The People of Africa will challenge the colonizers!", USSR 1961.

Part of the tragicomedy of the Cold War is that, even though the United States and Soviet Union presented themselves as foils to one another, as diametrically opposed foes, their behaviours and belief systems manifested in incredibly similar ways—in other words, sometimes they appeared more alike than different. One prominent example of this phenomenon is imperialism. To some, describing the Soviet Union as "imperial" might appear strange. After all, the Soviet Union often presented itself as the antithesis of imperialism, often using the phrase "the imperialists" as synonymous with the United States and Western Europe (Figure 22).[331] On the other hand, however, US President Ronald Regan famously described the Soviet Union as an "evil empire", positioning the Cold War as a battle between good and evil,

[331] Khrushchev, N. S. *To Avert War, Our Prime Task*. Moscow: Foreign Languages Publishing House, 1963.

with the US on the side of good.[332] What to do, then, if both nations argue the other is imperial, and that they themselves are not? Of course, defining empire is a rather difficult thing to do; historians have long struggled with this framing. Soviet historian Felix Schnell has argued that, protestations aside, the Soviet Union was (like the US) an empire, or at the very least, behaved imperially. He defines the Soviet Union as an "empire in disguise", hosting an imperial structure by way of exploitative, expansionist, and extractionist actions, but "for obvious ideological reasons", concealing the true nature of this structure. [333] Given this understanding, I will argue that both the US and USSR undertook imperialist actions and ideologies during the Cold War, while recognizing these imperialist tendencies stemmed from different origins. For while frontier mythology and the philosophy of manifest destiny promoted Space Age science in the United States, a different philosophy, Russian Cosmism, was likely a major contributor to determinist and expansionist ideologies in Soviet science and technology.[334] Originating in pre-revolutionary Russia, Cosmism is a widely known philosophical and cultural movement in Russian academia yet has gained little attention from Western academics due to the dearth of translated sources.

Cosmism was developed in the late 19th and early 20th centuries, spearheaded by philosopher Nikolai Fedorovich Fyodorov and inspired by science fiction and the development of rocketry for space travel.[335] The tenets of Cosmism focused on "active self-directed human evolution; the need for universal solutions to existential problems; …universal immortality as a human task; and a view of man as a citizen not only of the earth but of the entire cosmos".[336] Proponents of Cosmism believed "the world is in a phase of transition from the 'biosphere' (the

[332] "Evil Empire Speech – Ronald Reagan, 8 March 1983." Voices of Democracy: The US Oratory Project. Accessed 22 May 2021. https://voicesofdemocracy.umd.edu/reagan-evil-empire-speech-text/.
[333] Schnell, F. "Empire in Disguise: The Soviet-Russian Imperial Metamorphosis after World War II." *The Journal of Modern European History/Zeitschrift für moderne europäische Geschichte/Revue d'histoire européenne contemporaine* 13, no. 2 (2015): 203.
[334] This section on Russian Cosmism draws on research conducted during my Master of Science degree at the University of Oxford: Charbonneau, R. "Examining Intelligent Life in the Universe: How SETI Internationalism Facilitated Scientific Collaboration during the Cold War", Dissertation, University of Oxford, 2017.
[335] Young, George. *The Russian Cosmists: The Esoteric Futurism of Nikolai Fedorov and His Followers* (Oxford: Oxford University Press, 2012): 151.
[336] Ibid, 3.

sphere of living matter) to the 'noosphere' (the sphere of reason)."[337] The results of this transition are what Cosmists called "planetarian consciousness," which posited humanity would overcome sectarianism and divisiveness, and rationally work together to overcome disease and death, ideally culminating in "an immortal human race", which would spread throughout the cosmos.[338] Crucially, Cosmism was also technologically determinate. According to Cosmists, the predestined "teleological evolution" which would lead to cosmic immortality would be guided by technological development—a technogenesis.[339] Since Cosmism predicted a future in which all of humanity would take to the stars to live out its immortal destiny in the cosmos, it was particularly appealing to those who had dedicated their lives to space science and the medical extension of life.

Cosmism's explicit role in 20th century Russia, however, was short lived. After the Communist revolution and establishment of the Soviet Union, it was effectively banned due to the belief that it was one of many forms of counterrevolutionary mysticism, which the Communist Party worked to suppress during the early days of the Soviet Union. Under the USSR's Marxist and Leninist vision, the Party worked to fight an uphill battle against the magic, religion, and occultism, which saw the repression of Cosmist ideologies due to its spiritually charged undertones. Despite its official dedication to state atheism, however, the Soviet Union played with other forms of pseudo-religious themes, such as state mandated mythology, which drew inspiration from the Cosmist thought the party also sought to repress. Just like the American's believed in a cosmic manifest destiny, the Soviets saw something of themselves in the cosmos. While Americans created narratives about a final frontier, an extension of the driving force of manifest destiny, Soviets admired what they saw as the inherent Communism and alleged anti-imperialism of the cosmos, which was the province of humankind.

Many Cosmist thinkers, such as Konstantin Tsiolkovsky, father of Soviet rocketry, fantasised about a human destiny among the stars, of a utopian future of human harmony and cooperation. A sense of awe and wonder is fundamental to religious belief, even when divorced

[337] Ibid, 4.
[338] Ibid, 4.
[339] Hagemeister, Michael. "Russian Cosmism in the 1920s and Today." In eds. Rosenthal, Bernice Glatzer. *The Occult in Russian and Soviet Culture* (Ithaca: Cornell University Press, 1997): 185.

from a personal god or deity (a theme which will be studied further in Chapter Three); Cosmism created similar theological sentiments for those who followed it. The Soviet Union might have banned Cosmism, but Soviet preoccupation with its major tenets, and especially with its utopian futurism and cosmic ambition, remained not only in the popular zeitgeist, but in the minds and practice of Soviet scientists. In fact, several proponents of Cosmism, especially Russian philosopher and Cosmist Alexander Konstantinovich Gorsky, believed Cosmism complimented Soviet goals, and campaigned on its behalf, even writing letters to Stalin in its support.[340] In Russian academia, CETI scientists are considered among those who promoted Cosmism, perhaps implicitly, during the Soviet era. In a contemporary article in the *Herald of the Russian Academy of Sciences,* I.S. Shklovsky's CETI book *Universe, Life, Mind* (1962) is sometimes upheld as an example of a Soviet book which "complemented the worldview of Russian Cosmism" and presented ideas which served as a "theoretical cornerstone" to the philosophy.[341] Further research is needed to fully understand the role of Cosmism in 20th century scientific internationalism, but it is clear that futurist and expansionist philosophies were an important facet of shared belief amongst US and Soviet space scientists, including CETI.

Cosmism was not the only philosophy which imbued Soviet CETI. Chapter One's discussion of the 1964 Soviet CETI conference emphasized the importance of adhering Soviet science to the principles of dialectical materialism to gain state support. In an article titled "Soviet Attitudes Concerning the Existence of Life in Space", published in The Handbook of Soviet Space-Science Research (1968), Soviet astronomer Nicholas Bobrovnikoff claimed:

> [Soviet scientists] are emphatic that their materialistic philosophy is in complete agreement with the idea of extraterrestrial civilizations. According to this philosophy life is a normal and inevitable consequence of the development of matter, and intelligence is a normal consequence of the existence of life. Even the best-informed scientists in the USSR, like Oparin and Shklovsky, must necessarily subscribe to this [Marxist interpretation].[342]

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[340] Young, George. *The Russian Cosmists: The Esoteric Futurism of Nikolai Fedorov and His Followers* (Oxford: Oxford University Press, 2012): 204.

[341] Pryakhin, V. "Russian Cosmism and Modernity." *Herald of the Russian Academy of Sciences* 82, no. 6 (2012): 474.

[342] ed. Wukelic, George E. *Handbook of Soviet Space-Science Research* (New York, 1968): 456.

The word "inevitable" is important here; Like Cosmism, Communist ideology was in many ways determinate, purporting an inevitable progression of culture (towards Communism). This perspective similarly imbued the space sciences. With this interpretation, the aforementioned Kardashev scale is an excellent example of how Soviet CETI science was perfectly 'of the moment'—reflecting a uniquely Soviet perspective on life and civilization. The Soviet Union was a technocratic, expansionist, space-faring state, and therefore, so were the civilizations in Kardashev's scale. By creating the scale, he demonstrated how CETI scientists projected their understanding of technological and cultural evolution onto both Earth and alien civilization.

Carl Sagan later applied the Kardashev scale to Earth, giving it a 0.7 ranking. [343] 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 it is the presence of both those qualities that reveals the depth of colonialist assumptions at the heart of CETI, which resulted in projections of extraterrestrial civilizations in an Orientalist light. 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; it is precisely because they say nothing explicit about it that betrays the political-imperial resonance of their works. The same applies to CETI; these things do not need to be said, they are unveiled in the quietly established deterministic framework. CETI scientists were not supremely conscious of the colonial qualities of their theories—quite the opposite. It is simply assumed that this was the way the universe works, because it is how the world as they knew it worked.

There is perhaps no better example of the manifestation of this determinism than astronomer Michael Hart's influential 1975 paper, "An Explanation for the Absence of Extraterrestrials on Earth."[344] 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

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[343] Sagan, Carl, *Carl Sagan's Cosmic Connection: An Extraterrestrial Perspective* (Cambridge: Cambridge University Press, 2000: 233.

[344] Hart, Michael H. "Explanation for the Absence of Extraterrestrials on Earth." *Quarterly Journal of the Royal Astronomical Society* 16 (1975): 128-135.

* The Fermi Paradox is not really a true paradox, yet that is what it is called so I refer to it as the "paradox" here.

myth, queried the apparent emptiness of the universe during a lunch at Caltech in 1950, asking "Don't you ever wonder where everybody is?"[345] If the universe is teeming with extraterrestrial civilizations, the paradox posits, humans surely would have found evidence of them by now. CETI as a field has dedicated much effort to responding to the Fermi Paradox, with Hart's attempt being an early and notable example.[346] In his paper, Hart, then an active-but-sceptical member of the CETI community, argued that CETI scientists should extrapolate from the "only evidence concerning the behaviour of technologically advanced civilizations.... the human species."[347] Hart claimed that since the one available data point, humanity, "has explored and colonized every portion of the globe it could", it is natural to assume at least one alien civilization, if they existed, would have colonized the galaxy by 1975.[348] Since there was no evidence this had happened, Hart argued CETI was probably a "waste of time and money", though noting humanity would someday "probably occupy most of the habitable planets in the Galaxy".[349] In making this claim, Hart assumed that because some cultures on Earth engaged in colonialism, the inevitable unilineal evolutionary track would lead humanity to someday conquer the cosmos. Hart's paper was particularly influential in the CETI community. In a 1978 paper exploring the ubiquity of intelligent life in the universe, Shklovsky referenced Hart's paper and agreed that given "[that civilizations] must take to the road of unlimited expansion", it might be unlikely there were many intelligent civilizations near the Earth, since there was no apparent evidence of them.[350]

In her chapter "Social Evolution: The State of the Field" in NASA History volume *Cosmos and Culture: Cultural Evolution in a Cosmic Context* (2009), SETI anthropologist Kathryn Denning explored the popular reliance on unilineal evolution by contemporary SETI scientists and noted that SETI ideas "about extraterrestrial Others are deeply infused with thought about social

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[345] DeVito, Carl. "On the Meaning of Fermi's Paradox." *Elsevier* 106 (2019): 21-23.
[346] Hart, Michael H. "Explanation for the Absence of Extraterrestrials on Earth." *Quarterly Journal of the Royal Astronomical Society* 16 (1975): 128-135.
[347] Ibid, 132.
[348] Ibid, 132.
[349] Ibid, 135.
[350] Shklovsky, I.S. "Mind-Endowed Life in the Universe: Can It Be Unique?" *Social Sciences* 2, no. 9 (1978): 199-215 (in Russian).

evolution on Earth."[351] As a result, she argued, scientists "tend to develop syntheses that pull all human experience together into a single narrative".[352] 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".[353] 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. My historical research provides evidence that supports Denning's claims that SETI relies on unilineal social evolution—the Kardashev scale is a clear example of a theory which relies on a unilineal evolutionary perspective—but departs from her argument slightly. While Denning focuses on features of social evolution and argues that SETI's superficial engagement with the discipline has sometimes resulted in perpetuating outdated (and potentially harmful) theories, my historical framework provides a different but complimentary perspective. My research shows that CETI's dependence on unilineal evolution, what I call instead technological determinism because it is a unilineal evolution predicated on technogenesis, is not simply caused by cursory engagement with humanities subjects, but also a product of the techno-imperial Cold War atmosphere in which the field was formed.

The danger of CETI's engagement with technologically determinate social evolution 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 white people were superior) and would be best segregated from each other.[354] 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

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[351] Denning, Kathryn. "Social Evolution." in eds Dick, Steven J., and Lupisella, Mark L. *Cosmos and Culture: Cultural Evolution in a Cosmic Context* (Washington, D.C.: NASA History Office, 2009): 66.
[352] Ibid.
[353] Ibid, 79.
[354] "American Renaissance." The Southern Poverty Law Center, Accessed August 8, 2020. https://www.splcenter.org/fighting-hate/extremist-files/group/american-renaissance.

Western countries", "Racial differences in intelligence and how to deal with them", and "The Islamic threat".[355] Because of the nature of the discipline of CETI, which investigates the ideologically significant 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 19th and 20th centuries.

Let Philosophy Go to Hell

Some CETI 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 Sciences jointly sponsored a US-USSR conference on the subject of communicating with extraterrestrial intelligence, a conference which will be addressed in further detail in the next chapter. Prior to the 1971 conference, at least two CETI conferences had been held in the US and USSR, including one in Green Bank in 1961 and one in Byurakan in 1964. What made the 1971 conference unique, however, was the convergence of cultures—not only Soviet and American, but science and humanities. Therefore, at the conference, there existed not only a 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 who 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 CETI. He hoped that a historian with expertise in communication between cultures might provide some insight into how CETI might approach the problem of communication with alien intelligence. Unfortunately for the CETI scientists, McNeill was

[355] "Conference 2009," Preserving Western Civilization, Accessed August 1, 2020. https://www.preservingwesternciv.com/conference-2009-2/.

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 bewildering.[356] 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 CETI, 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".[357] 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, has condemned the superficial use of history and anthropology in CETI, 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.[358]

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".[359] 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

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[356] McNeill, William H. "Journey from Common Sense: Notes of a Conference on Communication with Extraterrestrial Intelligence, Byurakan, Armenia, September, 1971." *The University of Chicago Magazine,* LXIV: 5 (1972), 2-14, from the Wellcome Library Archives, Francis Crick (1916-2004), Box 102.
[357] Basalla, George. *Civilized Life in the Universe: Scientists on Intelligent Extraterrestrials* (Oxford: Oxford University Press, 2006): 153.
[358] DeVito, Carl. "On the Meaning of Fermi's Paradox." *Elsevier* 106 (2019): 21-23.
[359] Basalla, George. *Civilized Life in the Universe: Scientists on Intelligent Extraterrestrials* (Oxford: Oxford University Press, 2006): 153.

Russian, 'Let philosophy go to hell'".[360] This reticence to seriously engage in humanities scholarship, coupled with the unwitting utilization of 19th century social scientific modes of knowledge such as unilineal evolution, is perhaps an example of a phenomenon novelist and physical chemist C.P. Snow has called "the two cultures" problem.[361] 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".[362] Snow believed the "infiltration" of humanities subjects to the general scientist was poor, with subjects such as philosophy being "[viewed] with indifference".[363] This lack of engagement with social science encouraged the ahistorical and deterministic bias in CETI, to the detriment of the field.

Sagan, arguably the main enthusiast for incorporating social science into CETI, was also one of the few scientists critical of employing colonial metaphors in CETI. 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.[364]

[360] Interview with Lev Gindilis on 3 October 2019 in Moscow, Russia, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.
[361] Snow, C.P. "The Two Cultures," New Statesman, Republished January 2, 2013. https://www.newstatesman.com/cultural-capital/2013/01/c-p-snow-two-cultures.
[362] Ibid.
[363] Ibid.
[364] Davis, Donald. "The Opening Ceremony of the High-Resolution Microwave Survey on October 12, 1992 at Goldstone, California," Don Davis. Accessed 21 June 2020. http://www.donaldedavis.com/2012%20new/HRMSSPEECH.html.

Despite his greater mindfulness on the negative implications of utilizing colonial rhetoric, however, Sagan still reproduced a classical portrayal of humanity in his CETI endeavours.

Life As We Know It

In the early 1970s, 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.[365] 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 aluminium plaque on each probe with a message from Earth, designed by Sagan and Drake (Figure 23).[366] The plaque contained a variety of symbols, including a pulsar map intended 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. In later autobiographical writings, he claimed he tried to make the man and woman look "panracial", even though the figures were modelled after the

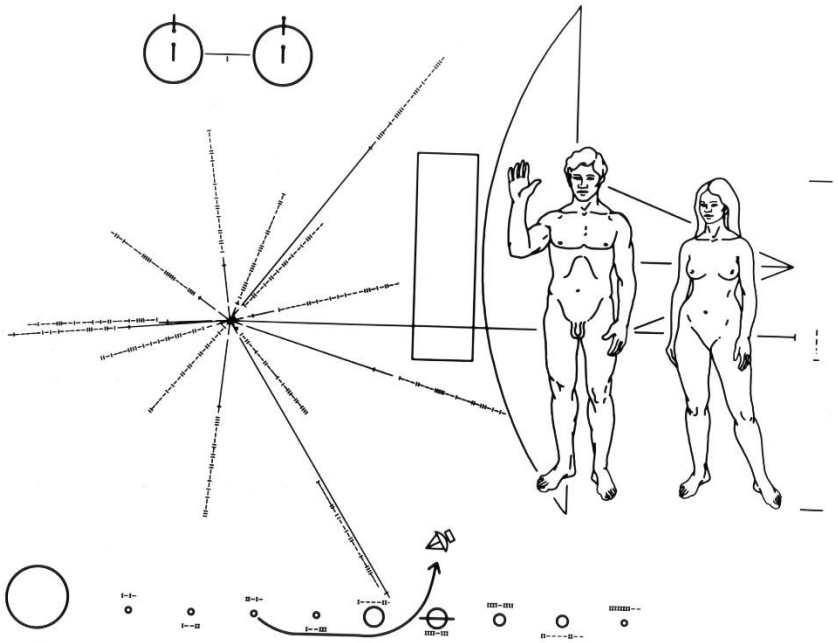

Figure 23. Pioneer Plaque Symbology, attached to the Pioneer 10 and 11 probes, launched in 1975. From NASA on the Commons.

[365] "Pioneer 10, 11." *NASA Jet Propulsion Laboratory Mission and Spacecraft Library.* Accessed June 23, 2020. https://space.jpl.nasa.gov/msl/QuickLooks/pioneer10QL.html.

[366] Howell, Elizabeth. "Pioneer 10: Greetings from Earth." *Space.com,* 18 September 2012. Accessed August 3, 2020. https://www.space.com/17651-pioneer-10.html.

Classical Greek ideal, and therefore a key motif of the iconography of 'Western Civilization'.[367] 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".[368] By this, Sagan meant there was concern that a depiction of the culturally taboo female genitalia might prevent the plaque from being approved by what he called NASA's "scientific-political hierarchy".[369] By modelling 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.

[367] Aldersey-Williams, Hugh. *Anatomies: A Cultural History of the Human Body* (New York: W. W. Norton & Company, 2013): 205.
[368] Sagan, Carl. *Carl Sagan's Cosmic Connection: An Extraterrestrial Perspective* (Cambridge: Cambridge University Press, 2000): 22-23.
[369] Ibid.

The Pioneer Plaque revealed the situated nature of what is often called "METI" (messaging extraterrestrial intelligence) or "active CETI", the act of not simply searching for intelligent signals and messages but sending them ourselves. Yet METI not only unveiled the perspectives of its message designers, it also revealed a monopoly on who was able to send messages representing Earth, and who controlled what the content may be. The earliest example of using radio facilities to contact ETI took place shortly after the Yevpatoria planetary radar complex was constructed in 1962. The Soviet Union's first message to the cosmos was sent in Morse code and used frequency manipulations to send the message "МИР ЛЕНИН СССР" [Peace/World, Lenin, USSR] to Venus (Figure 24).* In this case, the message was designed more to demonstrate the abilities of the new facilities; extraterrestrials would of course not be able to understand Morse Code, and the message was nationalist in nature, suggesting it was a show of technological power at the height of the Space Race. But the use of the Yevpatoria array in this manner also suggested the real possibility of engaging in cosmic conversation, for the first time in human history.

В космосе слова: «Ленин», «СССР», «Мир»

Первая в мире радиолокация планеты Меркурий ◆ Радиоразговор Земля—Венера—Земля.

Институт радиотехники и электроники Академии наук СССР сообщил агентству печати Новости (АПН) о новой победе советской науки и техники.

Как известно, исследование планет Солнечной системы до последнего времени производилось астрономическими методами, в основе которых лежит наблюдение отраженного планетами солнечного света и собственного теплового излучения планет. Создание мощных передатчиков, больших антенных сооружений и чувствительных приемных устройств позволило в настоящее время получить радиолокационные отражения посланных с Земли сигналов от ближайших планет — Венеры и Меркурия.

Впервые успешная радиолокация планеты Венера была проведена в 1961 году одновременно в Советском Союзе, Англии и Соединенных Штатах Америки. Целью этих экспериментов было определение астрономической единицы — основного масштаба при измерении космических расстояний, оценка периода вращения Венеры и получение данных о ее поверхности.

До последнего времени астрономическая единица и определяемые через нее расстояния в Солнечной системе были известны с ошибкой, как теперь выяснилось, около 0,1 процента. Такая, казалось бы, высокая точность была достаточна для астрономических наблюдений, но совершенно недостаточна для вождения межпланетных космических кораблей. Ошибка определения расстояния до планеты Венера, например, составляла несколько ее диаметров, то есть порядка 50 тысяч километров.

Для радиолокационных наблюдений Венеры в Советском Союзе использовались радиосигналы на частоте около 700 мегагерц. Расстояние до Венеры в этих наблюдениях (около

Л Е Н И Н

С С С Р

М И Р

45 миллионов километров) было в 120 раз больше, чем расстояние до Луны.

Значение астрономической единицы, полученное по этим измерениям, составляет 149.599.300 километров, с максимальной ошибкой в две тысячи километров.

Коэффициент отражения Венеры, определенный по принятым радиосигналам, составил 8 процентов.

какое наблюдается при радиолокации Луны.

Следующим этапом радиолокационного изучения планет является произведенная в октябре—декабре 1962 года в СССР повторная радиолокация планеты Венера. На протяжении этого времени регулярно производились измерения расстояния до Венеры и наблюдения за свойствами поверхности. Результаты измерений сейчас обрабатываются.

Одновременно с этим **советским ученым впервые в истории человечества 19 и 24 ноября 1962 года удалось осуществить радиосвязь через планету Венера.** Переданное с Земли телеграфным кодом 19 ноября 1962 года слово «МИР» достигло планеты Венера, отразилось от нее и, пройдя общее расстояние 81 миллион 745 тысяч километров, через 4 минуты 32,7 секунды было принято опять на Земле.

24 ноября этим же методом на планету Венера были переданы слова «ЛЕНИН», «СССР». Отразившись от поверхности планеты, через 4 минуты 44,7 секунды эти слова были приняты на Земле. Общий путь, который они прошли в космосе, равен 85 миллионам 360 тысячам километров.

Подробные результаты радиолокационных наблюдений Меркурия и Венеры в 1962 году будут опубликованы в научных журналах.

Создание в Советском Союзе мощного космического радиолокатора и проведение с его помощью наблюдений планет Венера и Меркурий — результат работы большого коллектива представителей науки и техники.

Figure 24. "Words to the Cosmos: Peace, Lenin, USSR." *Krasnaia Zvezda* 30 December 1962.

As already evidenced by the Pioneer Plaque, the politics of messaging ETI were rife with Earthly tensions. In the mid-20th century, the world was undergoing what is sometimes called

* It should be noted that while the intention was to send the message to Venus, it was later calculated in 2002 that the message was probably unintentionally sent in the direction near the star HD131336 in the Libra constellation.

"planetary consciousness": the awareness that human beings share (and are responsible for) one planet.[370] This was touched upon in the introduction, when I discussed how the psychology of space flight and CETI introduced concepts such as the Cosmic Mirror, which purported to promote a unified global perspective. Planetary consciousness can also be seen in the establishment of world governmental organizations during the mid-20th century, such as the United Nations and the World Health Organization. In the case of METI, planetary consciousness posed troubling questions—who should speak on behalf of Earth? Whose perspectives should be represented, and most importantly, who had the *ability* to speak for Earth (meaning, access to the tools and techniques required to send messages). Furthermore, some worried that establishing contact with ETI could be dangerous. For example, shortly after Kardashev published his paper on the scale of civilizations, the *New York Times* printed an article written by biochemist and author Isaac Asimov titled "Hello, CTA-21—Is Anyone There?".[371] In his article, Asimov took seriously Kardashev's suggestion that CTA-21 and CTA-102 might be evidence of supercivilizations who Asimov surmised might be "several thousands of years ahead of us [in technological evolution]".[372] Asimov acknowledged that some people might have concerns that messaging ETI might bring unwanted attention: "Even we ourselves, so little removed from the Nazi horrors… Are supercivilizations to be less decent than our imperfect selves?"[373]

In some cases, individuals tried to craft their own messages to ETI, outside of a state or institutional setting such as NASA or Yevpatoria. For example, Joe David, an artist, upon learning that "the images of humans placed aboard the Pioneer 10 and 11 spacecraft show impeccably groomed men that lack any facial and body hair and women with no external genitalia", decided to take the matter of human representation to the cosmos into his own hands. He designed a device which consensually recorded the vaginal contractions of ballerinas before converting the recordings into radio signals. He also designed what he called a "Vaginal

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[370] Laszlo, Ervin and the Dalai Lama. "Manifesto on Planetary Consciousness." Accessed 2 June 2021. https://web.archive.org/web/20120828003626/http://www.worldshiftinternational.org/manifesto-planetary-consciousness/.
[371] Asimov, Isaac. "Hello, CTA-21—Is Anyone There?" *The New York Times,* 29 Nov 1964.
[372] Ibid.
[373] Ibid.

Excursion Module" which he would use along with MIT's Millstone radar facility to broadcast the signals to four star systems, including Tau Ceti and Epsilon Eridani, which were the two systems Drake observed in Project Ozma.[374] The Millstone facility, however, was contracted to the Air Force by MIT—yet another example of the military-industrial complex at play within astronomy. Davis later noted to a journalist that his project, named "Poetica Vaginal", was responding to the Pioneer plaque censorship not with the extraterrestrial in mind, but the human: "By making this attempt to communicate with the other… we're really communicating with ourselves."[375] Unfortunately for Davis, however, the Air Force found out about the contents of Poetica Vaginal, and shut his broadcast down after only 20 minutes.[376] Clearly, there was no democratic access to cosmic communication, and, as was also the case with the figures on the Pioneer Plaque, the message could be controlled by those in power.

Drake and Sagan were given another attempt at METI through their involvement with NASA. In 1972, NASA had an ideal opportunity to launch two spacecraft, named Voyager 1 and 2, to explore the outer solar system, which included visits to Jupiter, Saturn, Uranus, and Neptune. The opportunity was golden because the precise locations of the planets—a rare alignment which only occurs every 175 years—allowed the engineers to use gravitational slingshots to efficiently accelerate the probes, turning a potentially 30-year journey to Neptune into just 12 years. Several months before the launch, Carl Sagan lobbied NASA for the opportunity to attach another METI design to the probes and received approval. He gathered a small team to design the message, which included himself, Drake, writer Ann Druyan, artist Jon Lomberg, and his then-spouse Linda Salzman-Sagan. The final product would be a set of records, coated in gold to protect them from debris and radiation on their journey through the interplanetary medium. Limited in space, the contents of the record would only be able to include about 115 images and a short suite of audio recordings including music, spoken greetings, and natural sounds of Earth. The images depicted the Earth and other planets in our

[374] "Poetica Vaginal." JWZ. Accessed 15 April 2020. https://www.jwz.org/blog/2010/01/poetica-vaginal/.
[375] Gibbs, W. Wayt. "Art as a Form of Life." Scientific American. Accessed 15 April 2020. http://www.thegatesofparadise.com/joe_davis.htm.
[376] Ibid.

solar system, DNA, and various images of life on Earth, such as sports events, a traffic jam, the Arecibo telescope, a Chinese dinner party, and a school of fish.[377]

Sagan credited his inspiration in designing the Voyager Golden Record back to a childhood visit to the 1939 New York World's Fair, when he was five years old. Walking among the scientific marvels of the "World of Tomorrow" and the displays from civilizations around the world, Sagan claimed to have had an important epiphany stemming from the main message communicated by the World Fair: "there were other cultures and there would be future times".[378] What if those other cultures included extraterrestrial cultures, and in those future times there were space-faring civilizations? This sparked an early interest in Sagan in communicating with alien cultures, both those on Earth and in the Universe.

There was a recognition by the Voyager team that the Record was equally, if not mainly, a form of communication with Earthlings, rather than extraterrestrials. A consultant on the Record, Hewlett-Packard executive and SETI engineer Barney Oliver, told Sagan:

> There is only an infinitesimal chance that the plaque will ever be seen by a single extraterrestrial, but it will certainly be seen by billions of terrestrials. Its real function, therefore, is to appeal to and expand the human spirit, and to make contact with extraterrestrial intelligence a welcome expectation of mankind.[379]

Recognizing this truth, and that close attention would be paid by Earthlings to the contents of the Record, there were understandably concerns that the Record would be biased from a US-dominant perspective, and so great efforts were made to avoid this bias. Yet, for a message which purported to concern extraterrestrials, the Golden Record team often found themselves inexplicably dealing with Earth-based problems.

For example, Sagan decided to include a collection of greetings on the Record and determined the best thing to do would be to collect audio recordings of simple greetings, such

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[377] "Images on the Golden Record." NASA Jet Propulsion Laboratory. Accessed 13 March 2021. https://voyager.jpl.nasa.gov/golden-record/whats-on-the-record/images/.
[378] eds. Sagan, Carl. *Murmurs of Earth: The Voyager Interstellar Record* (New York: Ballantine Books, 1979): 3.
[379] Ibid, 11.

as “Hello”, from a wide variety of Earth languages. His initial thought was to visit the UN headquarters in New York City, suggesting that a delegate from each member nation stop by the sound studio to say their indigenous version of “Hello”. In addition to national and ethnic diversity, Sagan also hoped to have a roughly balanced gender representation among the voices. Unfortunately, he discovered that “virtually all the chiefs of delegations were male, and it was unlikely that they would delegate the privilege of saying ‘Hello’ to the stars to anyone else”.[380]

This presented a problem for more reasons than one. It left a burning question in the design of the Record: Should the team represent the world as it truly was, including the gender imbalance in leadership resulting from a long legacy of patriarchy, as well as other forms of oppression such as racism and war? Lomberg, who was tasked with designing the image collection, noted the team decided against this “truthful” representation of humanity, instead opting for a “best foot forward” approach. There were concerns, for example, that depictions of war or nuclear bombs might be interpreted as hostile and threatening to an extraterrestrial civilization. Therefore, the Record was devoid of images of violence, colonialism, slavery, and other human ills.

But even a “best foot forward” approach presented problems, because humans on Earth could not agree on what made a good first impression. For example, in a collection of essays on the international music content of the Record, Sagan recounted a story in which the US team selected “The Young Peddler” as its principal example of Russian folk music. The song, which predated the Soviet Union, had lyrics that told a story of a salesman interacting with a young woman, as they haggled and debated over the price and quality of the goods he was attempting to sell. The story used the argument over goods as a metaphor for romantic courtship and marriage. The Soviet Union was unhappy with the representation of Russian music being a single song honouring a capitalistic transaction, which undermined their ideological stance that human society would eventually move towards Communism. Sagan wrote to an unnamed Soviet colleague asking for a better suggestion. The request was taken seriously and debated

[380] ed. Sagan, Carl. *Murmurs of Earth: The Voyager Interstellar Record* (New York: Ballantine Books, 1979): 24.

thoroughly within the USSR Academy of Sciences, which eventually recommended "Moscow Nights", a popular Soviet song with simple, descriptive lyrics about an evening in Moscow. Unfortunately, the response with their choice arrived too late for incorporation into the Record, and Sagan had selected instead "Tchakrulo", a Soviet Georgian song about revolt against a tyrannical landlord, in an attempt to include a song which aligned with Soviet ideals. Clearly, the introspection caused by crafting messages to aliens evoked passion and disagreement stemming from conflict on Earth.

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, as already argued in the introduction and the above analysis of Orientalism. Lomberg once claimed, "I found myself increasingly playing the role of extraterrestrial" as he attempted to figure out how to best represent the Earth in only 115 images. In other words, in trying to give a fair representation of Earth and human culture, the team tried to view the world around them as outsiders, with the hope that this perspective would aid them in constructing a universal view of the planet. 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."[381] Missing from this perspective, however, was the recognition that we often inadvertently replicate the familiar when attempting to summarize the world. We are limited by our situated perspectives, or life as *we* know it. When assessing the pushback from feminists regarding the depiction of the woman on the Pioneer Plaque, for example, Drake noted Linda Salzman-Sagan, Sagan's wife who had drawn the figures for the plaque, was surprised at the accusations of sexism, as she considered herself a "liberated woman" and had not intended to present women as unequal to men.[382] But this example demonstrates the inherent bias of our situated perspectives, even when trying to convey universality. Linda Salzman-Sagan might not have consciously considered women more passive or less powerful than men, but it certainly was a truthful representation of her contemporary culture, just as the UN delegation represented the gender imbalance within political representation. Salzman-

[381] Said, Edward. *Orientalism* (New York: Pantheon Books, 1978): 259.
[382] ed. Sagan, Carl. *Murmurs of Earth: The Voyager Interstellar Record* (New York: Ballantine Books, 1979): 59.

Sagan's unconscious bias demonstrates a limitation in our ability to convey universality; even when aspiring towards an objective and unbiased perspective, we inevitably betray our own experiences.

The introduction to this dissertation introduced the idea of the Cosmic Mirror, the notion that taking the alien point of view reflects our own biases, prejudices, and perspectives back at us. There is a long history of people evoking beings on other worlds when evaluating our own. Even Benjamin Franklin, for example, evoked a concept like the Cosmic Mirror when condemning bringing Africans over to the Americas as slaves, not because of the violation of human rights, but because of aesthetics:

> I could wish their numbers were increased. And while we are, as I may call it, scouring our planet, by clearing America of woods, and so making this side of our globe reflect a brighter light to the eyes of inhabitants in Mars or Venus, why should we… darken its people? Why increase the Sons of Africa, by planting them in America, where we have so fair an opportunity, by excluding all blacks and tawneys, of increasing the lovely white and red?[383]

In that case, Franklin's evocation of an alien viewpoint reflected his own racism and the paternal colonialism of his time. Clearly, ideas of universality and an alien outlook tend to reveal more about the scientists and their situated perspectives than they do the universe or extraterrestrial life. In other words, the messages we send to aliens say more about the messenger than anything else.

Conclusion

One might reasonably argue that because the Pioneer Plaque or Voyager Record were mainly designed by white, American men in the 1970s—a period and culture in which men were generally viewed as more dominant than women, and white people held more power and visibility than other racial groups—it is understandable that the plaque represented their

[383] Gould, Stephen Jay. *The Mismeasure of Man* (New York: W.W. Norton & Company, 1996): 64.

perspective of Earth culture. After all, it is common for humans to centralize and prioritize the familiar. For example, representations of Jesus Christ often reflect local norms in the colour of his skin; it would not be surprising to travel to an Ethiopian Orthodox Tewahedo Church and discover icons of Jesus Christ depicted as an Ethiopian man. Viewing the Pioneer Plaque as an artefact of a moment in time and place would be a fair historical perspective. Yet because CETI aims to represent not a single culture, but an entire species, it behoves scientists to critically interrogate their situated perspectives. Just like the Kardashev Scale, what was being universalised was assumed to already be universal at the start—there was little introspection into how they came to possess their frame of reference. Assuming 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 inhabited them, but it additionally hindered their science goals. The highly specific sociological placing of CETI 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 and was exceptionally 'of the moment' in the Cold War period.

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, researched the sustainable practices of various Native American nations, and argued 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".[384] In other words, not all Earth cultures have a history of colonialism or environmental extractionism. A CETI 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

[384] Marchand, Michael E. "The River of Life: Sustainable Practices of Native Americans and Indigenous Peoples." Ph.D Dissertation (University of Washington, 2013): 3.

suggest intelligent civilizations may be sustainable and localized.[385] 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 considering alternative ontologies may be of benefit to CETI scientists regards the search for a 'universal' language. CETI 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. Yet, while it may be the case that the behaviour and composition of matter in the universe are uniform, the 'laws' of physics themselves are a human language, and there is even variation within mathematical and physical systems in different cultures on Earth. For example, cognitive scientist Rafael Nunez studied 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 the Yupno people have no concept of a number line, which is a foundational concept in mathematics that "maps numbers to unidimensional space".[386] 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".[387] If mathematics as a language is not universal on Earth, it can hardly be said to be cosmic. As historian of science Bruno Latour notes in *Science in Action* (1987), although scientific predictions may be successful within the networks they operate in, "no one has ever observed a fact, theory, or machine that could survive outside of the networks that gave birth to them".[388]

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[385] Haqq-Misra, Jacob D., and Baum, Seth D. "The Sustainability Solution to the Fermi Paradox." *Journal of the British Interplanetary Society* 62, no. 2 (2009): 1.
[386] Ibid.
[387] Ibid.
[388] Latour, Bruno. *Science in Action: How to Follow Scientists and Engineers Through Society* (Cambridge: Harvard University Press, 1987): 248.

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 CETI 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".[389] Yet when they travelled from Athens to Crete to begin the project, "they were met with a totally unexpected 'outside'" when they discovered the local inhabitants were not willing to have their land expropriated.[390] 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 have always been aspects of siting astronomical observatories, but one by and large underappreciated by scientists and funding bodies, resulting in many of the conflicts seen today.

Colonial heritage marked and limited how CETI scientists listened and how they spoke—both to each other and to extraterrestrials. That marking was complex— as with the 19th century Odalisque, CETI 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 US, leading to a highly deterministic perspective. The aim of this chapter is not to argue that we must entirely condemn astronomy or CETI 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

[389] Ibid.
[390] Ibid.

another. Nor does this chapter attempt to argue that CETI is an unworthy pursuit. In fact, even if extraterrestrial life were never discovered, CETI might be a valuable endeavour regardless, even if only for the reflectivity it engages in scientists who must grapple with social and abstract questions in its pursuit. For in addition to the imaginative cosmos and alien Odalisque conjured by scientists, CETI has also offered representations of the self, as seen in the figures on the Pioneer Plaque and Drake's Arecibo message. In that sense, CETI also presented the inverse of the Odalisque; in addition to making the alien familiar, it attempted to reproduce the self as alien. It was a challenge to define the alien in part because it was difficult to define ourselves, so CETI scientists described the alien by making assumptions about who *we* are, and the history of colonial expansion and military imperialism surreptitiously defines our world. Furthermore, as a product of the Cold War period, and utilising its institutions and tools, it might be helpful to conceptualise mid-20th century US and Soviet CETI/METI as not directly communicating with extraterrestrials but representing a dialogue between the US and USSR in particular. As Sagan was cognizant of in creating the Golden Record, the principal audience of METI was on Earth. Like with the mention of Lenin in the Soviet 1962 message, or in the promotion of patriarchal puritanism in the Pioneer Plaque, each nation aimed to (quite literally) universalise its own ideals. Given the expansionist and imperialist values of these nations, it is no wonder these values were also replicated in CETI messages.

As the CETI 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 a few prominent astronomers now actively advocating for the relocation of telescopes such as the TMT. While some observatories face greater economic and social consequences due to the legacy of colonialism than others, it is clearly of both moral and technical importance 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 behoves CETI scientists to communicate across borders—interdisciplinary, national, and cultural—in their pursuit of cosmic communication. 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 if there is

no 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.

Chapter Three:

Life

"If they [other planets] be inhabited, what a scope for misery and folly; if they be not inhabited, what a waste of space".[391]

— Attributed to John Carlyle (1795-1881) by John Burroughs in *Accepting the Universe* (1920)

"In order to undertake meaningful communication with extraterrestrial intelligence it would seem that meaningful communication among terrestrial intelligence is a prerequisite."

— Carl Sagan, *Communication with Extraterrestrial Intelligence* (1973)

In the first chapter, I demonstrated both that radio astronomy developed directly out of military infrastructure and support, and that there was a direct link between the goals of both CETI and the intelligence community, leading to a significant yet wrought relationship between the two communities. Given this mutually beneficial connection, the motivation of the governments and militaries of the US and USSR to invest in both radio astronomy and CETI was made clear. The second chapter dealt with the disciplinary boundaries of CETI and explored a different dimension of its relation to military influence by way of postcolonial analysis. This analysis revealed a tension within the CETI community: the desire to define universality while dependent on a determinist and colonial framework. Insufficiently addressed in both chapters, however, was the motivations of individual scientist's interest in CETI, and how those came to be developed. The main goal of this dissertation is to show how CETI encapsulates the major tensions in Cold War science, and this would be impossible to achieve without assessing the mindsets of the individuals pursuing the science. Thus, this chapter shifts the focus from

[391] Burroughs, John. *Accepting the Universe*. Boston: Houghton Mifflin, 1920.

institutions and disciplines to individual scientists and explores how Cold War anxieties fuelled an interest in pursuing the question of finding intelligent life in the universe.

As we saw in the second chapter, the desire to define universality stemmed from a belief that there were unifying forces that CETI cultivated, a belief that has so far been identified as the Cosmic Mirror. CETI has long been considered an internationalist scientific pursuit because the notion of viewing humanity as a singular whole in a potential universe teeming with other intelligent civilizations was thought to bring about a global perspective. This hopeful scientific internationalism is reflected in much of the discourse and material culture surrounding the search for and communication with extraterrestrial intelligence. For example, the anti-national "flag of Earth" (Figure 25) flies in many places associated with the field, such as the Ohio State University Radio Observatory and the offices of the premiere 21st century technosignature initiative, Breakthrough Listen. Indeed, many technosignature researchers, in studying the potential cultural impact of discovering extraterrestrial intelligence, have argued that the discovery of life on other worlds could possibly bring about global unity or peace.[392] Nor is this phenomenon exclusive to CETI. As shown in the introduction, the space sciences in general, including radio astronomy, often rely on internationalist rhetoric.

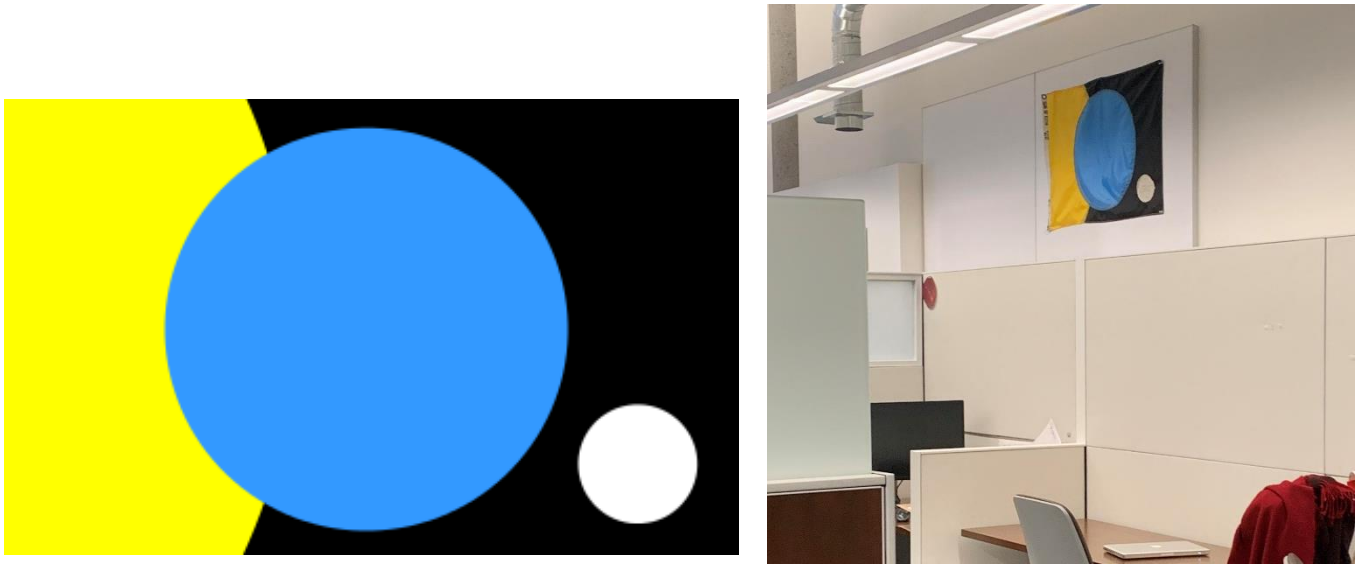

Figure 25. **Left**: The Flag of Earth, created in 1970 by James W. Cadle. **Right**: Photo by Rebecca Charbonneau. The Flag of Earth as seen inside the offices of Breakthrough Listen in Berkeley, California.

[392] Michaud, M. A. G. *Contact with Alien Civilizations: Our Hopes and Fears about Encountering Extraterrestrials* (New York: Copernicus Books, 2007): 292–293.

In its Cold War context, the Cosmic Mirror might be best understood as a form of the sublime, a concept developed by British philosopher Edmund Burke in his treatise *A Philosophical Enquiry into the Origin of our Ideas of the Sublime and Beautiful* (1757).[393] Eighteenth century artists such as J.M.W. Turner captured the sublime by painting scenes of nature such as storms and big waves that inspired a sense of awe and captured a feeling of being small and powerless when confronted by the great forces of nature (Figure 26). The Cosmic Mirror is often evoked in popular writing on space sciences, such as that in Carl Sagan's *Pale Blue Dot* (1994) which, like the Romantic sublime, elicited a sense of wonder that stemmed from an understanding that we are small in the face of an endless universe. In *Pale Blue Dot*, Sagan wrote about the view of Earth in a photograph taken by the Voyager probe, described in

Figure 26. Joseph Mallord William Turner, *Snow Storm - Steam-Boat off a Harbour's Mouth*, exhibited 1842 https://www.tate.org.uk/art/artworks/turner-snow-storm-steam-boat-off-a-harbours-mouth-n00530.

[393] Burke, Edmund. *A Philosophical Enquiry into the Origin of our Ideas of the Sublime and Beautiful*. London: John C. Nimmo, 1757.

the last chapter (Figure 27). In viewing the small light speck of the Earth surrounded by the depths of interplanetary space, Sagan stated:

> Our posturings, our imagined self-importance, the delusion that we have some privileged position in the Universe, are challenged by this point of pale light. Our planet is a lonely speck in the great enveloping cosmic dark. In our obscurity, in all this vastness, there is no hint that help will come from elsewhere to save us from ourselves.[394]

The description invokes a sense of helplessness, and Sagan uses that feeling to argue for peace and empathy, stating that the humility brought upon by the Voyager image should "[underscore] our responsibility to deal more kindly with one another, and to preserve and cherish the pale blue dot, the only home we've ever known".[395] Interestingly, Burke described the sublime as "whatever is in any sort terrible or is conversant about terrible objects or operates in a manner analogous to terror, is a source of the sublime', drawing a direct line between wonder and fear.[396] That fear is present, albeit subtly, in Sagan's description of the Pale Blue Dot. In this chapter, I will argue this combination of fear and hope is a fundamental part of the development of CETI, brought about largely by Cold War anxieties and a reckoning with mortality not only of the individual, but of the entire species. In doing so, I will address why CETI developed primarily in the US and USSR as opposed to other countries and further my argument that CETI was a direct product of the Cold War, primarily due to major military and government investment in scientific infrastructure and the influence of the Space Race on Soviet and American scientific and popular culture. The Cosmic Mirror created both a global perspective which prompted CETI pioneers to attempt to shed nationalism in

[394] Sagan, Carl. *Pale Blue Dot: A Vision of the Human Future in Space*. New York: Ballantine Books, 1994.
[395] Ibid.
[396] "Sublime." Tate Modern. Accessed 3 March 2021. https://www.tate.org.uk/art/art-terms/s/sublime#:~:text=Theory%20developed%20by%20Edmund%20Burke,Tate.

cooperation with their international peers, while also creating a new cosmic framework within to observe the global conflict and terrors of the Cold War.

Figure 27. The Pale Blue Dot, captured by the Voyager 1 probe. Image from NASA/JPL-CalTech.

Additionally, CETI's development during the Cold War led CETI researchers to face specific challenges regarding communication and collaboration across the Iron Curtain. I will show here that although CETI scientists in the 1960s were preoccupied with finding and communicating with extraterrestrial life, they simultaneously faced great challenges meeting and communicating with one another. These barriers to communication included restrictions and censorship in publication, mail interference, travel restrictions, and ideological differences. We might describe these as difficulties transmitting and interpreting textual signatures rather than technosignatures, and I will suggest that their search for extraterrestrial intelligence was complexly related to the diverse dimensions of interterrestrial intelligence. Understanding the role the Cold War played in inspiring scientists to pursue CETI will also reveal why the mid-20th century science was the exclusive domain of the US and USSR.

In addition to fostering a recognition of the influence of the Cold War on the philosophical questions posted by CETI, it is my hope this chapter will give the reader a greater

appreciation for the tenacity of early CETI pioneers, especially those who contributed from the Soviet Union. To illustrate the crisis of communication with the "alien"—both those on other planets and on Earth— during the Cold War, I will focus especially on the interactions between US astronomer Carl Sagan and Soviet astrophysicist I.S. Shklovsky and their attempts at publishing the first popular CETI book in the mid-1960s. In exploring the history of the Cold War and relations between the Soviet Union and United States, a greater context for the development of CETI emerges, providing insight into both the cosmic and Earth-based challenges faced by CETI pioneers. The Cosmic Mirror is rooted in both a unifying sense of wonder and deep terror—so too did the Cold War and its scientific-technical products foster deep awe of human achievement and its capacity for self-destruction. It is here where the chapter title, "Life", will take on an alternative meaning; not only will this chapter assess the scientific preoccupation with finding and defining life in the universe, but it will also call attention to the lives of CETI practitioners and develop a more personal understanding of their desires, motivations, and fears.

Radio to Stars

To understand the role of the Cold War in the development of CETI, it is first important to recognize how the intervention of technology revolutionized the approach to the question of the plurality of worlds. In Chapter One, I explained how the development of radar facilitated the growth of radio astronomy as a post-war discipline. And of course, it is the development of radio astronomy which led to the development of CETI, as evidenced by the launch of the first CETI projects in the 1960s, such as the previously discussed Project Ozma and Soviet observations of CTA-21 and CTA-102. Yet there is an interesting gap which I have not yet addressed. As noted in Chapter One, radio astronomy and its infrastructure developed rapidly in countries which had played a role in World War II radar development, including Britain, Australia, and the Netherlands. I have argued that the United States had a late start in developing radio astronomy and was primarily motivated by military application and the scientific-technical competition with the Soviet Union. I have also suggested that it was the development of these facilities that prompted the development of CETI. This leads to a pressing

question: why did the countries with thriving radio astronomy programs, other than the US and USSR, not develop an interest in CETI?

Before addressing this question, it is important to note that the development of radio astronomy as a field in the 1950s was not the sole cause of CETI—as stated in the introduction, ideas on using technology to pursue contact with extraterrestrials have existed for centuries, in a wide variety of countries. Yet until the start of the Cold War, the question of humanity's place in the cosmos remained a largely speculative one (at least as far as most commentators were concerned), mostly resigned to the musings of philosophers and theologians. In ancient Greece, atomist thinkers theorized on the plurality of *kosmoi*,[397] and in early modern Europe, physicists inspired by Copernicanism published tomes speculating on the existence of other planets, peopled just as Earth was.[398] These ponderings on the nature of the universe over the course of millennia are often referred to by historians as the "extraterrestrial life debate".[399]

In the 19th century, however, scientists began to explore the question of extraterrestrial life using scientific instruments such as the optical telescope, though their attempts remained largely rooted in conjecture and imagination, rather than systematic and empirical inquiry. For example, in 1906, Percival Lowell published a book titled *Mars and Its Canals*. In this book, Lowell, an American businessman and mathematician who had previously founded an astronomical observatory, asserted Mars was populated by intelligent life that had built intricate canals on the surface of the Red


THE TOMAHAWK, WHITE EARTH, MINN.

Nello, Earth! Nello!"

Marconi believes he is receiving signals from the planets

Figure 28. Illustrations of Tesla and Marconi in an article titled "Hello Earth! Hello!" in *The Tomahawk*, March 18, 1920, Image 6. Digital scan held in the Library of Congress.

[397] Dick, Stephen J. *Plurality of Worlds: The Origins of the Extraterrestrial Life Debate from Democritus to Kant*. Cambridge: Cambridge University Press, 1982.
[398] Huygens, C. *ΚΟΣΜΟΘΕΩΡΟΣ* (English translation of Latin: *Cosmotheoros: The Celestial Worlds Discover'd: or, Conjectures Concerning the Inhabitants, Plants and Productions of the Worlds in the Planets*). London: Timothy Childe, 1698.
[399] Crowe, Michael. *The Extraterrestrial Life Debate, 1750-1900*. New York: Dover Publications, 2011.

Planet.[400] Such assertions were not without some observational basis; Lowell had made countless observations of Mars in his observatory, and in 1907 published a mathematical essay in which he attempted to prove that the mean surface temperature of Mars was similar to an unseasonably warm winter day in England.[401] Still, even speculation rooted in some form of empiricism was inevitably unsubstantiated, and as a result, drew criticism and mockery from both the public and his scientific contemporaries. Alfred Russel Wallace, for example, published an entire book in refutation of Lowell's assertions, in which he sharply concluded: "Mars… is not only uninhabited by intelligent beings such as Mr. Lowell postulates, but is absolutely *uninhabitable*".[402] Because of a hypothesis which lacked falsifiability, in addition to the eccentric characters who investigated it, such as Lowell, the extraterrestrial life debate had a dubious reputation within the scientific community. But there was soon a dramatic shift in the scientific perception of the extraterrestrial life debate, thanks to the development of radio technology.

Interest in using radio technology to communicate with extraterrestrials has been around for nearly as long as radio technology itself. The newfound ability to communicate with foreigners across the expanse of the sea prompted speculation that the same tools could be used to communicate across the expanse of space. In 1896, Serbian-American electrical engineer and physicist Nikola Tesla asserted that his new electrical transmission system could be used to communicate with Mars and soon after Italian radio engineer Guglielmo Marconi claimed to have received radio signals from Mars. Although Tesla claimed to have used his radio experiments to become "the first to hear the greeting of one planet to another" in 1901, it was not until about two decades later that using radio to communicate with other planets became widely discussed in engineering circles.[403] In January 1919, *The New York Times* published an article titled "Radio to Stars, Marconi's Hope".[404] It contained a summation of an interview the

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[400] Lowell, P. *Mars and its Canals.* (London: Macmillan Company, 1906): 173.
[401] Lowell, P. "A General Method for Evaluating the Surface-Temperature of the Planets; with Special Reference to the Temperature of Mars." *Philosophical Magazine* 6, no. 1 (1907): 161-176.
[402] Wallace, A.R. *Is Mars Habitable?: A Critical Examination of Professor Percival Lowell's Book "Mars and Its Canals."* (London: Macmillan, 1907): 110.
[403] Dick, S.J. *Life on Other Worlds: The 20th-Century Extraterrestrial Life Debate.* Cambridge: Cambridge University Press, 1998: 201.
[404] "Radio to Stars, Marconi's Hope." *The New York Times,* 20 January 1919.

English journalist Harold Begbie had conducted with Marconi, during which Marconi discussed "the possibility of communicating by wireless with the stars".[405] In the interview, Marconi speculated on the potential use of radio technology for interstellar communication. He said:

> Messages that I sent off ten years ago have not yet reached the nearest stars. When they arrive there why should they stop? … That is what makes me hope for a very big thing in the future… communication with intelligences on other stars.[406]

The very next year, Marconi announced that he was investigating signals he postulated may have come from Mars.[407] *The New York Times* once again published a lengthy article on Marconi's so-called "Mars signals". In Europe, Marconi's claims faced mostly ridicule; one French newspaper, for example, publicized Marconi's discovery under the headline "Hello, Central, give me the moon", referring sardonically to Marconi's wireless telegraphy system.[408] Yet the signals Marconi received, which he described as "distinct but unintelligible", generated much excitement in the United States. A newspaper in Minnesota, *The Tomahawk*, published an article titled "Hello Earth! Hello!", which jumped at the possibility of communication with extraterrestrial intelligence (Figure 28). In the article, Marconi is quoted as having said,

> If there are any human beings on Mars I would not be surprised if they should find a means of communication with this planet. Linking of the science of astronomy with that of electricity may bring about almost anything.[409]

Still, despite interest and international conversation, these early investigations into the use of radio technology to communicate with extraterrestrials were rooted in conjecture and imagination, not rigorous scientific investigation. For example, according to *The Tomahawk,* Marconi proposed Martians may use Morse code to communicate with Earth, which

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[405] Ibid.
[406] Ibid.
[407] "Marconi Testing His Mars Signals", *The New York Times*, 29 January 1920.
[408] Ibid.
[409] "Hello Earth! Hello!" *The Tomahawk*, 18 March 1920, Image 6. Digital scan held in the Library of Congress. http://chroniclingamerica.loc.gov/lccn/sn89064695/1920-03-18/ed-1/seq-6/.

demonstrates that although ideas for interplanetary radio contact were forming, there was no serious scientific investigation into the problem of communication with extraterrestrial intelligence.

The advent of radio astronomy shifted the investigation of communication with extraterrestrial intelligence from a speculative one to a truly technical one because it gave scientists the opportunity to test their theories by making strategic radio observations of the cosmos. Although experiments began as early as 1931 with Karl Jansky's discovery of the cosmic sources of radio waves[410], Chapter One noted how the formal discipline of radio astronomy was a direct product of World War II, growing out of the radar tools and techniques developed during the war. After the war, there was a great interest held by former war-time radio engineers in using the recently developed radar and radio communication technologies for scientific purposes, and scientists in the nations that had been involved in the war, especially Australia, Britain, the US, and the USSR, began to pursue research in the newly burgeoning field of radio astronomy.[411] It was not until the discovery of the 21cm hydrogen line, however, what historian Steve Dick has called "the magic frequency", that CETI began its development.[412]

A Most Important Find

The prediction of the 21-cm hydrogen line is generally attributed to Hendrik van de Hulst, a Dutch astronomer and mathematician who published a paper in 1945 that suggested that the transition of neutral hydrogen at 1420 MHz should be theoretically observable using radio telescopes.[413] This was a highly significant insight in the development of radio astronomy because of the abundance of hydrogen in the universe, and just a few years later in 1951, Harvard University astronomers Harold Ewen and Edward M. Purcell became the first to observe the line. Since then, the hydrogen line has become a fundamental part of observational radio astronomy, allowing astronomers to map the structure of the Milky Way and other

[410] Jansky, K.G. Radio Waves from Outside the Solar System. *Nature* 132, no. 3323 (1933): 66.
[411] Sullivan III, W. *Cosmic Noise: A History of Early Radio Astronomy*. Cambridge: Cambridge University Press, 2009.
[412] Dick, Stephen J. *The Biological Universe: The Twentieth Century Extraterrestrial Life Debate and the Limits of Science* (Cambridge: Cambridge University Press, 1999): 418.
[413] van de Hulst, H. The Origin of Radio Waves from Space. *Nederlandsch Tijdschrift voor Natuurkunde* 11, no. 210 (1945).

galaxies as well as the large-scale structure of the Universe, since hydrogen is the most common element in galactic formations. So significant was its discovery to radio astronomy that it has even been memorialized in song form, with a chorus that reminds listeners that,

"Ewen and Purcell caught the radiation line

Of interstellar hydrogen, a most important find."[414]

When examining the historiography of the discovery of the line, however, another name besides van de Hulst's sometimes appears: Iosif Samuelovich Shklovsky, the Soviet astrophysicist who instigated Kardashev and Sholomitskii's investigation of CTA-102. Several sources, including *The Biographical Encyclopaedia of Astronomers* (2007) and Frank Drake's *Is Anyone Out There*? (1992), claim that Shklovsky predicted the existence of the 21-cm hydrogen line entirely independently of van de Hulst. This is a mischaracterization of what occurred, but a somewhat understandable one if unfamiliar with the issue of Soviet journal publishing. Astronomer and historian of astronomy Woodruff Sullivan, who conducted oral history interviews with Shklovsky before his death in 1985, noted in his book *Cosmic Noise: The History of Early Radio Astronomy* (2009) that Shklovsky was not able to obtain van de Hulst's paper in the Soviet Union because of the aforementioned publication issues. Instead, Shklovsky read a brief mention of van de Hulst's discovery in an astronomical review paper published in 1947. The mention of this prediction in the review "lit [him] on fire", and inspired him to attempt to calculate the transition of the line on his own, without access to van de Hulst's original paper.[415] In 1949, the same year he received his doctorate, Shklovsky published a paper titled "Monochromatic Radio Emission from the Galaxy and the Possibility of its Observation".[416] Shklovsky credits van de Hulst in the first line of his paper, asserting: "Van de Hulst was the first

[414] "Hydrogen Line", lyrics © 1995 by Dr H. Paul Shuch, https://www.qsl.net/n6tx/poetry/setisong/hydrogen.htm.
[415] Sullivan III, W. *Cosmic Noise: A History of Early Radio Astronomy*. Cambridge: Cambridge University Press, 2009) 397.
[416] Shklovsky, I.S. Monochromatic Radio Emission from the Galaxy and the Possibility of its Observation. *Астрономический журнал* 26 (1949).

to point out the probability of the existence of monochromatic radio emission from the galaxy".[417]

Nonetheless, Shklovsky's semi-independent calculations of the 21-cm hydrogen line helped to establish him as a significant early contributor to the development of radio astronomy in the USSR. Yet there is another way the 21-cm line had an impact on Shklovsky's life. Once observed by Ewen and Purcell, the newly important status of this line to radio astronomy inspired two physicists, Philip Morrison and Giuseppe Cocconi to propose its use in searching for extraterrestrial intelligence. Published in *Nature* in 1959, Morrison and Cocconi's paper, "Searching for Interstellar Communications", advocated a search for artificial signals on the hydrogen line, becoming the first scientific publication to propose a CETI observational technique.[418] Their rationale in observing at 1420 MHz was that, if an extraterrestrial civilization wanted to send a signal at a frequency that Earth was sure to detect, it would make most sense for them to broadcast it at a frequency that is important to radio astronomy, where humans were already looking. Shklovsky was "greatly impressed" by Cocconi and Morrison's article, which added such great potential purpose to the line he had played a role in discovering.[419] Shortly after the publication of the Morrison and Cocconi paper, Drake conducted Project Ozma in April 1960, searching for signals near the hydrogen line. Although his results were non-conclusive, Project Ozma excited the scientific community, including Shklovsky. Shortly after, in 1960, Shklovsky published his first CETI paper in the Russian journal *Priroda* [*Nature*], titled, "Is it possible to communicate with intelligent beings of other planets?".[420]

His paper began with an acknowledgement that "the very title of this paper will seem fantastic to readers of *Priroda*… is it even possible to discuss such an unusual problem on the pages of this serious journal?" He then broke down the problem by steps, bringing in other

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[417] Shklovsky, I.S. Monochromatic Radio Emission from the Galaxy and the Possibility of its Observation. *Астрономический журнал* 26 (1949): 10.
[418] Morrison, Philip and Cocconi, Giuseppe. "Searching for Interstellar Communication." *Nature* 184, no. 4690 (1959).
[419] Shklovsky, I.S. *Five Billion Vodka Bottles to the Moon*. New York: WW Norton & Co. Inc., 1991: 250.
[420] I. S. Shklovsky, "Is It Possible to Communicate with Intelligent Beings of Other Planets?" *Priroda* 7 (1960): 21–30. (in Russian).

areas of astronomical inquiry, such as "are there other planetary systems?"[421] He concluded the paper by referencing to Morrison and Cocconi and Project Ozma , noting their "elegant idea" of using the 21cm hydrogen line for communication, since if ETI are "reasonable beings at a high level of technological development", they too "must conduct intensive studies of the Cosmos precisely on this wavelength".[422] In other words, that is where they will be looking, and where they would assume we would be looking as well. Importantly, Shklovsky's paper essentially made the argument to the readers of *Priroda* that CETI is not simply a significant field in astronomy, but *the* field. He argued that all areas of astronomical inquiry support and lead up to asking the question: is there intelligent life in the universe?

Universe, Life, Mind

The start of the Space Race deepened Shklovsky's fascination with the possibility of searching for extraterrestrial intelligence. In January 1959, shortly before he learned of the Morrison and Cocconi paper, the Soviet mission *Luna 1* launched. After the glowing success of the first three *Sputniks*, *Luna 1* became yet another important achievement for the Soviet Union at the start of the Space Race: It was the first spacecraft to reach the Moon.[423] There was a small dilemma, however: as explained in Chapter One, in 1959, the Soviet Union did not yet have a radio telescope capable of tracking their satellite and probe launches. It is for this reason that Sir Bernard Lovell, then director of Britain's Jodrell Bank Observatory in Manchester, became a figure of much acclaim in the USSR. His Mark I telescope became the first telescope in the West to track the launch of Sputnik I in 1957, confirming the Soviet achievement to the rest of the world.[424] Without their own radio telescope, obtaining the exact coordinates of their rocket launches was a real challenge for the Soviets. For the launch of *Luna 1*, Shklovsky had proposed a solution. With the support of the "Chief Designer" of the Soviet space program, Sergei Korolev, Shklovsky and his team at Shternberg Astronomical Institute at Moscow University designed what they called an "artificial comet" to aid optical observations of rocket

[421] Ibid, 21.
[422] Ibid, 29.
[423] "Luna 1." NASA Space Science Data Coordinated Archive. Accessed 20 January 2021. https://nssdc.gsfc.nasa.gov/nmc/spacecraft/display.action?id=1959-012A.
[424] Grahn, S. "Jodrell Bank's role in early space tracking activities - Part 1." Jodrell Bank Centre for Astrophysics. Accessed 4 November 2020. http://www.jb.man.ac.uk/history/tracking/part1.html.

trajectories.[425] This "comet" was composed of a luminescent cloud of sodium gas, which would be ejected from the rocket during launch and photographed, making the spacecraft visible at high altitudes and therefore easier to track optically.[426] For his work on the *Luna 1* rocket telemetry, Shklovsky was awarded the Lenin Prize, the highest award for scientific achievements bestowed by the Soviet government.[427]

This success put him on good terms with the President of the Soviet Academy of Sciences, Mstislav Vsevolodovich Keldysh, who was sometimes referred to as the "Chief Theoretician" of the Soviet space program, in conjunction with Korolev. As a result of his success, Shklovsky was invited to group meetings held in Keldysh's office for "regular [discussions] of space projects".[428] During one such meeting in 1961, Keldysh reminded the group that the five-year anniversary of Sputnik I's launch was only a year away, and "should be properly celebrated". As noted in the Chapter One section on CTA-102, anniversaries held special importance in the Soviet Union, and especially five-year anniversaries, which evoked the "five-year plans"—the Soviet economic strategy to move the state towards communism. Shklovsky, whose imagination had so been swept up by the Morrison and Cocconi paper and the romance of the burgeoning Space Age that he felt "like a kid who'd fallen in love", eagerly proposed that he write a popular science book exploring the idea of extraterrestrial life.[429] Keldysh approved, but this meant there was only one year to write the book. What might have been a problem to some, Shklovsky saw as an opportunity.

That was because, in addition to the censorship of foreign scientific journal publication in the Soviet Union, there were also censorships placed on internal publications in the Soviet Union. In particular, any works regarding "space" during the Space Race were particularly challenging to get through censors.[430] The main organization of press censorship was called the

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[425] Shklovsky, I.S. *Five Billion Vodka Bottles to the Moon*. New York: WW Norton & Co. Inc., 1991: 248.
[426] Shklovsky, I. S., Esipov, V. F., Kurt, V. G., Moroz, V. I., & Shcheglov, P. V. "An Artificial Comet." *Soviet Astronomy* 36, no. 6 (1959): 986.
[427] Kardashev, N.S. and Marochnik, L.S. "The Shklovsky Phenomenon." *Astronomical and Astrophysical Transactions* 30, no. 2 (2017): 119–124.
[428]Shklovsky, I.S. *Five Billion Vodka Bottles to the Moon*. New York: WW Norton & Co. Inc., 1991: 248.
[429] Ibid, 247.
[430] Interview with Leonid Gurvits on 4 October 2019 in Moscow, Russia, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.

Main Administration for the Protection of Military and State Secrets in the Press under the USSR Council of Ministers—or, "Glavlit" for short, an acronym for its Russian name.[431] Glavlit had an associated office called the "Commission for Research and Exploitation of Cosmic Space" which held specialized censors for space sciences. During the Space Age, "every book, article, radio or TV broadcast in any way connected with space flights [had to] have an authorization from [that] censorship office."[432] Because of the significance of publishing the book for the fifth anniversary of Sputnik's launch, however, Shklovsky suspected he "would have a better chance of escaping the embraces of the general censorship", as censors would have less time to review it if it would be published on time.[433] Getting past censorship was particularly important for a book on the subject of extraterrestrial life. Although by the 1960s Trofim Denisovich Lysenko's State sanctioned views on biology had begun to fall out of favour, the official end to the ban on criticism of Lysenkoism, was not lifted until the 1980s.[434] This was relevant to Shklovsky since in writing about the development of life in the universe he intended to "demolish" the theories of Alexander Oparin, Soviet biochemist and "close confederate" of Lysenko, who researched the origins of life on Earth.[435] Challenging Oparin was a potentially dangerous undertaking, not to mention challenging. After all, it was difficult to find reputable books on molecular biology in the Soviet Union during the Lysenkoist period.[436] Nonetheless, Shklovsky's bet paid off. His book, titled *Universe, Life, Mind* made its way past the censors in its rush to be printed in time for the Sputnik anniversary and it was published in December 1962.[437]

Despite the initial challenges, *Universe, Life, Mind* became immensely popular in the Soviet Union and internationally. To date, there have been seven Soviet/Russian editions made of the book, the most recent being published in 2006. The book was promoted among the public because of its comprehensive and approachable exposition on modern astrophysics. The Soviet All-Union Society "Znanie" [*Knowledge*], an educational propaganda organization, awarded the

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[431] Vladimirov, L. "Glavlit: How the Soviet Censor Works." *Index on Censorship* 1, no. 3-4 (1971): 31.
[432] Ibid, 35.
[433] Shklovsky, I.S. *Five Billion Vodka Bottles to the Moon*. New York: WW Norton & Co. Inc., 1991: 250.
[434] Gordin, M.D. "Lysenko Unemployed: Soviet Genetics after the Aftermath." *Isis* 109, no. 1 (2018): 73.
[435] Shklovsky, I.S. *Five Billion Vodka Bottles to the Moon*. New York: WW Norton & Co. Inc., 1991: 250.
[436] Ibid, 250.
[437] Ibid, 251.

book first prize for the category "best popular science book".[438] It was well received by both popular and scientific audiences, but interestingly, the book also sparked works in other disciplinary areas, such as philosophy. For example, the *Summa Technologiae* (1964), a futurological treatise by the Polish philosopher and science fiction author Stanislaw Lem, dedicated an entire chapter to a philosophical interpretation of *Universe, Life, Mind*. In his analysis of *Universe, Life, Mind*, Lem spent most of his time reflecting on the longevity of cosmic civilizations, questioning whether the apparent lack of obvious evidence of extraterrestrial civilizations meant the universe spawned only "suicidal intelligence" which inevitably destroys itself.[439] This theme is significant because, as we shall see, CETI works often produced reflection on existential issues, a key trait of the Cold War mentality.

Universe, Life, Mind's tremendous success was due in part to the large public impact of Soviet space activities. In the early 1960s, the Soviet Union had been dominating the United States in the so-called "race to space", as it had been labelled by President Kennedy in 1961.[440] By 1962, the Soviet Union had become the first nation on Earth to launch a satellite into orbit, put the first living creature in space, put the first man in orbit, take the first photograph of the far side of the Moon, launch the first space craft to reach the Moon, and send the first probe to impact the Moon. Characteristically, the Soviet government capitalized on these victories with great displays of promotional propaganda in the form of films, posters, and parades (Figure 29). Iina Kohonen, an expert in space-related visual propaganda and photojournalism in the Soviet Union, has argued that the Soviet space program was composed of a combination of "military

[438] "Shklovsky I.S. Universe, Life, Mind." Nuclear Physics on the Internet. Accessed 20 April 2021. http://nuclphys.sinp.msu.ru/books/pop/%D0%A8%D0%BA%D0%BB%D0%BE%D0%B2%D1%81%D0%BA%D0%B8%D0%B9.htm. (in Russian).
[439] Stanislav, Lem. *Summa Technologiae*. Moscow: Mir Publishers (1968): 608 (in Russian).
[440] "John F. Kennedy Moon Speech - Rice Stadium." Johnson Space Centre. Accessed 20 April 2021. https://er.jsc.nasa.gov/seh/ricetalk.htm.

Figure 29. Gagarin waves from the car outside the headquarters of Amalgamated Union of Foundry Workers after receiving a medal, 12th July 1961. From the Daily Herald Archive/National Museum of Science & Media/Science & Society Picture Library.

aspirations, state propaganda and utopian thinking".[441] It is the latter characteristic, "utopian thinking", which largely fuelled Soviet public interest in space, and led to the success of Shklovsky's book, which painted an exciting future of human cosmic exploration. As noted in Chapter Two, Soviet depictions of the future in space portrayed a universe in which communism had succeeded, the world was peaceful, and humanity dedicated itself to the pursuit of science and exploration of the cosmos. As we have seen, this Cosmist mentality was not limited exclusively to the Soviet Union. Americans similarly created narratives about a human destiny in space—albeit with a US-centric bent. While Soviet literature espoused spreading a communist ideology throughout the cosmos, Americans viewed space as a "final frontier", an extension of the driving force of manifest destiny.[442] Therefore, in the United States, public interest in space exploration was also growing by the time Shklovsky published his book. The US had managed a rocky start in the competition, but especially after Kennedy's exhortation of the goal of a 'moon-shot', the US public imagination was captured by the Space Age. Yet the hopeful nationalist visions of a future in space were tainted by the hostility of the Cold War, which often utilised the same infrastructures of space exploration for military purposes.

First Contact

In the first chapter's discussion of the development of CETI and Very Long Baseline Interferometry, I argued that international collaboration in radio astronomy and CETI was both

[441] Kohonen, I. "The Space Race and Soviet Utopian Thinking." *The Sociological Review* 57 (2009): 115.
[442] Buzan, Berry "America in Space: The International Relations of Star Trek and Battlestar Galactica." *Millennium: Journal of International Studies* 39, no. 1 (2010): 175-180.

inhibited and facilitated by the overlap of scientific tools and techniques with military application. In this section, I will make a similar argument, but focus on the individual scientists rather than instruments. In doing so, I will analyse a concept called "citizen diplomacy", which I have described elsewhere as "actions pursued by private citizens that support the goals of public diplomacy".[443] As historian of science Audra Wolfe has noted, there were individual and cultural dimensions of warfare practiced by both the US and Soviet Union during the Cold War, and this affected how scientific ideology was portrayed during this period. Wolfe notes:

> The US foreign policy establishment saw a particular way of thinking about scientific freedom as essential to winning the global Cold War—and not just because science created weaponry. Throughout this period, the engines of US propaganda amplified, circulated, and, in some cases, produced a vision of science, American style, that highlighted scientists' independence from outside interference and government control. Science, in this view, was apolitical.[444]

The promotion of apolitical science as a political tactic generated scientific exchange programs between the US and USSR. Former Program Coordinator for US-Soviet and East European Programs at the National Science Foundation and historian of science Gerson Sher described the citizen diplomacy of scientific exchange programs in his book *From Pugwash to Putin: A Critical History of US-Soviet Scientific Cooperation* (2019). Sher tracks the development of scientific exchange programs between the US and USSR beginning in the 1950s, with President Eisenhower's assertion that individuals should "leap governments [or] if necessary evade governments" because to do so would allow for people from different nations to learn and grow from one another, in theory leading to more peaceful interactions.[445] Yet Sher rightfully argued that there were multiple elements to these exchanges, noting that even the word 'exchange' "brought to mind a carefully calibrated and planned transaction, not unlike an

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[443] Charbonneau, Rebecca. "Capturing the Human Side of Cold War Scientific Cooperation." *Physics Today* 73, no. 5 (2020).
[444] Wolfe, Audra. *Freedom's Laboratory: The Cold War Struggle for the Soul of Science*. (Baltimore: Johns Hopkins University Press, 2018): 2.
[445] Sher, Gerson. *From Pugwash to Putin: A Critical History of US-Soviet Scientific Cooperation*. (Bloomington: Indiana University Press, 2019): 12.

exchange of spies".[446] Indeed, like many facets of Cold War scientific activities, scientific exchange programs had dual motivations—to promote the ideology of science as apolitical and peace-generative, as well as to obtain human intelligence on Soviet science and technology. As we saw in Chapter One with Lovell's reporting on Yevpatoria and the visits to NRAO by the Department of Defense, gathering intelligence on Soviet technology was a fundamental goal of the US Cold War strategy.

Yet, as Wolfe notes, the scientists in both the US and USSR were "both building genuine friendships with their Soviet counterparts *and* collecting scientific intelligence"; these relationships were complex and multi-dimensional.[447] As with the CETI and VLBI scientists (who were sometimes one and the same), this was certainly the case, as seen in Chapter One's example of KRT-10, which was built by some of the same scientists who had, but a few years prior, cooperated with their US peers in the first US-USSR experiment. One astronomer from the University of Cambridge, Malcolm Longair, explained in an oral history interview that his motivations for undertaking an exchange to work with Soviet astrophysicist Vitaly Ginzburg at the Lebedev Physical Institute in 1968 were largely curiosity and admiration-driven: "I wanted to actually understand the Russian character, the Soviet character more because it was something else… and of course the music is absolutely out of this world."[448] In his oral history interview, Longair was genuine and enthusiastic about his desire to cooperate with scientists in the Soviet Union and learn from both their scientific theories and culture. Yet Longair's exchange program through the Royal Society came with a stipulation—he had to complete a confidential report which detailed his visit to the USSR, much like Lovell's 1963 diary and memorandum. In some ways, scientific exchange programs were an even more valuable approach to intelligence gathering than traditional human intelligence strategies with spies; after all, US and British scientists formed genuine connections and were therefore sometimes

[446] Ibid, 14.
[447] Wolfe, Audra. *Freedom's Laboratory: The Cold War Struggle for the Soul of Science*. (Baltimore: Johns Hopkins University Press, 2018): 15.
[448] Interview with Malcolm Longair by Rebecca Charbonneau on 4 November 2019 in Cambridge, UK, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.

given insider access and trust by their Soviet counterparts, allowing their home governments an intimate look at Soviet science, technology, and institutions.

The government use of naïve scientists for intelligence gathering might well have had another impact—an increased desire by some scientists, and as we shall see, especially CETI scientists—to cooperate surreptitiously with their Soviet peers. For example, in 1960, Carl Sagan began his two-year postdoctoral fellowship at University of California, Berkeley, where he was preoccupied with the problem of finding life in the universe. One day, during his fellowship, he received a call from a US general who informed Sagan that he was presently escorting three Soviet scientists around Los Angeles and asked if he would like to join them. One of the Soviet scientists in LA was Alexander Alexandrovich Imshenetsky, who was, as Sagan described, "in charge of the Soviet effort for constructing instruments to search for extraterrestrial life".[449] Sagan was invited to join the group given Imshenetsky's specialization and its overlap with his own research. Sagan later wrote about this event in his semi-autobiographical collection of essays published in 1973, tellingly titled "Carl Sagan's Cosmic Connection: An Extraterrestrial Perspective".[450] He later described this meeting as the "first such contact" he would have with a Soviet scientist, and upon meeting Imshenetsky he eagerly engaged him in a conversation on extraterrestrial life.[451]

Also in attendance with the group was a man who, in his retrospective essay, Sagan referred to by the false name "Igor Rogovin", who was supposedly a translator from the Library of Congress. At one point during the meeting with the Soviets, Sagan was left alone with Rogovin, and was asked what he had "[found] out" during his conversation with Imshenetsky.[452] In his essay, Sagan regrettably noted that at that young age he was "unwise in the ways of the world" and "politically unsophisticated" and so enthusiastically summarized what he had learned from Imshenetsky, before realizing that Rogovin was not a translator, but an intelligence agent.[453] Sagan claimed to have berated Rogovin, scolding him that "it was possible to have a

[449] Sagan, Carl. *The Cosmic Connection: An Extraterrestrial Perspective*. (South Shore: Anchor Press, 1973): 96.
[450] Ibid.
[451] Ibid, 96.
[452] Ibid, 96.
[453] Ibid, 96.

conversation with a Soviet scientist that was intended for the benefit of science, rather than for the benefit of American military intelligence services".[454] As evidenced by the "Extraterrestrial Perspective" title of his book, it is clear in 1960 Sagan was already forming an association between scientific internationalism and the pursuit of extraterrestrial life. After his hostile interaction with Rogovin, Sagan contacted the CIA to lodge a complaint about the conduct of the agent, only to discover the CIA did not think he was one of their agents, given his blasé conduct. Sagan was asked for discretion as the CIA was worried about such a story reaching the public, "particularly after the 'bad press' they had been getting about the Bay of Pigs".[455] After two weeks of investigation, it was revealed that Rogovin was an agent for Air Force Intelligence, not the CIA. The experience had an impact on the young Sagan. He was surprised that "Soviet plans for the search for life elsewhere…could be considered of interest to Air Force Intelligence", though of course this dissertation has established a strong connection between the two.[456] Sagan was also disquieted that it "had taken about two weeks for the Central Intelligence Agency to determine the employment of a member of a fellow U.S. intelligence operation".[457] At the time, the naïve Sagan was appalled that intelligence agents would try to use an "innocent young [scientist]", as he described himself, to attempt to gather intel on Soviets.[458] He believed their efforts aimed to "detract from the credibility of legitimate scientific exchanges among scientists in different countries" even though he believed such exchanges were "particularly necessary in an age that hangs a thread away from nuclear destruction, and in which scientists have access to at least half an ear of the politicians in power".[459]

This episode in Sagan's life is significant to the history of CETI for three reasons. First, it formed the basis of his later internationalist philosophies, which would lead to the Cosmic Mirror perspective he developed in writings such as the Pale Blue Dot and in METI projects, such as those discussed in Chapter Two. Second, it helped him to first recognise the presence and mission of US intelligence agencies, an understanding that would later aid him in navigating

[454] Ibid, 96.
[455] Ibid, 97.
[456] Ibid, 97.
[457] Ibid, 97.
[458] Ibid, 98.
[459] Ibid, 99.

the difficult distinction between artificial signals of extraterrestrial or Earth origin. And finally, his frustration with political interference in science energised him to collaborate with Soviet colleagues, something that would later shape the character of US and Soviet CETI.

Same Planet, Different Civilizations

This last reason resulted in one of the most significant episodes in CETI history—Sagan's collaboration with I.S. Shklovsky. While Shklovsky had been designing his artificial comet for the Soviet lunar program in 1959, Sagan was similarly involved in the race to space. At only 25 years old, he had been hired as a consultant to the newly established National Aeronautics and Space Administration (NASA).[460] By August 1962, just a few months before the publication of *Universe, Life, Mind*, Sagan had just seen to the launch of NASA's Mariner 2 mission to Venus, which he had helped to design and manage. He was also a member of NASA's Planetary Biology Subcommittee and hoped to find signs of life on other planets through his work on NASA missions.[461]

In April of 1961, the year prior to the publication of *Universe, Life, Mind*, Sagan was introduced to the radio search for extraterrestrial intelligence. Drake's Project Ozma had created interest in CETI within the scientific community, and so the Space Sciences Board of the National Academy of Sciences (NAS) decided to support what they called a "quiet meeting" in the subsequent autumn, to discuss the possibility of making radio contact with extraterrestrial intelligence.[462] Although small, the first US CETI conference was attended by an elite group of scientists from several fields, including NRAO director Otto Struve, future Nobel prize winning physicist Charles Townes, Nobel prize winning chemist Melvin Calvin, NASA astrophysicist Su Shu Huang, Project Manhattan scientist Philip Morrison, and John C. Lilly, a biologist who researched dolphin communication.[463] The scientists at the conference drew connections between Lilly's work and their own— the pursuit of communication with the non-human and

[460] "Carl Sagan (1934-1996)." NASA Science Solar System Exploration. Accessed 12 May 2021. https://solarsystem.nasa.gov/people/660/carl-sagan-1934-1996/.
[461] Morowitz, H. "Life on Venus." *Nature* 215 (1967): 1259-1260.
[462] Letter from Hugh Odishaw to Otto Struve July 1961, Search for Extraterrestrial Intelligence (SETI) Series, National Radio Astronomy Observatory Archives, Charlottesville, VA USA.
[463] List of attendees, 1961 SETI Conference, Search for Extraterrestrial Intelligence (SETI) Series, National Radio Astronomy Observatory Archives, Charlottesville, VA USA.

with unknown intelligences. As a result, they dubbed themselves "The Order of the Dolphin", a semi-secret CETI society.[464] Sagan was the youngest scientist in attendance, perhaps invited mainly because of his connections with Melvin Calvin, who had written a letter of recommendation that helped him acquire his postdoctoral position at UC Berkeley.[465]

The Space Sciences Board had outlined three major topics to be addressed at the conference. First, they wanted the attendees to consider the "estimates of limiting values for the probability of existence of planets on which civilized life is likely to have evolved".[466] Secondly, the attendees should determine whether this number was sufficiently large and decide whether present search methods were useful enough to make the search worth pursuing. And finally, the conference attendees were to make recommendations to the Board for further study.[467] To address this issue of feasibility, Drake devised an equation which was henceforth known as "the Drake Equation". The equation was simple, a product of factors, the values of which were largely unknown at that time. The Drake Equation was represented as "$N = R^* \bullet f_p \bullet n_e \bullet f_l \bullet f_i \bullet f_c \bullet L$", with each variable defined as follows:

N = The number of civilizations in the Milky Way Galaxy whose electromagnetic emissions are detectable.

R* = The rate of formation of stars suitable for the development of intelligent life.

f_p = The fraction of those stars with planetary systems.

n_e = The number of planets, per a planetary system associated with one star, with an environment suitable for life.

f_l = The fraction of suitable planets on which life actually appears.

f_i = The fraction of life bearing planets on which intelligent life emerges.

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[464] Order of the Dolphin members list, 1961 SETI conference, Search for Extraterrestrial Intelligence (SETI) Series, National Radio Astronomy Observatory Archives, Charlottesville, VA USA.
[465] Davidson, Keay. "California Cosmology: Carl Sagan: The Berkeley Years." SF Gate. 1999. https://www.sfgate.com/magazine/article/CALIFORNIA-COSMOLOGY-Carl-Sagan-The-Berkeley-3490527.php
[466] Letter from Hugh Odishaw to Otto Struve July 1961, 1961 SETI conference, Search for Extraterrestrial Intelligence (SETI) Series, National Radio Astronomy Observatory Archives, Charlottesville, VA USA.
[467] Ibid.

f_c = The fraction of civilizations that develop a technology that releases detectable signs of their existence into space.

L = The length of time such civilizations release detectable signals into space.[468]

Since the equation could not be reasonably calculated with their present knowledge, it was instead meant as a tool that the attendees of the conference could use to frame their estimates of ETI in the galaxy.

The final variable, *L*, has been the focus of many studies in technosignature literature, with estimates ranging from incredibly optimistic (upwards of millions of civilizations) to deeply bleak (only humans).[469] As time has progressed and fields of study such as exoplanetary science have developed, many of the Drake equation variables have begun to fill in, but the answer to *L* has remained elusive and highly relevant. SETI anthropologist Kathryn Denning has argued that *L* is the variable in which "we are exceptionally emotionally invested", because "our estimates of *L* are intertwined with our forecasts for our own civilization's end".[470] For that reason, Drake's inclusion of *L* in the equation is particularly revealing of the cultural climate in which CETI developed—after all, almost exactly one year following the first CETI conference in Green Bank, the world would experience its first nuclear stand-off, the Cuban missile crisis. The question of *L* was inextricably tied to concerns about the role of technology in the destruction of life and civilization, concerns which were extremely pressing during the height of the Cold War.

Shortly after the NRAO CETI conference concluded, Sagan wrote a paper titled "Direct Contact Among Galactic Civilizations by Relativistic Interstellar Spaceflight", in which he made an argument in support of his own estimate for the values in the Drake Equation, including the variable *L*. While he began his paper admitting that the "parameters are poorly known", he nonetheless came to the conclusion that there exists about a million "extant advanced

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[468] "Drake Equation." The SETI Institute. Accessed 2 Dec 2020. https://www.seti.org/drake-equation-index.
[469] Shostak, S. "The Value of 'L' and the Cosmic Bottleneck." in *Cosmos and Culture: Cultural Evolution in a Cosmic Context*, eds. Dick S.J. and Lupisella M. Washington, D.C.: National Aeronautics and Space Administration Government Printing Office, 2012.
[470] Denning, K. "'L' on Earth." in *Civilizations Beyond Earth: Extraterrestrial Life and Society*. eds. Vakoch D.A. and Harrison A.A. (New York: Berghahn Books, 2011): 74.

technical civilizations in our Galaxy".[471] Perhaps having heard of the Soviet interest in CETI from someone at the conference, Sagan sent a draft of this paper to Shklovsky on 8 June 1962, inviting his comments.[472]

"The prey runs to the hunter…", began Shklovsky's reply, using a Russian proverb which means that someone interested in something suddenly comes across what he wanted to find.[473] He asked Sagan if he might be permitted to incorporate his article into the upcoming book, which was to be published at the end of the year. He ended the letter to Sagan with a joke—wondering if perhaps they might someday meet, although remarking "the probability of this event is no smaller than the probability of a visitation of the Earth by [extraterrestrial] astronauts".[474] Sagan agreed to have his paper incorporated into *Universe, Life, Mind*, and in return asked Shklovsky if he had any plans to publish an English translation of the book in the United States. If not, Sagan proposed allowing him to aid with such a publication himself.[475] He cheerfully ended the letter proposing that they meet at a conference held in Poland, jokingly stating that doing so might "insure [sic] the visitation of the Earth by extraterrestrial cosmonauts".[476] They would not end up meeting, however, until well after the publication of the English book. This is largely because of constraints put upon Shklovsky because of his standing in the eyes of the Soviet authorities—yet another example of barriers to communication placed upon scientists during the Cold War period.

Although Shklovsky was held in high regard by his colleagues for his work early in the Space Race, his outspoken personality prevented him from experiencing the mobility and access granted to some of his peers. His letter to Sagan regarding the unlikelihood of their meeting reflected the personal resentment Shklovsky held towards Soviet bureaucracy for limiting his ability to collaborate with international peers. In a short autobiographical account

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[471] Sagan, C. "Direct Contact Among Galactic Civilizations by Relativistic Interstellar Spaceflight." *Planetary and Space Science* 11 (1963): 485-498.
[472] Letter from Carl Sagan to I.S. Shklovsky, 8 June 1962, Library of Congress, Carl Sagan and Ann Druyan Archive.
[473] Letter from Shklovsky to Sagan, no date, Library of Congress, Carl Sagan and Ann Druyan Archive.
[474] Ibid.
[475] Letter from Carl Sagan to IS Shklovsky, 6 August 1962, Library of Congress, Carl Sagan and Ann Druyan Archive.
[476] Letter from Carl Sagan to I.S. Shklovsky, 8 June 1962, Library of Congress, Carl Sagan and Ann Druyan Archive.

published posthumously, Shklovsky recounted his first expedition outside the Soviet Union; a research trip to Brazil in 1947, to observe a solar eclipse. Shklovsky wrote of the time:

> I took it for granted that the forthcoming expedition to the Tropic of Capricorn, to a faraway Brazil as beautiful as anything in a fairy-tale, was just the beginning and that many more fine and soul-stirring things yet unknown lay ahead. After a poverty-stricken youth and the harsh suffering of the war years, the world had at last opened up for me."[477]

Unbeknownst to him at the time, Shklovsky would not be allowed to travel abroad for another 19 years. Despite his many accomplishments, including the Lenin Prize for his work during the Space Race, Shklovsky often faced travel bans, and was never elected as a full member of the Soviet Academy of Sciences, which he resentfully concluded was because of his Jewish heritage and commitment to promoting human rights.[478] This was not atypical in the Soviet Union; another former-Soviet astronomer I interviewed for this research project, the Director of the Pushchino Radio Astronomy Observatory, Rustam Dagesamanski, told me with regret that he was often barred from travelling abroad to international conferences because he had refused to join the communist party:

> In the 60s, [I was invited] to the Communist Party... but I said, 'thank you, but I don't want [to]'... If I would be Communist Party member, I should say all things as the Community Party says. But I tried to keep my own opinions... [if I had become a member of the Community Party] it would [have been] easier for me to travel [outside the USSR].[479]

Soviet astronomers often faced consequences to their scientific freedom if they did not align themselves with the correct ideologies or political party, and in some cases these consequences could be severe.

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[477] Friedman, Herbert. "Introduction" in Shklovsky, I.S. *Five Billion Vodka Bottles to the Moon* (New York: W.W. Norton & Co Inc, 1991): 9.
[478] Ibid, 17.
[479] Interview with Rustam Dagesamanski on 8 October 2019 in Pushchino, Russia, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.

In his collection of autobiographical stories, humorously titled *Five Billion Vodka Bottles to the Moon* (1991), Shklovsky recounted his memory of the "astronomers purge" during Stalin's Great Terror of 1936-38, during which time over two dozen leading Soviet astronomers were arrested, many of whom were later executed, or died in the Gulag.[480] The purge occurred in part because of an astronomy PhD student who failed his candidacy exam, and afterwards wrote a letter of denunciation of the astronomer who administered his examination, Boris Numerov.[481] Denunciations were common practice in the Soviet Union, especially during the Stalinist era, and according to historian Sheila Fitzpatrick, largely fell into three categories of accusation: political disloyalty, "concealment of class identity", and "abuse of power".[482] The state would investigate the accused and punish those who they deemed guilty. This, however, led to the problem of individuals abusing the system by using the state to "settle personal scores or advance the denouncer's individual interests", as was clearly the case with the failed PhD student.[483] In his denunciation, he accused his examiner of having "foreign contacts", and shortly afterward the NKVD began investigating Numerov. After arresting and torturing him, he confessed "to being the organizer of a counterrevolutionary group of astronomers and geophysicists that had cooperated with German fascists and had engaged in wrecking, spying, and terror since 1929".[484] In his confession, Numerov listed nearly the entire astronomy community as co-conspirators, setting off a chain of subsequent arrests and denunciations which historian and foreign diplomat Robyn McCutcheon argued led to the 'disappearance' of approximately "10 percent to 20 percent of all astronomers in the Soviet Union in 1935".[485] Only a graduate student at the time of the purge, Shklovsky avoided being arrested, but after his death, his account of the events leading up to the purge were published, a clear indication that the memory of the ordeal remained with him for the rest of his life.[486] Still, despite the threat of denunciation, Shklovsky often risked life and freedom by standing for what he

[480] McCutcheon, R.A. "The 1936-1937 Purge of Soviet Astronomers." *Slavic Review* 50, no. 1 (1991): 100.
[481] Ibid, 108.
[482] Fitzpatrick, S. (1994) *The Practice of Denunciation in Stalinist Russia*. The National Council for Soviet and East European Research, Washington, D.C.: III.
[483] Ibid, III.
[484] McCutcheon, R.A. "The 1936-1937 Purge of Soviet Astronomers." *Slavic Review* 50, no. 1 (1991): 108-111.
[485] Ibid.
[486] Shklovsky, I.S. "Non-Fiction Stories." *Eniergiia* 6 (1988): 41-42. (in Russian)

believed in, and continually criticized the USSR for, among other things, its anti-Semitism and restriction of scientific freedom.

Even as his fellow physicists occasionally disappeared or died under mysterious circumstances, Shklovsky would defend mistreated colleagues and condemn what he viewed as ethical transgressions committed by the Academy or Soviet government. For example, in 1973, approximately forty members of the Soviet Academy of Sciences signed a document condemning Soviet nuclear physicist and political dissident Andrei Sakharov in a denunciation.[487] Shklovsky, on the other hand, sent in a strong letter of advocacy for Sakharov. As a result of this daring move, he was forbidden to appear at international scientific meetings he had previously been allowed to attend, such as the International Astronomical Union meetings. When asked by Western colleagues about Shklovsky's absence from international conferences, Soviet officials would reply "his health is too poor" to travel abroad.[488] An American colleague encountered Shklovsky in the USSR during this period of travel ban and enquired about his health, to which Shklovsky wryly replied "Yes, I have diabetes. Too much Sakharov".[489] This was a joke because the word for "sugar" in Russian is "Sakhar".

Although he avoided arrest during the Stalinist era, Shklovsky's dissidence sometimes still put his life in danger. As noted in Chapter One, in his capacity as the director of the Jodrell Bank Observatory Sir Bernard Lovell went on an "unprecedented" scientific visit to the Yevpatoria Deep-Space Communication Centre in the USSR in 1963, shortly after *Universe, Life, Mind* was published.[490] The official reason for the visit was because of a planned international scientific collaboration; the Jodrell Bank Observatory was to assist in upcoming Soviet-US communication satellite experiments.[491] Lovell's refusal of the Soviet offer for him to stay in the USSR as a member of the Academy, alongside his newfound insight into Soviet scientific

[487] Shklovsky, I.S. *Five Billion Vodka Bottles to the Moon*. New York: WW Norton & Co. Inc., 1991: 17.
[488] Ibid, 17.
[489] Ibid, 17.
[490] The Kennedy Proposal for a Joint Moon Flight. *NASA History Office*. Accessed 12 June 2020. https://history.nasa.gov/SP-4209/ch2-4.htm.
[491] Ibid.

infrastructure, may have led to his previously noted concerns that his Soviet colleagues attempted to brainwash him using radiation from a telescope's radar beam.[492]

As discussed in the previous chapter, it is unlikely the events Lovell described truly occurred as he perceived them—it was instead likely the product of Lovell's paranoia and the many myths and rumours enveloping the secretive state. Nonetheless, that case is another example of Cold War anxiety. The previous chapter noted that Lovell's memorandum also detailed an encounter with an unnamed Soviet scientist who implored him to invite Shklovsky to his laboratory in England, for Shklovsky's life was "in great danger".[493] The nature of the danger and the reason for it remained a mystery to Lovell, and there are no available sources that might explicitly explain the cause. I would argue, however, that it may have been due to the biology controversy stirred up from the publication of *Universe, Life, Mind.*

Earlier in this chapter, I noted that Shklovsky intended to "demolish" the theories for Lysenko-sympathizer Alexander Oparin in *Universe, Life, Mind*. After the publication of his book, Shklovsky sent Oparin a letter out of courtesy, explaining his disagreement with Oparin's theories. Oparin then allegedly shredded the letter, stuffed it back in an envelope, and returned it to Shklovsky.[494] Clearly, temperatures were running hot, and during the Lysenkoist period, many scientists experience life-threatening consequences for pushing back against the academic establishment. Why then, did Shklovsky not face serious harm for his transgression? As Lovell noted in his diary, "Shklovsky later often appeared in the West… and as far as I knew he eventually died peacefully in the Soviet Union".[495] Lovell also noted that he "did as requested" and invited Shklovsky to visit Jodrell Bank.[496] Shklovsky was unable to make the visit, however, perhaps in part because his open dissent to the treatment of Jewish academics likely cost him the ability to travel outside the Soviet Union between 1947 and 1966.[497] In his

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[492] University of Manchester, John Rylands Archive, Memorandum by Sir Bernard Lovell on the Files Covering Contact with Soviet Scientists and Visits to the Soviet Union, 1963 File.
[493] Ibid.
[494] Shklovsky, I.S. *Five Billion Vodka Bottles to the Moon*. New York: WW Norton & Co. Inc., 1991: 251.
[495] University of Manchester, John Rylands Archive, Memorandum by Sir Bernard Lovell on the Files Covering Contact with Soviet Scientists and Visits to the Soviet Union, 1963 File.
[496] Ibid.
[497] Friedman, Herbert. "Introduction" in Shklovsky, I.S. *Five Billion Vodka Bottles to the Moon* (New York: W.W. Norton & Co Inc, 1991): 16.

diary, Lovell appeared to suggest that perhaps this invite held enough weight to aid Shklovsky, though recognizing he had "no idea".[498] I would argue, however, that Shklovsky's safety had less to do with Lovell's intervention than it did the shifting scientific culture of the early 1960s. Historian of Soviet science Michael Gordin has noted in a study charting the downfall of Lysenkoism, "Lysenko Unemployed", that in 1962, the same year *Universe, Life, Mind* was published, Lysenko's' theories and experiments began to come under heightened scrutiny within the Soviet Union. An Academy of Sciences commission tasked with visiting one of Lysenko's experimental farms were highly critical, noting that there was "widespread fabrication of data in order to cover up the shockingly poor, even ruinous, results. Lysenko, naturally, protested both the procedures and the findings of the commission".[499] A second report plainly noted:

> T. D. Lysenko confines himself only to general arguments and unsubstantiated assertions and presents unfounded accusations addressed to the commission, but he does not provide in this case any arguments, proofs, facts. Thus academician T. D. Lysenko is unable to refute even one of the commission's statements.[500]

Oparin had relied on the strength of Lysenko, as well as his own close relationship with Stalin, to maintain his scientific-political power. With Lysenko "finally ousted" and Stalin deceased, there was little Oparin could do to punish Shklovsky for his daring publication.[501] This shift in the Soviet structure of scientific politics was important in the development of transnational CETI, for it allowed a great flexibility in discussing the origin of life in the universe. The increase in freedom allowed Shklovsky to share his formerly dissident perspectives, as well as make and maintain relationships with scientists around the world by extensive correspondence, including with Carl Sagan.

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[498] University of Manchester, John Rylands Archive, Memorandum by Sir Bernard Lovell on the Files Covering Contact with Soviet Scientists and Visits to the Soviet Union, 1963 File.
[499] Gordin, M. "Lysenko Unemployed: Soviet Genetics after the Aftermath." *Isis* 109 (2018): 58.
[500] Gordin, M. "Lysenko Unemployed: Soviet Genetics after the Aftermath." *Isis* 109 (2018): 58.
[501] Ibid, 59.

Intelligent Life in the Universe[502]

Yet establishing these international correspondences did not come easily, and the road to the publication of the English translation of Shklovsky's book was rife with difficulties. When the US publishers, Holden-Day, wrote Shklovsky in January 1963 to confirm their agreement to publish the translation with the aid of Sagan, they stated that they intended to "make every effort to publish the book in the shortest possible time and [estimated] that this could be done in three to four months…".[503] Over eight months later, however, Shklovsky had no update from Sagan or the publishers. Feeling frustrated that he had not heard from Sagan within the few months the publishers had assured, an irate Shklovsky wrote to Sagan asking, "do you deny me the courtesy of informing of the status of the American translation of the book?".[504] Unbeknownst to him, however, Sagan had sent him several letters regarding the translation and its progress. Shklovsky had simply not received them—an example of yet another type of crisis in Earth-bound communication common during the Cold War: the unreliability of postal correspondence across the Iron Curtain.

The issue of Soviet interference with the post is well documented. In the 1980s, for example, there was a concerted effort by the US government to address the issue of deliberate interference with the flow of mail between the US and USSR. A 1989 report on the history of mail interruption prepared for the US Committee on Post Office and Civil Service of the House of Representatives examined what they described as a "long existing problem".[505] The report claimed that over many years, a "significant number" of items of communication sent from the US to USSR had "disappeared, or were opened, inspected, and/or confiscated by officials of the Soviet Union, without the proper notification given to mailers".[506] Mail interruption was

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[502] Some of the research for this section was conducted during my Master of Science degree in History of Science, Medicine, & Technology at the University of Oxford. To read my master's dissertation, see: "Examining *Intelligent Life in the Universe*: How SETI Internationalism Facilitated Scientific Collaboration during the Cold War", Dissertation, University of Oxford, August 2017.

[503] Letter from Frederick H. Murphy to I.S. Shklovsky on 9 January 1963, Library of Congress, Carl Sagan and Ann Druyan Archive.

[504] Letter from Shklovsky to Sagan on 26 September 1963, Library of Congress, Carl Sagan and Ann Druyan Archive.

[505] Gilman, B. *A History of the Deliberate Interference with the Flow of Mail: The Cases of the Soviet Union and the People's Republic of China: A Report.* Washington, D.C.: U.S. Government Printing Office, 1989): vii.

[506] Ibid, 1.

described as a "violation of human rights" by the authors of the report, who also presented data which indicated the rate at which letters were not delivered. For example, in 1985, non-delivery of letters was at approximately 12 percent.[507] Given that 1985 was the year *perestroika* began, it is reasonable to assume earlier decades might have faced higher rates of mail interruption, although data to support this hypothesis is difficult to attain.

It would be naïve, of course, to assume the problem of mail disruption existed exclusively on the side of the Soviets. As Edward Pessen, historian of American history, has pointed out, "what a nation's leaders call its policy is after all only its stated policy".[508] Although United States policy was purported to be emblematic of a 'free' society, there is also evidence of US interference with postal communication. As Pessen points out, "in blatant violation of the law creating it, the CIA kept files and spied on American citizens, tampered with and opened the mail of hundreds of thousands".[509]

What differed between the US and USSR, however, were the populations targeted by mail disruption. For example, both the authors of the 1989 report, as well as an earlier Congressional hearing on disruption of mail service in 1984, argued that Soviet Jewish people were disproportionately impacted by mail disruption.[510] The report argued that these obstacles were indicative of an effort to "isolate the Jewish community in general, and the 'activists' in particular, from any contact with the outside world".[511] The Soviet Union practiced anti-Zionist campaigns throughout the latter half of the 20th century, fuelled in part by its negative relations with Israel during the Cold War. Anti-Zionist propaganda (Figure 30) promoted historically anti-Semitic representations of Jewish people, which in turn provoked anti-Semitic

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[507] Ibid, 2.
[508] Pessen, E. "Appraising American Cold War Policy by its Means of Implementation." *Reviews in American History* 18, no. 4 (1990): 453.
[509] Ibid, 460.
[510] United States Congress, House Committee on Post Office and Civil Service. Subcommittee on Postal Operations and Services. *Soviet disruption of mail: hearing before the Subcommittee on Postal Operations and Services of the Committee on Post Office and Civil Service, House of Representatives, One Hundredth Congress, second session*. Washington, D.C.: U.S. Government Printing Office, 1988.
[511] Gilman, B. *A History of the Deliberate Interference with the Flow of Mail: The Cases of the Soviet Union and the People's Republic of China: A Report.* Washington, D.C.: U.S. Government Printing Office, 1989): 4.

attitudes within the Soviet Union, leading to negative impacts on Jewish Soviets.[512] In a state where denunciations on political or social loyalty could lead to deadly consequences, questioning Jewish loyalty through anti-Zionist campaigns was no small accusation. As both a Jewish man and someone who might have been perceived as an activist, it is not unreasonable to assume anti-Semitism might have been a reason for Shklovsky's difficulties with international correspondence.

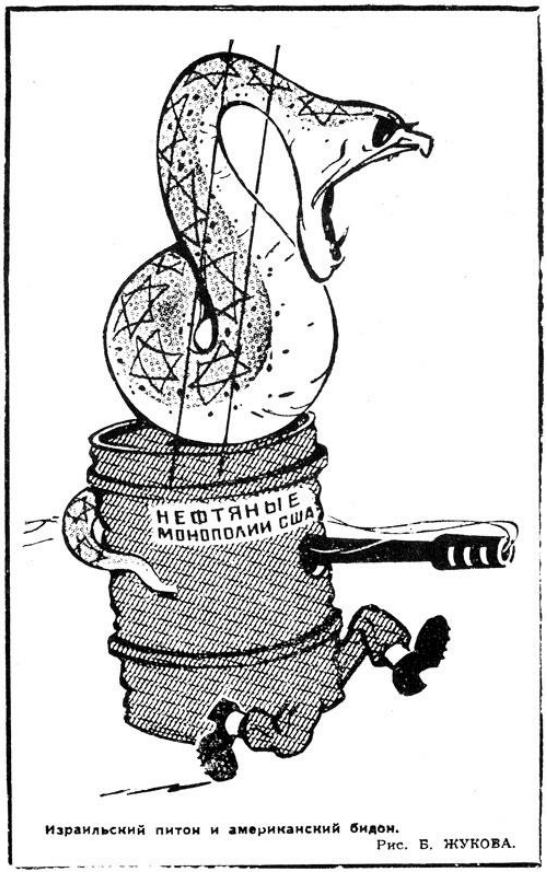


Figure 30. 'The Israeli python and the American barrel,' B. Zhukov, Pravda Vostoka, Feb. 11, 1968. (From The Israeli-Arab Conflict in Soviet Caricatures, 1967–1973 by Yeshayahu Nir, Tcherikover Publishers, 1976).

After receiving Shklovsky's letter of frustration, an upset Sagan replied: "I was very distressed to hear… that you had not received any of the four or five letters which I have sent to you since May, 1963."[513] He continued, "these communication difficulties are surely not as painful for me as they are for you, but believe me, I am deeply upset by them".[514] Sagan then went on to alert Shklovsky to the fact that his book had been successfully translated, but challenges had been presented regarding the illustrations in *Universe, Life, Mind*. The Soviet Union did not join the Universal Copyright Convention, and therefore did not need to receive permissions from creators outside the Soviet Union to reproduce them in print. As Sagan pointed out in his letter to Shklovsky, however, the United States was a member of that convention, and therefore it was a hefty task tracking down and gaining permissions to

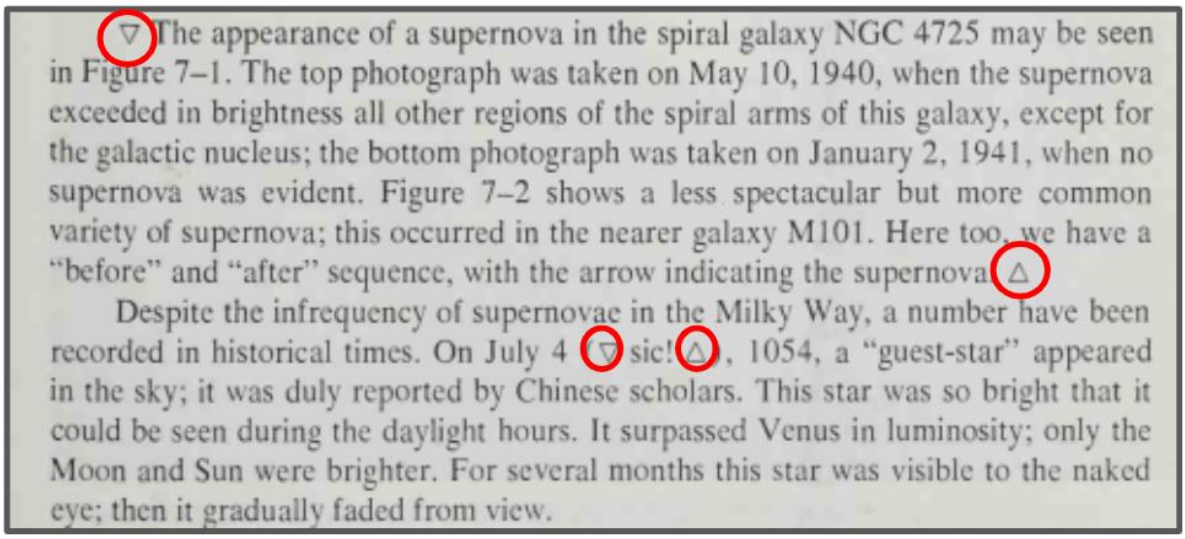
[512] Tabarovsky, I. "Understanding the Real Origin of that New York Times Cartoon." *Tablet Magazine.* 2019. https://www.tabletmag.com/jewish-arts-and-culture/285781/soviet-anti-semitic-cartoons.
[513] Letter from Carl Sagan to I.S. Shklovsky on 8 October 1963, Library of Congress, Carl Sagan and Ann Druyan Archive.
[514] Ibid.

reproduce the illustrations in the US. Although this caused delay, it was not the main reason the book was not yet ready for publication.

In an earlier letter to Sagan, under the mistaken impression that he had trained as a biologist, Shklovsky commented that Sagan was welcome to make "changes and additions to the biological and genetic sections of the book", adding that he believed he would be "much more competent in these matters", especially since Shklovsky had limited access to biology texts due to Lysenkoism.[515] Decades later, Shklovsky claimed that Sagan "interpreted my request broadly", which, given what happened, might be considered an understatement.[516] In his letter explaining the delay, Sagan informed Shklovsky that he "felt obliged to introduce explanatory addenda" in order to make it "more accessible to Western readers".[517] In his attempts to slightly modify the book for a US readership, however, in his introduction to the book the young Carl Sagan admitted he "found [himself] unable to resist the temptation to annotate the text, clarify concepts for the scientific layman, comment at length, and introduce new material", until the English translation had about doubled in size.[518] This came as a shock

[515] Letter from Shklovsky to Sagan on 29 September 1962, Library of Congress, Carl Sagan and Ann Druyan Archive. (in Russian).
[516] Shklovsky, I.S. *Five Billion Vodka Bottles to the Moon*. New York: WW Norton & Co. Inc., 1991: 251.
[517] Letter from Carl Sagan to I.S. Shklovsky on 8 October 1963, Library of Congress, Carl Sagan and Ann Druyan Archive.
[518] Sagan, Carl and Shklovsky, I.S. *Intelligent Life in the Universe*. (San Francisco: Holden-Day, 1966): vii.

to Shklovsky, who upon receiving the finalized copy of the English translation in the post, noticed that "on the cover were crammed the names of two authors: Shklovsky and Sagan"[519].



▽The appearance of a supernova in the spiral galaxy NGC 4725 may be seen in Figure 7–1. The top photograph was taken on May 10, 1940, when the supernova exceeded in brightness all other regions of the spiral arms of this galaxy, except for the galactic nucleus; the bottom photograph was taken on January 2, 1941, when no supernova was evident. Figure 7–2 shows a less spectacular but more common variety of supernova; this occurred in the nearer galaxy M101. Here too, we have a "before" and "after" sequence, with the arrow indicating the supernova.△

Despite the infrequency of supernovae in the Milky Way, a number have been recorded in historical times. On July 4 [▽sic!△], 1054, a "guest-star" appeared in the sky; it was duly reported by Chinese scholars. This star was so bright that it could be seen during the daylight hours. It surpassed Venus in luminosity; only the Moon and Sun were brighter. For several months this star was visible to the naked eye; then it gradually faded from view.

Figure 31. Excerpt from *Intelligent Life in the Universe* (1966). Sagan made contributions to Shklovsky's original text by interjecting between "▽△" symbols. In the second paragraph above, Sagan inserts a tongue-in-cheek 'sic erat scriptum' to poke fun at the unintentional reference to the American Independence Day. Red circles added for emphasis.

Shklovsky might have been understandably annoyed by this but said of Sagan: "[he] showed a certain integrity; he left my text unchanged and set off his with little triangles" (Figure 31).[520] By "little triangles", Shklovsky was referring to the fact that Sagan, in his attempts to be clear about what was Shklovsky's original wording in *Universe, Life, Mind*, and what were his own contributions, enclosed his added text within inverted delta signs. As a result of Sagan's attempts to delineate his own words and thoughts from Shklovsky's, the English edition, which was titled *Intelligent Life in the Universe* (1966), reads in a somewhat awkward manner. It was neither a conversation between two scientists, nor a streamlined narrative, but instead, as described by Sagan, "a peculiar kind of cooperative endeavour".[521] The disjointed organization highlighted the different perspectives of the two scientists, which served an extremely valuable purpose. On the one hand, it gave readers an insight into the different ways a Soviet and an American astrophysicist approached the problem of

[519] Shklovsky, I.S. *Five Billion Vodka Bottles to the Moon*. New York: WW Norton & Co. Inc., 1991: 252.
[520] Ibid, 252.
[521] Sagan, Carl and Shklovsky, I.S. *Intelligent Life in the Universe* (San Francisco: Holden-Day, 1966): vii.

extraterrestrial communication. But additionally, and perhaps most crucially, it prevented Shklovsky from facing problems in the Soviet Union for what would have been viewed as undesirable arguments deployed within the book. Shklovsky was able to get the first edition of *Universe, Life, Mind* past censors because of the fortuitous circumstances outlined earlier, but the new edition, with all of Sagan's cultural additions, would face greater problems. Sagan pointed out in the introduction to the book:

> As the reader might expect for a book written by two authors, one in the Soviet Union and one in the United States, there are occasional ideological differences. I have not tried to avoid these problems, but I also have not tried, in what is primarily a scientific work, to rebut each ideological assertion. When Shklovsky expresses his belief that lasting world peace is impossible while capitalism survives, or implies that lasers are being developed in the United States for their possible military applications alone, I have let the content of these statements stand, despite their political intent.[522]

Shklovsky later noted the benefit of Sagan's approach to delineate their words, later claiming he realized "that my American 'co-author' had done me a priceless boon in distinguishing his text with triangles. Otherwise, our vigilant official 'readers' could have made things tough for me."[523] Clearly, the challenges faced by Shklovsky and Sagan in their attempts to work with one another across the Iron Curtain demonstrates that the CETI community found communicating on Earth posed nearly as large a challenge as communicating with extraterrestrials.

Intelligent Life in the Universe (1966) was one of the first CETI books to be published for a general readership, quite possibly the first of its kind. It was written in the style of a popular science textbook aimed at teaching cosmology, planetary science, and astrobiology principles to both university students and the general public. The book's structure was divided into three parts: "The Universe", "Life in the Universe", and "Intelligent Life in the Universe". The first section, "The Universe", read like a textbook and exposed the reader to fundamental physics

[522] Ibid, viii.
[523] Shklovsky, I.S. *Five Billion Vodka Bottles to the Moon*. (New York: WW Norton & Co. Inc., 1991): 252.

and chemistry principles that would set a foundation for the rest of the book. The second part of the book, "Life in the Universe", introduced the reader to the science of cosmology and astrobiology, questioned how life developed on Earth, and explored the potential of the recently developed field of planetary science. The book's inclusion of planetary science was almost as unique as its content on extraterrestrial intelligence. In an interview published a few decades after the book's release, Sagan noted that "planetary science was considered disreputable" in the mid-20th century.[524] "There was not a single other person working full-time on [planetary astronomy]", Sagan stated, excepting himself and his doctoral adviser at the University of Chicago, G.P. Kuiper. Indeed, according to Sagan both the ongoing quest for extraterrestrial life and the goals of planetary astronomy, which were to investigate the topography and chemical composition of other planets, were all "considered nonsense" at the time of the publication of *Intelligent Life in the Universe*.[525]

Sagan was not exaggerating when he said that many scientists in the mid-20th century were resistant to new scientific fields they thought were far-fetched or based on science fiction. For example, when British Astronomer Royal Richard van der Riet Woolley was interviewed by *Time Magazine* in 1956, he said, in response to a query about the future of space exploration, "It's utter bilge".[526] Given that global investment and interest in space exploration would explode with the launch of Sputnik the very next year, such a statement shows that there was little hope for more speculative disciplines like CETI and planetary astronomy. Therefore, the devotion of several chapters in *Intelligent Life in the Universe* to educating the public on these two issues was extremely crucial in establishing them as serious domains of research.

The book's third section, which shared its name with the title of the book, "Intelligent Life in the Universe", was the most unusual; the graphs and calculations that littered the previous sections all but vanish, replaced by cryptic photos of Assyrian cylinder relief sculptures and philosophical reflections on the possible theological consequences of contact with ETI. Within its first year of publication, *Intelligent Life in the Universe* had approximately twenty thousand

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[524] Swift, David W. *SETI Pioneers: Scientists Talk about Their Search for Extraterrestrial Intelligence* (Tucson: University of Arizona Press, 1990): 214.
[525] Ibid, 214.
[526] "Science: Utter Bilge?" *Time Magazine*. Accessed 31 July 2019. http://content.time.com/time/magazine/article/0,9171,861825,00.html.

copies in circulation—a strong number for that time.[527] The reception of the book was mixed; it was popular with the public but met tepidly by the scientific community. One astronomer argued in a review that *Intelligent Life in the Universe* took "only [a] shadow of a factual approach", which he felt "served publicity" but was "misleading" and "unbelievable".[528] School teachers, on the other hand, praised the book, calling it "the most outstanding illustration of our contemporary thinking on this highly exciting subject" since it provided such extensive yet understandable scientific explanations of celestial phenomena; the book was assigned as a textbook for university courses.[529]

Despite its popularity in the mid-20th century, however, its success was short-lived, as it is today one of the few books written by Sagan that is no longer in print, and it has not been republished since 1998. This is not entirely surprising, given that today there are dozens of popular science books on the subject of extraterrestrial life. What sets Intelligent Life in the Universe apart from contemporary popular literature, however, is the way it stands as a remarkable example of Cold War collaboration between Soviet and American scientists, as well as a demonstration of how CETI internationalism influenced the conduct of the scientists who practiced it. While the overt subject of the book concerns extraterrestrial life, the underlying thread that runs through the book is humanity's place in the Universe. While the book was firmly founded in empiricism, it was also underpinned with a spiritual interest in the cosmic potential in humanity's future, in-line with both the Soviet Cosmist and US Frontier mythos. Furthermore, *Intelligent Life in the Universe* also addressed the *L* variable designating the longevity of extraterrestrial civilizations in the Drake Equation. Here, the Cold War connection with CETI rose to the surface; in the 1960s and 70s, the United States alone possessed 1,054 nuclear missiles[530], over ten times more than necessary to make the Earth hostile to human

[527] Library of Congress, Correspondence between Iosif S. Shklovsky and Carl Sagan in The Seth MacFarlane Collection of the Carl Sagan and Ann Druyan Archive. Box 27, Shklovsky, I.S.
[528] E.J. Öpik, "Intelligent Life in the Universe (book review)." *Irish Astronomical Journal* 8 (1967): 94.
[529] Library of Congress, Correspondence between Iosif S. Shklovsky and Carl Sagan in The Seth MacFarlane Collection of the Carl Sagan and Ann Druyan Archive. Box 27, Shklovsky, I.S.
[530] Burr, W. "How Many and Where Were the Nukes?: What the U.S. Government No Longer Wants You to Know about Nuclear Weapons During the Cold War." *National Security Archive Electronic Briefing Book No. 197.* 2006. https://nsarchive2.gwu.edu/NSAEBB/NSAEBB197/index.htm.

life.[531] For the first time in human civilization, human beings had the capacity to destroy their entire species in a nuclear war. This realization led Sagan and Shklovsky to consider the following in *Intelligent Life in the Universe*:

> Another question of some relevance to our own time, and one whose interest is not restricted to the scientists alone, is this: Do technical civilizations tend to destroy themselves shortly after they become capable of interstellar radio communications?[532]

This question, posed by a Soviet and American, is demonstrative that CETI's reach extended far beyond physics and cosmology, but promoted questions of a philosophical, historical, and sociological bent. Furthermore, these questions were distinctly relevant in the Cold War period.

Longevity Anxiety

Chapter One referenced the first US-USSR experiment in VLBI, using it as an example of how détente spurred cooperation between the Soviet Union and United States, while also noting how even cooperative scientific endeavours served military intelligence gathering purposes. As noted earlier in this chapter, the rise of détente also culminated in the creation of scientific exchange programs to serve a similar purpose. One such formal agreement between the US and USSR was the "Agreement on Exchange of Scientists Between the National Academy of Sciences of the USA and the Academy of Sciences of the USSR in 1970 and 1971", which would support the exchange of individual scientists from each country for scientific-diplomacy and information-exchange visits.[533] As I noted in Chapter One, after the success for the first US-USSR VLBI experiment, Kardashev was invited to visit NRAO in 1970. According to Soviet CETI scientists Lev Gindilis, at some point during this trip Kardashev met Sagan, and the two decided the agreement between the two Academies should support CETI. Sagan subsequently approached the US National Academy of Sciences to sponsor a joint US-USSR CETI conference,

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[531] By some estimates, more than 100 nuclear detonations in even a best-case-scenario for attack by an aggressor state would result in devastating environmental impacts, sometimes called a "nuclear winter" or "nuclear autumn". For more, see: Pearce, J.M. and Denkenberger D.C. "A National Pragmatic Safety Limit for Nuclear Weapon Quantities." *Safety* 8 (2018): 25.

[532] Sagan, Carl and Shklovsky, I.S. *Intelligent Life in the Universe* (San Francisco: Holden-Day, 1966), 358.

[533] NAS-NRC Archives: Central File: ADM: IR: Exchange Programs: USSR: Symposia: Extraterrestrial Intelligence: [1971].

arguing that such a conference would support the goals of the NAS agreement, which stated that "the National Academy of Sciences of the USA and the Academy of Sciences of the USSR agree on the desirability of conducting in the USA and the USSR jointly sponsored symposia on important scientific problems".[534] In his proposal, Sagan argued that "contact" between the US and USSR on the issue of CETI might lead to the development of scientific collaboration between the two nations:

> …The time seems ripe to examine seriously these important issues. Even if extraterrestrial intelligence prove to be so rare as to be indetectable in the near future, the potential contribution of such meeting to many interdisciplinary scientific questions seems to be very great. It is possible that this contact will lead to cooperative research programs by scientists of the US and USSR.

The conference was approved and supported by the Academies in both nations, and a joint US-USSR CETI conference was organised, with Sagan chairing the US side, and Shklovsky chairing the Soviet side.[535] Chapter Two briefly referred to the US-USSR CETI conference as a means of addressing the interdisciplinary conflicts within CETI, as well as highlighting the determinist perspectives of the scientific attendees. In this section, I will continue my analysis of the conference, focusing instead on how Cold War consciousness influenced the nature of the discussion and subjects raised.[536] In this chapter thus far, I have shown how the Cold War presented barriers to collaboration between by affecting infrastructures such as mail, publishing, and exchanges. In this final section, I will ultimately argue that the Cold War shaped not only the infrastructures, rhetorics, and collaborations of CETI, but also the mentalities of CETI scientists. The tensions in the field were not lost on its practitioners, and their cognizance of Cold War anxieties resulted in a great focus on existential issues regarding life in the universe.

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[534] Interview with Lev Gindilis on 3 October 2019 in Moscow, Russia, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.; NAS-NRC Archives: Central File: ADM: IR: Exchange Programs: USSR: Symposia: Extraterrestrial Intelligence: [1971].

[535] Ibid.

[536] The following section on the 1971 US-USSR CETI conference was developed from research undertaken during my Master of Science dissertation at the University of Oxford, 2016-2017.

There were 54 participants in attendance at the conference, with ten sessions dedicated to problems such as "the origin of life", "the evolution of intelligence", and "the possible consequences of establishing contact with extraterrestrial civilizations" (Figure 32).[537] Among the American delegation were most of the US CETI pioneers, including Frank Drake, Philip Morrison, Freeman Dyson*, and Ken Kellermann. The Soviet delegation included many CETI scientists previously mentioned in this dissertation, including Lev Gindilis, Nikolai Kardashev, Yuri Pariiskii, and Vsevolod Troitsky. Although the conference was officially a joint US-USSR conference, there were four participants from other countries; Britain, Canada, Hungary, and Czechoslovakia sent one representative each.[538] Interestingly, Britain's representative was Sir Francis Crick, Nobel Prize winner and co-discoverer, along with Rosalind Franklin and James Watson, of the helical structure of the DNA molecule. Later in his career, Crick had become preoccupied with the origins of life and promoted a theory called "directed panspermia", which argued that life might have been deliberately "seeded" throughout the universe by intelligent extraterrestrials, an argument also posited by Shklovsky and Sagan in *Intelligent Life in the Universe*.[539]

The American delegation was particularly interested in the Soviet search effort, which they believed was more readily embraced in the USSR than it was in the United States. In fact, in Sagan's NAS proposal, he specifically argued that one reason why the conference was a necessity was because "through a state commission in the Soviet Union for the study of communication with extraterrestrial intelligence, there exists a more active theoretical and observational program in this area than exists at the present time in the US".[540] Due to the centralised funding systems in the Soviet Union, which were less competitively-based than in the US, Soviet institutions received generally the same number of funds each year, and senior scientists determined how those funds were allocated. This Soviet organization of science was

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[537] eds. Sagan, Carl. *Communication with Extraterrestrial Intelligence (CETI)* (Cambridge: MIT Press, 1973): 353.

* Although Dyson was born in the UK, he spent most of his career working for universities in the US and was an American citizen. He attended the conference as part of the American delegation.

[538] eds. Sagan, Carl. *Communication with Extraterrestrial Intelligence (CETI)* Cambridge: MIT Press, 1973.

[539] Orgel, Leslie E. and Crick, Francis. "Directed Panspermia." Icarus 19 (1973): 341-346.

[540] NA NAS-NRC Archives: Central File: ADM: IR: Exchange Programs: USSR: Symposia: Extraterrestrial Intelligence: [1971].

created as a deliberate foil to Western science; as historian of Soviet science Loren Graham has noted, Soviets believed major flaws in Western science stemmed from "inefficiency due to competition among secretive independent industries, lack of centralised planning, and inadequate financial support from the government" and so created a system through which science funding was centralised and government-supported.[541] Therefore, if a science had the backing of key governmental or institutional figures, it would receive government funds. For example, if a highly respected scientist who headed an institution, such as Shklovsky, decided to promote CETI, a search could be arranged, as was the case with the CTA-102 observations. The US scientific community was decidedly more hostile to CETI observational efforts, and by 1970, Drake's Project Ozma remained the only radio CETI observation conducted in the United States—a decade after it took place.[542] Drake believed there was a strong political motivation on the part of the Soviets that led to their state-support of CETI. He believed Soviet authorities "correctly perceived the search enterprise as an area where Soviets could compete with and possibly excel over American efforts" and that, unlike the US,

> …Soviet scientists at big institutions had money to spend on search efforts, and met no opposition when they opted to build special equipment or staff projects devoted to detecting alien civilizations. And while I wish we American astronomers had enjoyed a warmer reception on this account, I believe that the Soviet acceptance was not entirely benign. Indeed, it had little to do, in my opinion, with wide regard for the search enterprise itself, but… there was also a political motive behind the governmental support for these activities. [543]

Drake's suggestion neglects the complexities of Soviet funding systems, of course. As Benjamin Peters argues in his book *How Not to Network a Nation: The Uneasy History of the Soviet Internet* (2016), there was intense interministerial competition over scientific and technical funding in the Soviet Union, and this competition was mired in politics and personality.[544]

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[541] Graham, Loren. *Science in Russia and the Soviet Union*. (Cambridge: Cambridge University Press, 1994): 174.
[542] "Radio List." The SETI Institute. Accessed 21 February 2021. https://technosearch.seti.org/radio-list.
[543] Drake, Frank, *Is Anyone Out There?* (New York: Delacorte Press, 1992): 96.
[544] Peters, Benjamin. *How Not to Network a Nation: The Uneasy History of the Soviet Internet*. Cambridge: MIT Press, 2016.

Nevertheless, it is true that individual Soviet scientists had more autonomy in choosing which projects to support, so long as there was institutional backing. In the US, on the other hand, CETI project often had to 'piggyback' off of what were considered more 'serious' scientific projects. For example, Drake, in conducting Project Ozma, had to make sure the tools he developed for his search, such as the radiometer, could be used for more traditional scientific purposes, like searching for evidence of the Zeeman effect.[545]

Despite these subtle undertones of jealousy or competition, the 1971 conference was laden with internationalist rhetoric, further cementing the parallels between contact with extraterrestrial aliens and terrestrial aliens established by Sagan in the conference proposal. In fact, in the conference opening remarks, Viktor Ambartsumian, a Soviet astronomer and the Director of the Byurakan Observatory, paraphrased a conversation he had with Shklovsky:

> Professor Shklovsky was right when he said to me that before we are able to solve the problem of communicating with extraterrestrial civilizations, it might be a good thing for there to be communication on the subject among nations, and that is precisely the purpose of our conference.[546]

The conference proved to be quite lively, with participants who agreed and disagreed on many details regarding the search for and communication with extraterrestrial intelligence, including the likelihood of successful communication. For example, some advocated for the use of the 'Universal' language of mathematics, while others argued that if human beings could not meaningfully communicate with cetaceans (another arguably intelligent species on Earth), there could be no hope for communicating with ETI, which would be far more alien than dolphins and porpoises. One thing all participants seemed to agree on, however, was the imagined impact of CETI science on "the future development of mankind", a sentiment oft repeated throughout the conference.[547] Chapter Two explored how CETI philosophies

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[545] Drake, Frank. "Project Ozma." in eds. Kellermann, K.I. and Seielstad, G.A. *The Search for Extraterrestrial Intelligence: Proceedings of an NRAO Workshop Held at the National Radio Astronomy Observatory* (Green Bank: NRAO, 1985): 19.
[546] eds. Sagan, Carl. *Communication with Extraterrestrial Intelligence (CETI)*. (Cambridge: MIT Press, 1973): 3.
[547] Ibid, 353.

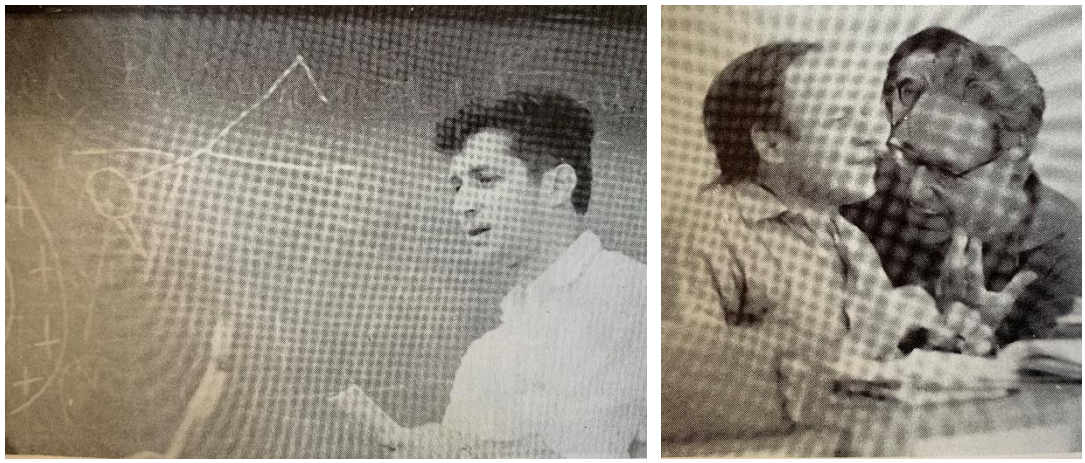

Figure 32. **Top Left:** Nikolai Kardashev presenting a paper at the US-USSR CETI Conference. Photo by Phyllis Morrison, in eds. Sagan, Carl. Communication with Extraterrestrial Intelligence (CETI). Cambridge: MIT Press, 1973; **Top Right:** Shklovsky "making a point with some vigour to Philip Morrison" with Sagan listening from behind. Photo by Phyllis Morrison, in eds. Sagan, Carl. Communication with Extraterrestrial Intelligence (CETI). Cambridge: MIT Press, 1973; **Bottom:** Carl Sagan and I.S. Shklovsky, who is described as being "unimpressed by an argument". Photo by Phyllis Morrison, in eds. Sagan, Carl. Communication with Extraterrestrial Intelligence (CETI). Cambridge: MIT Press, 1973.

developed out of both US Frontier and Soviet Cosmist mythologies, and these future-oriented ontologies manifested in ambitious predictions for the future of humankind at the conference. The conference proceedings clearly illustrated how the CETI scientists considered their field; they saw it as a great unifier, a science which could operate beyond politics and bring about universal peace. The conference participants felt that their "unanimity [sic] of purpose" provided them with "the courage to plot together for the future of all humankind".[548] Their faith in the peace-making capabilities of CETI were ambitious; Drake mentioned that there was discussion of constructing a CETI radio telescope which straddled the Israel-Egyptian border, for the purposes of "[searching] for extraterrestrial intelligence while promoting peace in the Middle East".[549]

[548] Drake, Frank, *Is Anyone Out There?* (New York: Delacorte Press, 1992): 115.

Given this enormous potential in the minds of CETI scientists, the conference resulted in the formation of an international working group to "coordinate national programs of research and to promote progress in this field", whose members included Frank Drake, Nikolai Kardashev, Philip Morrison, Bernard Oliver, Rudolph Pešek, Carl Sagan, Iosif Shklovsky, Vsevolod Troitskii, and G.M. Tovmasyan.[550]

The 1971 US-USSR CETI conference had far-reaching impact on the scientists in attendance. Drake later wrote about the excitement of the conference, during which the scientists involved "laid the groundwork for a number of new searches by both American and Soviet radio observatories", as well as engaged in discussions regarding the role of CETI in peaceful international collaboration.[551] The continued emphasis on peace-making, cooperation, and internationalism masked a significant undercurrent: many of the participants in the conference, including Shklovsky and Sagan, were fully aware of the many barriers and dangers of the Cold War atmosphere in which they were operating, and this awareness shaped the subjects discussed at the conference. This manifested largely in a focus on the "L"—longevity—in the Drake Equation, as conference attendees worried about whether technologically-advanced civilizations might bring about their own destruction. Chapter Two noted that among those invited to the Byurakan conference was a historian, William McNeil, who had achieved notoriety for his earlier publication of *Rise of the West* (1963). The presence of a historian whose expertise was in the rise and fall of civilizations reflected the pressing concern *L* held in the minds of CETI researchers. Shklovsky led a session titled "The Lifetimes of Technical Civilizations" in which discussion focused on the threats of "nuclear destruction, pollution, ecological disruption, overpopulation, and exhaustion of natural resources".[552]

Yet discussions on "L" were not the only aspects of the conference that betrayed Cold War anxieties. James Elliot, an astronomer then affiliated with the Laboratory for Planetary Studies at Cornell University, presented a talk titled "X-Ray Pulses for Interstellar

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[549] Ibid, 115.
[550] eds. Sagan, Carl. *Communication with Extraterrestrial Intelligence (CETI)*. (Cambridge: MIT Press, 1973): 353
[551] Drake, Frank, *Is Anyone Out There?* (New York: Delacorte Press, 1992): 115.
[552] eds. Sagan, Carl. *Communication with Extraterrestrial Intelligence (CETI).* (Cambridge: MIT Press, 1973): 151.

Communication".[553] The title only hints at the content which began by noting that X-rays might be a useful medium for transmitting an "announcement message" in CETI and pointing out that humans have "already used X-rays to send out signals" to the cosmos.[554] How was this so? Because, as Elliot explained, "these signals were sent in the course of several nuclear explosions" conducted by the US and Soviet Union.[555] Elliot argued that if the US and USSR "pooled their nuclear stockpiles to produce a single large explosion", pausing to add "far from Earth!", he believed the X-rays generated from such an explosion could "be detected at a considerable distance". Elliot then spent some time speculating what the existing nuclear arsenal might be, and if it was sufficient for such a message.[556] As we shall see, preoccupation with nuclear arsenals would become a point of focus for many CETI scientists.

Significantly, the 1971 conference also marked a major shift in how the field was defined. Up until this point, the preferred term to describe the activities and research interests of the scientists of the conference was "CETI"—communication with extraterrestrial intelligence. This name suited the conversations undertaken at the conference; for example, one attendee, Marvin Minsky, a computing pioneer in the field of artificial intelligence (AI), presented a paper on how to use AI to communicate with ETI without the need for long response periods—simply launch and place intelligent computers around planets which might harbour intelligent life and let it do the talking for us.[557] Sagan opened his conference remarks by noting how fitting the term 'CETI' was because it is the Latin genitive for 'whale', which he notes are "undoubtably another intelligent species inhabiting our planet", and also because the first CETI observation, Project Ozma, observed a star system named Tau *Ceti*. But within the contemporary technosignature community, it is generally recognised that at the conference a conversation took place between Shklovsky, Sagan, and Drake during which they discussed transitioning the phrase "CETI" to "SETI"—search for extraterrestrial intelligence.* Why the

[553] Ibid, 398.
[554] Ibid, 398.
[555] Ibid, 398.
[556] Ibid, 401.
[557] Ibid, 316.
* Given the informal nature of the conversation, there is of course no documentary evidence to support the claim. However, I spoke with Frank at a panel we both sat on in 2019 and he told me this. The conversation at the conference was allegedly overheard by Kellermann, who also corroborated what Drake claims.

shift? Some argue it was because there was a recognition that scientists must first find extraterrestrial intelligence before attempting communication, and therefore a focus on the 'search' rather than 'communication' would be more representative of the field's goals.[558] Alternatively, Sagan noted in the introduction to the conference proceedings that Boris Belitsky, the science editor for the English language programming on Radio Moscow, served as a translator for the conference in real time, translating from English to Russian and vice versa during each paper and discussion period, a task of enormous undertaking. Perhaps in recognising the various challenges of communication, both terrestrial and extraterrestrial, the cohort decided the first problem to solve would simply be the search; it was at the very least a more feasible goal than communication.

The Byurakan meeting prompted a number of new searches by both US and USSR radio observatories, including what Drake described as an "orbital radio [telescope] for the pursuit of the elusive signals"—possibly referencing what would later become RadioAstron, which was discussed in Chapter One. In his autobiography, Drake hailed the accomplishments of the conference, noting that all their plans and discussions were conducted "under the shadow of the Bay of Pigs, the Cuban missile crisis" and intense surveillance of Soviet scientists and their visitors by KBG.[559] Up until this point, I have described how Cold War anxieties hung over the meeting. But as Drake pointed out, the conference attendees had to deal with Cold War consequences beyond mental concerns. In recollecting the meeting, Minsky noted that the US attendants were constantly supervised by so-called "interpreters".[560] On one occasion, Minsky and Crick decided they had become tired of being supervised, so secretly left from the rear exit of the Academy of Sciences Hotel to avoid being followed on a walk around the city. Upon return, Minsky recalled they found their "interpreter" in tears. She told them "she feared she'd be punished severely if she 'lost' us again". [561] As noted in the last chapter, the parallels between the task of deciding how best to communicate with aliens and visiting a

[558]Interview with Kenneth I. Kellermann on 4 August 2020 in Charlottesville, Virginia, Niels Bohr Library & Archives, American Institute of Physic, College Park, MD USA.
[559] Drake, Frank, *Is Anyone Out There?* (New York: Delacorte Press, 1992): 115.
[560] "Remembering Minsky." Edge, 26 January 2016. https://www.edge.org/conversation/marvin_minsky-remembering-minsky
[561] Ibid.

technologically advanced foreign nation to hold discussions via translator and with intimidating 'interpreters' were not lost on the scientists in attendance at the meeting. In fact, the scientists embraced this view, with Drake noting that when the American delegation left, they felt that "gotten a hint of what life on another world was like".[562] Although friendships were formed between American and Soviet CETI scientists as a result of the conference, the challenges of conducting transnational CETI would remain.

For example, approximately two years after the conference, in 1973, Yuri Pariiskii, then the Director of radio telescope operations at the Pulkovo Observatory in Leningrad, attended a meeting of the IAU in Sydney, Australia. According to Drake, who was also in attendance at this meeting, Pariiskii approached both he and Sagan to inform them he had detected extraterrestrial signals which were "broad-band, like noise" and which were detected "for a few hours" before disappearing, repeating every day over the course of several months.[563] Pariiskii noted the signals seemed intelligent because they were encoded in 1, 2, 7, and 9 pulses. He had already approached Soviet military authorities about the detection and was told the signals were not coming from any known Soviet or American satellites. Pariiskii then told Sagan and Drake he was cautious about going public with the news because of the fallout from what he called the CTA-102 "fiasco".[564] But his wise reticence had presented a problem—he had not, up until that point, been able to consult with his American colleagues on this detection because, as Drake noted, "it was dangerous in those days for a Soviet scientist to divulge research data to an American through the mail, as censors read all the letters".[565] Given my above analysis of Soviet and American mail systems during the Cold War, this concern was not without merit. So Pariiskii had to wait for an opportunity to speak with them in person, telling Drake that their collective CETI goals "transcended questions of national identity."[566] This was both true and untrue. On the one hand CETI goals transcended national ones for the scientists engaged in them, but on the other hand their findings had to be conveyed in person, because those who

[562] Drake, Frank, *Is Anyone Out There?* (New York: Delacorte Press, 1992): 115.
[563] Ibid, 105-106.
[564] Ibid, 105-106.
[565] Ibid, 105-106.
[566] Ibid, 105-106.

were engaged in monitoring the communication of intraterrestrial intelligence would be too likely to intercept them. On the other hand, if they had published the information, perhaps it would only have revealed that the scientists who searched for extraterrestrials did not have the imagination (or classified knowledge) required to recognize evidence of earthly intelligence. Having already experienced several cases of military and intelligence interference in his scientific career, Sagan was sceptical of the signal, and after several weeks of inquiry, was able to confirm the existence of an American intelligence satellite called "Big Bird" which had an orbital pattern which aligned with the pattern of Pariiskii's signal. Drake wryly recalled: "Big Bird did not represent extraterrestrial intelligence, but it was in the business of intelligence-*gathering* from an extraterrestrial vantage point".[567]

Clearly, CETI scientists were forced to confront two incompatible ideas: that CETI promoted internationalism and peace, but also that the practice of CETI highlighted the highly nationalist and hostile world they lived in. It is no wonder, then, that the final variable of the Drake Equation became such a point of interest for the community. This preoccupation with the destruction of civilizations led Sagan, less constrained than Shklovsky in speaking out against nuclear weaponry (which in part had led Sakharov to exile), to dedicate much effort to anti-nuclear activism. In 1983 he published an essay titled "Nuclear War and Climactic Catastrophe: Some Policy Implications" in *Foreign Affairs*, where he argued that if the US and USSR did not reverse their arms race, "there [was] a real danger of the extinction of humanity".[568] Sagan's approach to nuclear disarmament differed from politicians such as President Ronald Reagan, who in the same year Sagan's "Nuclear War" paper was published had deemed the Cold War a "struggle between right and wrong and good and evil", with the US on the side of good. Instead of relying on dichotomies, Sagan utilised CETI internationalism in his anti-Nuclear rhetoric.

For example, in 1985, President Reagan, a known fan of science fiction, once asked General Secretary Gorbachev if the Soviet Union might rescue the US in the case of an

[567] Ibid, 105-106.
[568] Sagan, C. "Nuclear War and Climatic Catastrophe: Some Policy Implications." *Foreign Affairs* 62, no. 2 (1983): 292.

extraterrestrial invasion. Gorbachev replied, "no doubt about it".[569] This odd conversation inspired the premise for an essay Sagan penned in 1988, titled "The Common Enemy". In the essay, Sagan begins:

> "If only, said the American President to the Soviet General Secretary, extraterrestrials were about to invade—then our two countries could unite against the common enemy… An alien invasion is, of course, unlikely. But there *is* a common enemy—in fact, a range of common enemies, some of unprecedented menace, each unique to our time. They derive from our growing technological powers and from our reluctance to forgo perceived short-term advantages for the longer-term well-being of our species.[570]

Sagan's essay took an anti-nationalist stance by appealing to the common humanity shared by citizens of the US and USSR, critiquing both nations and noting that "each side has a long list of deeply resented abuses committed by the other".[571] The essay is driven by concern over the longevity of human civilization, strong implying that without cooperation, the weapons and hostility created by the Cold War would end civilization. Throughout the essay, extraterrestrials were a common theme. Sagan concluded with a call to action, hinging on the sense of common humanity and internationalism he spent the essay trying to instil:

> Is it possible that *we*—*we* Americans, *we* Soviets, *we* humans—are at last coming to our senses and beginning to work together on behalf of the species and the planet? Nothing is promised. History has placed this burden on our shoulders.[572]

Fascinatingly, the article was censored when it was published in *Ogonyok*. This should not be surprising to the reader of this dissertation, given the attention I have given to the Soviet

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[569] Lewis, Danny. "Reagan and Gorbachev Agreed to Pause the Cold War in Case of an Alien Invasion." *The Smithsonian Magazine*, 25 November 2015. https://www.smithsonianmag.com/smart-news/reagan-and-gorbachev-agreed-pause-cold-war-case-alien-invasion-180957402/.
[570] Sagan, Carl. "The Common Enemy." *Parade*, 7 February 1988. As reprinted in Sagan, Carl. *Billions and Billions: Thoughts on Life and Death at the Brink of the Millennium*. New York: Random House, 1997), 181-192.
[571] Ibid.
[572] Ibid.

censorship programs in this chapter. What is interesting, however, is what was censored and why. Much of what was removed was criticism of the Soviet government and history, while Sagan's criticism of the US government and history remained. The most significant removal was of the line "nothing is promised" at the conclusion of Sagan's essay. As I have already noted in Chapter Two, one of the tenets of Soviet Marxist philosophy was a belief that the eventual human progression towards Communism was "foreordained"; a unilineal progression that was ultimately projected on other areas of Soviet life.[573] Once again, it became clear that internationalist CETI rhetoric often found itself uncomfortably confronted with national tension.

Although this chapter has focused primarily on Carl Sagan's CETI internationalism– and rightly so, as he was foundational in shaping the rhetoric of the field—it is important to note that Sagan was not the only CETI scientist to become an anti-nuclear activist; Philip Morrison, recognised for his co-authorship of the first CETI paper in 1959, had previously served as a leader on the Manhattan Project and oversaw the assembly of the bomb which would detonate above the city of Nagasaki. After viewing the devastation in Japan as part of the Manhattan Project's survey team, Morrison became an adamant anti-nuclear activist and founded the Federation of American Scientists and the Institute for Defense and Disarmament Studies. He dedicated much of his life after the war to CETI and chaired the early NASA SETI workshops and studies.[574] At least in part, the search for intelligent life on other worlds had prompted its practitioners to fight to preserve civilization on Earth.

Conclusion

As he was dying from cancer in the 1990s, Carl Sagan wrote a retrospective memoir titled *Billions and Billions: Thoughts on Life and Death at the Brink of the Millennium* (1997). Much of the book covers Sagan's existential concerns, including climate change. In one chapter, he wrote explicitly on the anxiety that stems from world concerns:

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[573] Sagan, Carl. *Billions and Billions: Thoughts on Life and Death at the Brink of the Millennium*. (New York: Random House, 1997): 194.
[574] Shuch, H.P. "Prof. Phillip Morrison." *The SETI League*, 2005. http://www.setileague.org/admin/philmorr.htm.

> Everyone experiences at least a dull background level of assorted anxieties. They almost never go away entirely. Most of them are of course about our everyday lives. There is a clear survival value to this buzz of whispered reminders… The trick, if you can pull it off, is to pick the right anxieties. Somewhere between the cheerful dolts and nervous worrywarts there's a state of mind we ought to embrace.[575]

This chapter has demonstrated that the history of CETI was inextricably tied up in the Cold War, presenting many anxieties and posing communication challenges to the scientists involved, but also forcing them to confront larger philosophical questions. In some sense, the search for technosignatures as we know it today could not have existed without the enormous investment by US and Soviet governments into its major infrastructures and institutions, such as the establishment of NRAO, the funding of conferences, or the support for the publication of books. Similarly, without the Space Race, there might have been far less public support and individual interest in pursuing the CETI problem. Furthermore, it was the Cold War mindset that influenced CETI scientists such as Frank Drake to pose the question of longevity of civilizations, and that led others, such as Sagan, into anti-war activism. Although the Cold War played a role in the establishment of CETI, however, it also presented many challenges to those who pursued it and highlighted the cultural and communication barriers between scientists in the US and USSR. In striving to overcome interterrestrial cultural and communications difficulties, and in recognizing the existential dilemma posed by the Cold War, CETI scientists in some sense engaged far more in philosophical and historical problems than they did technical ones. Understanding the historical context in which CETI developed is fundamental to the continued pursuit of the search for technosignatures and communication with extraterrestrial intelligence, as scientists to this day continue to pose philosophical questions which are influenced by our present cultural and geopolitical circumstances.

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[575] Sagan, Carl. *Billions and Billions: Thoughts on Life and Death at the Brink of the Millennium*. (New York: Random House, 1997): 89.

Conclusion

Dr Arroway: "Our television signals leave this planet and go out into space...the signals spread out from the earth in spherical waves, a little like ripples in a pond. They travel at the speed of light, 186,000 miles a second, and essentially go on forever. The better some other civilizations' receivers are, the farther away they could be and still pick up our tv signals. Even we could detect a strong tv transmission from a planet going around the nearest star."

US President: "You mean everything? You mean to say all that crap on television - the car crashes, wrestling, the porno channels, the evening news?"

— Carl Sagan, *Contact: A Novel* (1985)[576]

This dissertation opened with an anecdote about a submarine and a crisis of communication between humans. I will now conclude with another episode concerning a submarine and communication failure, but this time, focus on an event in which humans failed to understand the communication of another species. In 1981, a Swedish fisherman discovered an enormous Soviet submarine, equipped with nuclear weapons, beached on the south coast of Sweden.[577] An international crisis ensued before it was discovered Sweden was not under attack, but rather the Soviet submarine had hit a rock which had scrambled its navigational instruments, forcing it aground. The submarine was escorted by the Swedish Navy back to international waters in the Baltic Sea. Though officially branded an accident, the event prompted much fear and speculation in Sweden, and reports of periscope and submarine sightings became regular occurrences on the Baltic coast. As a result, the Swedish Navy began to use helicopters and boats to lower hydrophones into the water, to try to find the submarines allegedly being spotted. Soon, the Navy began to hear the "typical sound" of Soviet subs all

[576] Sagan, C. *Contact*. (New York: Simon and Schuster, New York, 1986): 98-99.
[577] Leitenberg, Milton. "The Case of the Stranded Sub." Bulletin of Atomic Scientists 38, no. 3 (2015).

over Swedish waters. When a hydrophone picked up evidence of a sub, helicopters would drop charges into the sea, hoping to either provoke the subs to rise to the surface, or damage them.

Despite years of pursuing the subs, with frequent reports of sightings and the "typical sound" being constantly heard, a sub never materialized. By 1994, frustration boiled over and Swedish prime minister Carl Bildt angrily confronted Russian President Boris Yeltsin, who denied Russian military presence in Swedish waters.[578] At this point, several academics, including two biologists, Magnus Wahlberg and Hakan Westerberg, were invited to listen to the previously classified military intelligence recordings of the "typical sound" of Russian submarines, to determine their source. After much investigation, Wahlberg and Westerberg discovered that Swedish waters were indeed occupied by something lurking beneath the surface, but it was not a submarine: it was herring.

Most fish have an organ called a "swim bladder", a small pocket filled with gas, which allows fish to regulate how they float in the water. Herring, in massive schools, release this gas through their anal cavities, making a cacophony of bubbling sounds which the Swedish military had interpreted as the sounds from a Soviet sub. In addition to regulating their swim bladder, scientists believe herring also use these bubbles as a form of communication within the school. In other words, Sweden bombed schools of flatulating, chatty fish as part of a massive campaign to search for artificial signals from an alien nation. This event in the history of foreign relations, while superficially comedic (go ahead, laugh), is nonetheless revealing of a major theme in the history of the Cold War, as well as the search for extraterrestrial intelligence: the act of searching for and identifying intelligent signals from the "other"—when one does not fully understand how to define the motives, culture, or methods of communication of who or what they are seeking—will inevitably lead to mixed signals.

The Decline of Cold War CETI

As I have briefly alluded to earlier in this dissertation, CETI scientists also had a preoccupation with marine communication—the 1961 Green Bank CETI conference was attended by John Lilly,

[578] Zubko, Marat and Litovkinunder, Viktor. "Swedish Prime Minister Going to Moscow To Resolve 'Periscope Problem." CIA. Unclassified 3 February 1993. https://documents2.theblackvault.com/documents/cia/ufos/C05517522.pdf.

a dolphin biologist who aimed to discover a way to create a two-way dialogue between humans and dolphins. It is worth noting that Lilly's project, which had won funding from NASA because of its implications for CETI, faced a disastrous end.[579] Lilly's laboratory lost funding in part due to a disregard for animal welfare—Lilly, who also had a background in neurology, had injected the dolphins with LSD to study the effect of the drugs on cetacean brains and behaviour.[580] There were also later concerns over the sexual nature of the relationship between one scientist and the dolphins on the project.[581] Despite the loss of NASA funds, Lilly continued to try to develop dolphin-human communication, utilising traditional scientific methods as well as some less-traditional methods, including attempts at telepathy. [582] Lilly's attempts largely failed, and today the discipline of dolphin biology has shifted to trying to understand the complexities of dolphin communication, rather than trying to teach them English or establish direct dialogue. Lilly's laboratory has since faced much mockery, including inclusion on a lewd *Saturday Night Live* sketch titled "The Dolphin Who Learned to Speak".[583]

The problems with Lilly's laboratory reflect one of the biggest issues of mid-20th century CETI: primarily, the anthropocentric assumption that human conceptions of communication could be universalised with other species (or even other nations). And there is no shortage of pseudoscientific stories such as these in CETI history. For example, perhaps taking inspiration from Lilly's use of LSD and telepathic communication, CETI radio astronomer Gerrit Verschuur once claimed to have taken LSD and enclosed himself in a sensory deprivation tank to try to contact ETI with his mind.[584] Perhaps because of its close ties to pseudoscience and a history of some maverick ideas, scientific CETI has sometimes struggled with achieving serious recognition

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[579] Riley, Christopher. "The Dolphin Who Loved Me: The NASA-Funding Project That Went Wrong". The Guardian, 8 June 2014. https://www.theguardian.com/environment/2014/jun/08/the-dolphin-who-loved-me.
[580] Ibid.
[581] Mosendz, Polly. "How a Science Experiment Led to Sexual Encounters Between a Woman and a Dolphin." *The Atlantic*, 11 June 2014. https://www.theatlantic.com/international/archive/2014/06/how-a-science-experiment-led-to-sexual-encounters-for-a-woman-and-a-dolphin/372606/.
[582] Riley, Christopher. "The Dolphin Who Loved Me: The NASA-Funding Project That Went Wrong". The Guardian, 8 June 2014. https://www.theguardian.com/environment/2014/jun/08/the-dolphin-who-loved-me.
[583] *Saturday Night Live*. "The Dolphin Who Learned to Speak." Episode 5, Season 43. The National Broadcasting Company, 12 November 2017.
[584] Verschurr, Gerrit L. *Is Anyone Out There?: Personal Adventures in the Search for Extraterrestrial Intelligence.* Self-published, 2015.

within the scientific community and funding bodies, in part due to what I described in Chapter Two as the "giggle factor".

There are several sources for the giggle factor's impact on CETI. For one, the discipline is sometimes co-opted by UFO enthusiasts, much to the annoyance and frustrations of CETI scientists. Secondly, CETI scientist's evocation of themes popular within science fiction sometimes led the two to become entangled with one another. And third, because the premise of the field is inherently non-falsifiable (meaning that while one can definitively prove the existence of ETI through the evidence of an artificial extraterrestrial signal, the non-existence of ETI cannot be proved), which Karl Popper helped make a widely recognised (though problematic) criterion demarcating non-scientific knowledge from scientific knowledge, CETI is sometimes discredited as non-scientific. The giggle factor has contributed to a dearth of funding for CETI, especially after the Cold War period, when there was a declining interest in the intelligence applications of its technology or desire to fund scientific exchanges between the US and USSR. As I have shown, during the Cold War, CETI did receive minor support from the US government. The US government and some of its agencies funded CETI conferences, telescope design proposals, workshops, and even minor observational projects. Yet it is important to note that at the end of the Cold War, in the 1990s, American SETI suffered several setbacks. In the 1980s, planning and development for the first NASA-funded SETI observational project, the High-Resolution Microwave Survey were underway. The project officially launched in 1992, but the following year, in September 1993, Senator Richard Bryan, a senator from Nevada, introduced an amendment during a congressional meeting on NASA's budget which both defunded HRMS and removed SETI from NASA's mission altogether. That same year, the NSF established a prohibition for funding searches for extraterrestrial intelligence in its annual *NSF Guide to Programs.*[585] When introducing the amendment to end SETI funding, Senator

[585] Tarter, Jill et al. "Three Versions of the Third Law: Technosignatures and Astrobiology." *Astrobiology Science Strategy for the Search for Life in the Universe. National Academies of Sciences, Engineering, and Medicine*. White Paper, 2018.

Bryan exclaimed, “this hopefully will be the end of Martian hunting season at the taxpayer's expense”.[586]

There were several reasons for the sudden decline in government funded CETI/SETI. First, Jill Tarter has long noted that SETI is at a disadvantage to other sciences in that it has to request further funds (for more searches) based on what are perceived as failures (no detection made).[587] Second, by the 1990s, the Earth was becoming more radio quiet. Intelligence operations were shifting from signals intelligence to cyber security with the rapid development of computers, and in popular culture, video killed the radio star: the rise of cable television meant “all that crap on television”, as noted in this conclusion’s opening quote, was no longer reaching the cosmos. Quite possibly there was a recognition both in the government and in the SETI community that radio was not necessarily the modus operandi for cosmic communication, and there was certainly less of a need to rely on SETI for conducting signals intelligence. Finally, there was a general misunderstanding by government officials of the Fermi Paradox; by the 1990s, there was a growing sense that, after 30 years of CETI, if a detection had not been made, perhaps there were no extraterrestrials to be found. President Clinton’s science advisor stated in 1994 that “we’ve done a lot of observing and listening already; and if there were anything obviously here, I think we would have gotten some signal [by now].”[588] This was based on a misunderstanding of how many CETI/SETI searches had been conducted since 1960, but nevertheless had impact in the defunding of CETI. In the Soviet Union, where CETI had generally more support from state funds, there was also a drop in CETI activity in the 1990s, perhaps partly for similar reasons but primarily because of the dissolution of the Soviet Union. In their paper charting CETI/SETI research in the Russian, Soviet, and post-Soviet space, Gurvits and

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[586] Wright, Jason. “NASA Should Start Funding SETI Again.” *Scientific American*, 7 February 2018. https://blogs.scientificamerican.com/observations/nasa-should-start-funding-seti-again/?utm_content=bufferf2949&utm_medium=social&utm_source=facebook.com&utm_campaign=buffer&fbclid=IwAR1tQsjiwSlsmuGsyeYW96nAWAYUR2zG3YwWbHSDssC8_QMiz-wHu1DBKP0.

[587] Garber, Stephen J. “Searching for Good Science: The Cancellation of NASA’s SETI Program.” Journal of the British Interplanetary Society 52 (1999): 9.

[588] Ibid.

Gindilis admit "the general decline of science in Russia after the collapse of the Soviet Union could not but affect the state of SETI", leading to an overall decline in SETI activity.[589]

After SETI lost its government support in the 1990s, it turned to private support from the mega-rich—a trend in the 21st century space sciences more broadly, as evidenced by the development of private aerospace enterprises such as Elon Musk's Space X and Jeff Bezos' Blue Origin. For example, when attempting to build the first radio telescope array dedicated to SETI, scientists approached Paul Allen, co-founder for Microsoft, to fund what later became the Allen Telescope Array, the first array built for exclusively SETI purposes. More recently, the most ambitious SETI observational project in history launched in 2015, with the goal of surveying 1,000,000 stars over ten years.[590] The project, Breakthrough Listen, was given $100 million in funding from Russian billionaire philanthropist Yuri Milner. Nevertheless, outside of private financing, government support for CETI has overall declined since the 20th century.[591] Given this evidence, I conclude that 20th century radio CETI was a field defined by its relationship with the Cold War.

This dissertation set out to understand the relationship between CETI and Cold War infrastructure and ideologies. My subsequent analysis has shown that this apparently marginal, barely funded field of research is unusually revealing of Cold War communication because it involved a speculative use of resources on themes that are of broad cultural significance, using technologies and techniques that are important strategically both in scientific research and in military communication. For example, Chapter One established the origins of CETI and radio astronomy as distinct products of the Cold War by showing how governments invested in radio astronomy facilities and infrastructure in part to support a burgeoning interest in signals intelligence. That chapter also demonstrated that CETI's ties to military intelligence posed great

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[589] Gindilis, L.M. and Gurvits, L.I. "SETI in Russia, USSR, and the Post-Soviet Space: A Century of Research." *Acta Astronautica* 162 (2019): 22.

[590] "Breakthrough Listen." Breakthrough Initiatives. Accessed 24 May 2021. https://breakthroughinitiatives.org/initiative/1.

[591] There is some evidence may be changing: With the rise of exoplanetary telescopes and SETI's rebranding into technosignature research, governments appear open to funding search for extraterrestrial intelligence once again. For example, several of the next generation of radio telescopes, including the Square Kilometre Array and China's FAST, include technosignature searches as part of their science goals.

communications challenges between scientists in the US and USSR, as evidenced by the CTA-102 affair.

Chapter Two shifted the analysis of CETI infrastructure from intelligence gathering to the expansionist ideologies of the Cold War and how they influenced CETI philosophies and projects. For example, Chapter Two showed how the colonial heritage of radio astronomy led to the construction of instruments on settled land, resulting in conflict at observatory sites, such as Arecibo and Mauna Kea. As I have shown, space exploration and astronomy are deeply tied to people and places on the Earth, and despite its celestial ambitions, CETI is no different. In fact, Chapter Two demonstrated that the actual process of conducting CETI, as well as astronomy more broadly, was revealing of the world and ourselves. In other words, not only did CETI prompt reflectiveness, but the messages conveyed to extraterrestrial intelligence and the methods and tools used to conduct searches illuminated who held power, control of land and messages, and the hegemonic ability to define humanity. Scientists in both the US and USSR were influenced by the respective imperialist determinism of their nations, and these mentalities were reflected in the images they conjured of both humans and extraterrestrials.

Chapter Three took a more individualist approach to CETI history by examining the relationship between I.S. Shklovsky and Carl Sagan and showing how the established ties between CETI and the Cold War led to existentialist anxieties in the scientists, culminating in an preoccupation with the longevity of civilizations. This chapter showed how the major conflict in CETI, being both internationalist and dependent on military-governmental infrastructures, was reflective of one of the great ironies of the Cold War. As historian Vijay Prashad has noted, cooperation and peaceful exchanges were part of the arsenal of the Cold War, as "both sides…pelted each other with arguments about peace".[592] Scientists were able to cooperate with one another due to government support of exchanges and conferences but faced many barriers to their cooperation stemming from this governmental intervention. This tension led some prominent CETI scientists, and especially Carl Sagan, to engage in anti-nuclear activism and greater reflection on the longevity of human civilization.

[592] Prashad, Vijay. *The Darker Nations: A People's History of the Third World* (New York: The New Press, 2007): xv.

Recommendations for Future Research

This dissertation is perhaps the first sustained study solely dedicated to analysing Cold War-era CETI history, and certainly one of the first to include a transnational approach with inclusion of Soviet sources. There is therefore much need for future studies in this area. As stated in the introduction, acquiring Soviet CETI sources is a challenge—future historians will need to figure out how to expand the historical record. This will not always mean finding access to established archives; I noted, for instance, upon visiting Shklovsky's old office at the Shternberg Astronomical Institute at Moscow State University that there was a tremendous number of documents and files that had seemingly not been touched in decades; there is almost certainly a wealth of Soviet astronomical history buried in those rooms, if one has the time, funds, and ability to sort through it.

There is also a need to continue study of the relationship between astronomical observatories and governments. As evidenced in Chapter Two, siting telescopes on land with a history of colonialism and settlement exacerbates imperial tensions and undermines democratic input. Since the Cold War, international scientific collaboration has become the norm, not the exception, and global cooperation in the sciences is sharply increasing. According to a 2018 study, scientific papers with co-authors from two or more countries now account for 23% of total publications, an increase from only 13% in 2000.[593] Globalization and improved transcontinental communication account for some of this increase, but it is additionally the product of scientific projects growing in ambition and scale. Small telescopes can be funded by universities and national institutes, for example, but the premiere 21st century instruments such as the Atacama Large Milimeter Array, the Square Kilometre Array, and the planned Next Generation Very Large Array necessitate multi-national funding sources and research groups, as well as the sharing of land or launch facilities between countries.

[593] Matthews, K.R.W., Yang, E., Lewis, S.W., Vaidyanathan, B.R., and Gorman, M. "International Scientific Collaborative Activities and Barriers to Them in Eight Societies. *Accountability in Research* 12, no. 3 (2020).

My research has demonstrated that cooperation among nations can leave scientific projects vulnerable to conflict and political interference, and this investigation should expand to further examine international ground-based arrays, which are subject to the control of multiple governments. Furthermore, as ground-based facilities become increasingly expansive and expensive projects, problems with land rights and colonial disputes may also increase, leading to conflict with local communities, potential public opposition, and scientific disruption, such as has already been seen at some observatory sites. The contemporary technosignature community especially will want to reflect on these problems; as technosignature research is shifting in character to become part of exoplanetary science, many of the new radio astronomy facilities, including FAST and the SKA, include technosignature research as part of their primary science goals. This dissertation has argued that the search for extraterrestrial intelligence must be especially cognizant of Earth-based concerns—historical studies can be a valuable tool in understanding how social, cultural, and political elements impact and shape the science.

Beautiful Dreams and Horrible Nightmares

The introduction noted how science fiction, especially first-contact scenarios, often possessed metaphors for Cold War anxieties. It would be regretful, then, to conclude without giving some attention to one of the most well-known first-contact science fiction novels written by a CETI scientist. In 1985, Sagan published *Contact*, which told the story of a fictional SETI scientist named Dr Ellie Arroway, whose characterization was based on Jill Tarter.[594] In the novel, Arroway discovers an ETI message using the Arecibo radio telescope in Puerto Rico. The novel, while certainly located in the genre of science fiction, spends the majority of its pages devoted to the conflict and collaboration which resulted from the international effort to decode the mysterious alien message. In one chapter, Dr Arroway attempts to convince the President of the United States to permit the sharing of the classified extraterrestrial signal with radio telescopes all over the world. She argues:

> The Earth turns. You need radio telescopes distributed evenly over many longitudes if you don't want gaps. Any one nation observing only from its own

[594] "Jill Tarter Elected to American Academy of Arts and Sciences." The SETI Institute. Accessed 24 May 2021. https://www.seti.org/press-release/jill-tarter-elected-american-academy-arts-and-sciences

> territory is going to dip into the message and dip out—maybe even at the most interesting parts. Now this is the same kind of problem that an American interplanetary spacecraft faces. It broadcasts its findings back to Earth when it passes by some planet, but the United States might be facing the other way at the time… I don't think any nation can accomplish this project alone. It will require many nations, spread out in longitude, all the way around the Earth. It will involve every major radio astronomy facility now in place—the big radio telescopes in Australia, China, India, the Soviet Union, the Middle East, and Western Europe.

In moments like these, Arroway serves as a mouthpiece for Sagan and his beliefs about CETI's role as an international science, and its potential to bring about global unity.

The novel, written approximately a decade before his death, seems to serve almost as an alternate history; a collection of events and conversations Sagan imagined might have happened if the fruits of CETI's labour came to fruition. Although Arroway is the only character explicitly said by Sagan to have a counterpart in a real CETI scientist (in fact, the novel is prefaced with the disclaimer: "This book is a work of fiction… any resemblance to actual events or locales or persons living or dead is entirely coincidental"), it is difficult not to see parallels between Sagan's colleagues and the characters in the book. One character, Vasily Gregorovich Lunacharsky, is a Jewish Soviet scientist and close friend of Arroway, with good humour despite being often barred from traveling outside the USSR. Arroway, while introducing Lunacharsky's character in the novel, mentions how she once took him shopping around Berkeley on a rare occasion he was able to leave the USSR, and describes how he purchased a "Pray for Sex" button from one of the many irreverent hippy establishments. In his autobiography, Frank Drake recounts an almost identical story where I.S. Shklovsky, while visiting Berkeley in the 1970s, purchased a "Pray for Sex" button, joking "in your country, it is offensive in only one way. In my country, it is offensive in two independent ways".[595] Lunacharsky, clearly a stand-in for Shklovsky, is quoted in the novel as having said the same.[596] Sagan was also involved in the production of the screenplay for the film based off the novel, which included the addition of the

[595] Drake, Frank, *Is Anyone Out There?* (New York: Delacorte Press, 1992): 96.
[596] Sagan, C. *Contact*. (New York: Simon and Schuster, New York, 1986): 111.

character Kent Clarke, a blind astronomer working with Arroway, who is clearly modelled after the actual blind astronomer who worked with Tarter on the MCSA mentioned in Chapter One, Kent Cullers. The events in the book also parallel real CETI events; for example, when Arroway's first SETI search is shutdown, she turns to a private billionaire donor to fund the effort.

I mention *Contact* at the conclusion of this dissertation, not simply because it is an interesting novel, or because it is fun to see the parallels between fictional characters and real historical figures, but because it provides direct evidence that CETI scientists such as Sagan saw CETI as both a great unifier—the book and screenplay explicitly make the case that contact with extraterrestrial intelligence would foster international collaboration—and a discipline which highlighted human conflict. After Arroway's signal is detected, much of the friction in the book comes from politics and religion hindering the progress of the CETI scientists. The outside critique of this frustrating duality comes from the fictional extraterrestrials, who tell Arroway at the end of the film: "You're an interesting species. An interesting mix. You're capable of such beautiful dreams, and such horrible nightmares."[597] Evoking the "L" of Drake's equation, they warn, "in the long run, the aggressive civilizations destroy themselves, almost always".[598] Sagan's aliens themselves are aspirational—they belong to a galactic community, where different species had cooperated to engineer a supercivilization, somewhat like what Kardashev had envisioned as a Type III civilization. They fulfil the CETI dream of global cooperation, built on an expansionist, technocratic culture—a dream that essentially embodies Cold War-era science.

[597] Zemeckis, Robert. *Contact*. 11 July 1997, Burbank: Warner Brothers.
[598] Sagan, C. *Contact*. (New York: Simon and Schuster, New York, 1986): 359.

Appendix A

Новое в радиоастрономии

ИНТЕРВЬЮ «ПРАВДЫ»

Недавно молодой радиоастроном Московского университета Г. Б. Шоломицкий совместно со своими товарищами по работе обнаружил переменность потока радиоизлучения от космического источника, известного под обозначением СТА-102.

В беседе с корреспондентом «Правды» заведующий отделом радиоастрономии Государственного астрономического института имени Штернберга при Московском университете профессор И. С. Шкловский сообщил:

— Эти наблюдения проводились группой радиоастрономов нашего института под руководством Г. Б. Шоломицкого начиная с августа 1964 года. Успеху наблюдений способствовала специально разработанная приемная аппаратура с квантовым парамагнитным усилителем и антенна с большой эффективной площадью.

Источники космического радиоизлучения СТА-102 и СТА-21 были открыты пять лет назад американскими радиоастрономами. Эти источники обладают рядом необычных свойств, резко отличающихся от других источников (необычный радиоспектр, ничтожно малые угловые размеры).

Интерес к этим объектам стимулировался также опубликованной в прошлом году в советской научной печати очень смелой гипотезой московского радиоастронома И. С. Кардашева, который на основе анализа экспериментальных и теоретических данных предположил, что излучения от СТА-102 и СТА-21 могут иметь искусственное происхождение. Согласно гипотезе Кардашева эти источники могут быть радиосигналами весьма удаленных от нас космических цивилизаций.

Наблюдения московских радиоастрономов привели к крупному научному открытию. Было обнаружено, что поток излучения от источника СТА-102 регулярно меняется со временем по периодическому закону, причем период изменений потока близок к 100 дням (см. рисунок).

Что можно сказать по поводу этих в высшей степени интересных наблюдений? Этот источник радиоизлучения может быть либо представителем совершенно нового класса объектов, либо отражать совершенно новые свойства уже известных космических источников радиоизлучения (например, остатков взрывов так называемых «сверхновых» звезд). Конечно, нельзя исключить и волнующую гипотезу о том, что наблюдается искусственный сигнал от внеземной цивилизации. Необходимы, однако, новые специальные наблюдения, чтобы гипотеза стала научным фактом.

Прежде всего надо подтвердить наличие переменности потока СТА-102 независимыми наблюдениями на других частотах. Очень важно проводить и другие радиоастрономические наблюдения этого источника, например, исследовать его поляризацию.

На месте источника СТА-102 недавно американскими астрономами была обнаружена слабая звездочка 17-й величины. Было бы очень хорошо получить спектр этой звезды. Это позволило бы уточнить расстояние до СТА-102, что очень важно. Кроме того, очень важно исследовать возможную переменность этой звездочки.

Если переменность периодического характера у источника СТА-102 подтвердится, это будет одним из крупнейших открытий в радиоастрономии.

На рисунке приведена зависимость от времени отношения источников СТА-21 и СТА-102 к потоку от радиоисточника 3С-48, принимаемого за эталон. По горизонтальной оси указаны даты наблюдений. По вертикальной оси — отношения потоков СТА-21 и СТА-102 к потоку от источника 3С-48. Кружки относятся к источнику СТА-21, черные точки — к источнику СТА-102. Видно, что поток радиоизлучения от источника СТА-21 практически остается постоянным, в то время как радиоизлучение СТА-102 периодически меняется.

"New in Radio Astronomy." *Pravda*, 14 April 1965 (in Russian).

Recently, the young radio astronomer at the University of Moscow, G. B. Sholomitskii, together with his fellow workers, discovered variability in the flux of radio emission known under the designation CTA 102.

In an interview with a *Pravda* correspondent, the head of the radio astronomy department of the Sternberg State Astronomical Institute at Moscow University, Professor I.S. Shklovsky, said: "These observations have been carried out by a group of radio astronomers in our institute under the guidance of G. B. Sholomitskii since August 1964. A specially developed receiving equipment with a quantum paramagnetic amplifier and an antenna with a large effective area contributed to the success of the observations."

Sources of cosmic radio emission CTA-102 and CTA-21 were discovered five years ago by American radio astronomers. These sources have a number of unusual properties that differ sharply from other sources (unusual radio spectrum, negligibly small angular dimensions).

Interest in these objects was also stimulated by the very bold hypothesis of the Moscow radio astronomer N.S. Kardashev, published last year in the Soviet scientific press. On the basis of an analysis of experimental and theoretical data, Kardashev suggested that emissions from CTA-102 and CTA-21 could be artificial in origin. According to Kardashev's hypothesis, these sources can be radio signals of cosmic civilizations far from us.

Observations conducted by Moscow radio astronomers led to a major scientific discovery. It was found that the radiation flux from the CTA-102 source changes regularly with time according to a periodic law, and the period of flux changes is close to 100 days (see figure).

What can be said about these highly interesting observations? This source of radio emission can be either a representative of a completely new class of objects, or a new kind of radio emission (for example, from remnants of explosions of the so-called “supernova” stars). Of course, one cannot exclude the exciting hypothesis that an artificial signal from an extraterrestrial civilization is being observed. New special observations are necessary, however, for the hypothesis to become a scientific fact.

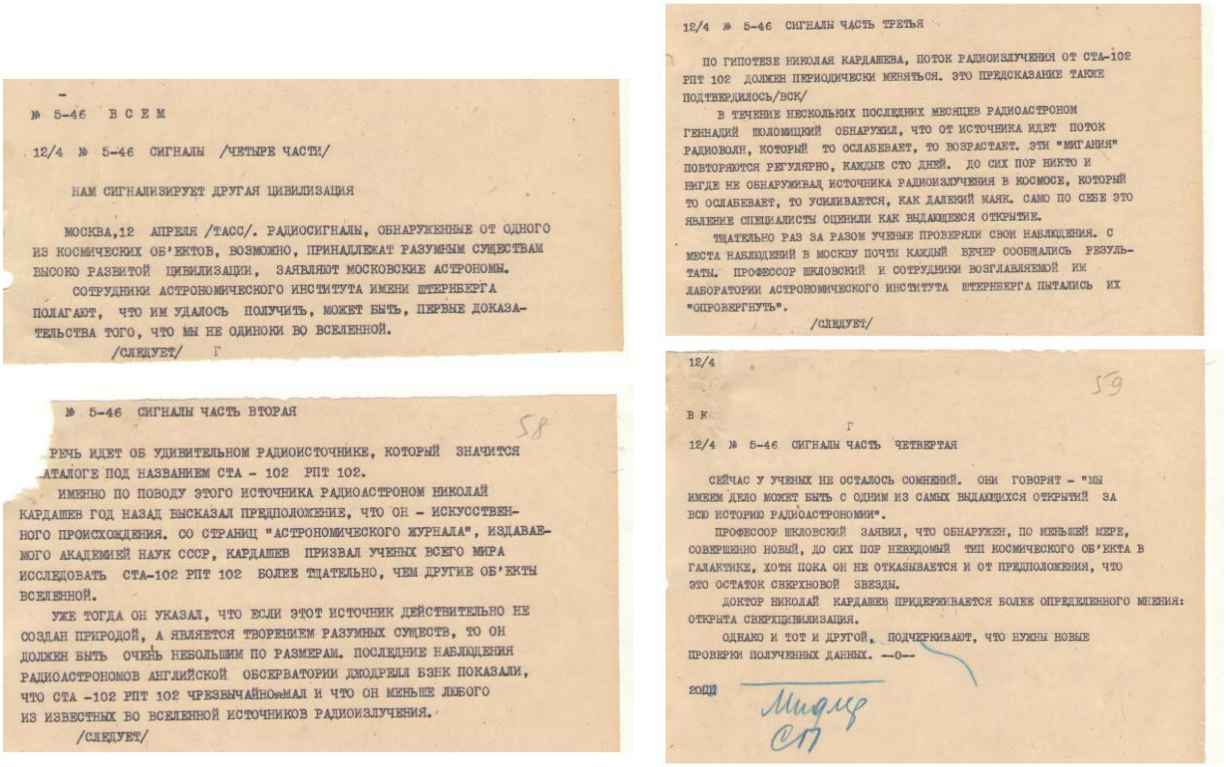
First of all, it is necessary to confirm the presence of variable CTA-102 flux by independent observations at other frequencies. It is very important to conduct other radio astronomical observations of this source, for example, to investigate its polarization.

At the site of the CTA-102 source, recently a small 17th magnitude star was discovered by American astronomers. It would be very good to get the spectrum of this star. This would clarify the distance to CTA-102, which is very important. In addition, it is very important to investigate the possible variability of this starlet.

If the variability of a periodic nature at source CTA-102 is confirmed, this will be one of the biggest discoveries in radio astronomy.”

Figure Caption: The figure shows the flux of CTA-21 and CTA-102 compared to the flux of the standard radio source 3C-48. The dates of observations are indicated on the horizontal axis. The vertical axis shows the ratio of the flux of CTA-21 and CTA-102 to the flux of source 3C-48. The circles refer to the CTA-21 source, the black dots to the CTA-102 source. It can be seen that the radio emission flux from the CTA-21 source remains practically constant while the CTA-102 radio emission changes periodically.

Appendix B



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12/4 № 5-46 СИГНАЛЫ /ЧЕТЫРЕ ЧАСТИ/

НАМ СИГНАЛИЗИРУЕТ ДРУГАЯ ЦИВИЛИЗАЦИЯ

МОСКВА,12 АПРЕЛЯ /ТАСС/. РАДИОСИГНАЛЫ, ОБНАРУЖЕННЫЕ ОТ ОДНОГО ИЗ КОСМИЧЕСКИХ ОБ'ЕКТОВ, ВОЗМОЖНО, ПРИНАДЛЕЖАТ РАЗУМНЫМ СУЩЕСТВАМ ВЫСОКО РАЗВИТОЙ ЦИВИЛИЗАЦИИ, ЗАЯВЛЯЮТ МОСКОВСКИЕ АСТРОНОМЫ.

СОТРУДНИКИ АСТРОНОМИЧЕСКОГО ИНСТИТУТА ИМЕНИ ШТЕРНБЕРГА ПОЛАГАЮТ, ЧТО ИМ УДАЛОСЬ ПОЛУЧИТЬ, МОЖЕТ БЫТЬ, ПЕРВЫЕ ДОКАЗАТЕЛЬСТВА ТОГО, ЧТО МЫ НЕ ОДИНОКИ ВО ВСЕЛЕННОЙ.

/СЛЕДУЕТ/ Г

12/4 № 5-46 СИГНАЛЫ ЧАСТЬ ТРЕТЬЯ

ПО ГИПОТЕЗЕ НИКОЛАЯ КАРДАШЕВА, ПОТОК РАДИОИЗЛУЧЕНИЯ ОТ СТА-102 РПТ 102 ДОЛЖЕН ПЕРИОДИЧЕСКИ МЕНЯТЬСЯ. ЭТО ПРЕДСКАЗАНИЕ ТАКЖЕ ПОДТВЕРДИЛОСЬ/ВСК/

В ТЕЧЕНИЕ НЕСКОЛЬКИХ ПОСЛЕДНИХ МЕСЯЦЕВ РАДИОАСТРОНОМ ГЕННАДИЙ ШОЛОМИЦКИЙ ОБНАРУЖИЛ, ЧТО ОТ ИСТОЧНИКА ИДЕТ ПОТОК РАДИОВОЛН, КОТОРЫЙ ТО ОСЛАБЕВАЕТ, ТО ВОЗРАСТАЕТ. ЭТИ "МИГАНИЯ" ПОВТОРЯЮТСЯ РЕГУЛЯРНО, КАЖДЫЕ СТО ДНЕЙ. ДО СИХ ПОР НИКТО И НИГДЕ НЕ ОБНАРУЖИВАЛ ИСТОЧНИКА РАДИОИЗЛУЧЕНИЯ В КОСМОСЕ, КОТОРЫЙ ТО ОСЛАБЕВАЕТ, ТО УСИЛИВАЕТСЯ, КАК ДАЛЕКИЙ МАЯК. САМО ПО СЕБЕ ЭТО ЯВЛЕНИЕ СПЕЦИАЛИСТЫ ОЦЕНИЛИ КАК ВЫДАЮЩЕЕСЯ ОТКРЫТИЕ.

ТЩАТЕЛЬНО РАЗ ЗА РАЗОМ УЧЕНЫЕ ПРОВЕРЯЛИ СВОИ НАБЛЮДЕНИЯ. С МЕСТА НАБЛЮДЕНИЙ В МОСКВУ ПОЧТИ КАЖДЫЙ ВЕЧЕР СООБЩАЛИСЬ РЕЗУЛЬТАТЫ. ПРОФЕССОР ШКЛОВСКИЙ И СОТРУДНИКИ ВОЗГЛАВЛЯЕМОЙ ИМ ЛАБОРАТОРИИ АСТРОНОМИЧЕСКОГО ИНСТИТУТА ШТЕРНБЕРГА ПЫТАЛИСЬ ИХ "ОПРОВЕРГНУТЬ".

/СЛЕДУЕТ/

№ 5-46 СИГНАЛЫ ЧАСТЬ ВТОРАЯ

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РЕЧЬ ИДЕТ ОБ УДИВИТЕЛЬНОМ РАДИОИСТОЧНИКЕ, КОТОРЫЙ ЗНАЧИТСЯ АТАЛОГЕ ПОД НАЗВАНИЕМ СТА - 102 РПТ 102.

ИМЕННО ПО ПОВОДУ ЭТОГО ИСТОЧНИКА РАДИОАСТРОНОМ НИКОЛАЙ КАРДАШЕВ ГОД НАЗАД ВЫСКАЗАЛ ПРЕДПОЛОЖЕНИЕ, ЧТО ОН - ИСКУССТВЕННОГО ПРОИСХОЖДЕНИЯ. СО СТРАНИЦ "АСТРОНОМИЧЕСКОГО ЖУРНАЛА", ИЗДАВАЕМОГО АКАДЕМИЕЙ НАУК СССР, КАРДАШЕВ ПРИЗВАЛ УЧЕНЫХ ВСЕГО МИРА ИССЛЕДОВАТЬ СТА-102 РПТ 102 БОЛЕЕ ТЩАТЕЛЬНО, ЧЕМ ДРУГИЕ ОБ'ЕКТЫ ВСЕЛЕННОЙ.

УЖЕ ТОГДА ОН УКАЗАЛ, ЧТО ЕСЛИ ЭТОТ ИСТОЧНИК ДЕЙСТВИТЕЛЬНО НЕ СОЗДАН ПРИРОДОЙ, А ЯВЛЯЕТСЯ ТВОРЕНИЕМ РАЗУМНЫХ СУЩЕСТВ, ТО ОН ДОЛЖЕН БЫТЬ ОЧЕНЬ НЕБОЛЬШИМ ПО РАЗМЕРАМ. ПОСЛЕДНИЕ НАБЛЮДЕНИЯ РАДИОАСТРОНОМОВ АНГЛИЙСКОЙ ОБСЕРВАТОРИИ ДЖОДРЕЛЛ БЭНК ПОКАЗАЛИ, ЧТО СТА -102 РПТ 102 ЧРЕЗВЫЧАЙНОмАЛ И ЧТО ОН МЕНЬШЕ ЛЮБОГО ИЗ ИЗВЕСТНЫХ ВО ВСЕЛЕННОЙ ИСТОЧНИКОВ РАДИОИЗЛУЧЕНИЯ.

/СЛЕДУЕТ/

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12/4 № 5-46 СИГНАЛЫ ЧАСТЬ ЧЕТВЕРТАЯ

СЕЙЧАС У УЧЕНЫХ НЕ ОСТАЛОСЬ СОМНЕНИЙ. ОНИ ГОВОРЯТ - "МЫ ИМЕЕМ ДЕЛО МОЖЕТ БЫТЬ С ОДНИМ ИЗ САМЫХ ВЫДАЮЩИХСЯ ОТКРЫТИЙ ЗА ВСЮ ИСТОРИЮ РАДИОАСТРОНОМИИ".

ПРОФЕССОР ШКЛОВСКИЙ ЗАЯВИЛ, ЧТО ОБНАРУЖЕН, ПО МЕНЬШЕЙ МЕРЕ, СОВЕРШЕННО НОВЫЙ, ДО СИХ ПОР НЕВЕДОМЫЙ ТИП КОСМИЧЕСКОГО ОБ'ЕКТА В ГАЛАКТИКЕ, ХОТЯ ПОКА ОН НЕ ОТКАЗЫВАЕТСЯ И ОТ ПРЕДПОЛОЖЕНИЯ, ЧТО ЭТО ОСТАТОК СВЕРХНОВОЙ ЗВЕЗДЫ.

ДОКТОР НИКОЛАЙ КАРДАШЕВ ПРИДЕРЖИВАЕТСЯ БОЛЕЕ ОПРЕДЕЛЕННОГО МНЕНИЯ: ОТКРЫТА СВЕРХЦИВИЛИЗАЦИЯ.

ОДНАКО И ТОТ И ДРУГОЙ, ПОДЧЕРКИВАЮТ, ЧТО НУЖНЫ НОВЫЕ ПРОВЕРКИ ПОЛУЧЕННЫХ ДАННЫХ. --О--

20ДД

Мидлр

СП

TASS telegram written by Alexander Midler, 12 April 1965, Records of the Telegraph Agency of the Soviet Union (*TASS*), Centre for Preservation of a Reserve Record, Ialutorovsk, Siberia, Russia. Scans courtesy of Leonid Gurvits (in Russian).

12/4 5-46 SIGNALS / FOUR HOURS /

“We Are Signalled by a Friendly Civilization”

Moscow, 12 April /*TASS*/. Radio signals, detected from a celestial object, possibly belong to the constructive establishments of a highly developed civilization, declare Moscow astronomers.

Staff of the Astronomical Institute
/ FOLLOW /

5-46 SIGNALS PART 2

Speech is about an amazing radio source, which is catalogued under the name CTA-102.

One year ago, radio astronomer Nikolai Kardashev assumed this source may be of artificial origin. From the pages of the “Journal of Astronomy”, published by the Academy of

Sciences of the USSR, Kardashev suggested that the scientists of the world should study CTA-102 more than other cosmic objects.

Back then he declared that if this source is not really created by nature, but it is the creation of rational creatures, then it should be very small in size. Recent observations of radio astronomy Jodrell Bank Observatory in England have shown that CTA-102 is extremely small and that it is smaller than any other known source of radiation in the universe.

12/4 5 46 SIGNALS PART 3

On the hypothesis of Nicholas Kardashev, the radio emission from CTA 102 might periodically change. This prediction has also been confirmed / VSK /

Over the course of the last several months, Gennadii Sholomitskii detected that radio waves from the source weaken and then grow. These “flickerings” repeat regularly, every hundred days. Until Sholomitskii, no one anywhere in the world had detected a source of radio emission in space which weakened, then was strengthened, like a distant lighthouse. As a result, this phenomenon is considered to be a tremendous discovery.

The scientists have carefully tested his observations. From the place of observation to Moscow, the results were reported almost every evening. Professor Shklovsky and employees of the Shternberg Astronomical Institute were testing ways to “disprove” them.
/ follow /

12/4 5 46 SIGNALS PART 4

Now the scientists have no doubt. They say—“we have a matter which may be one of the most outstanding discoveries in the history of radio astronomy”.

Professor Shklovsky declared that, at the least, what they have detected is brand new. Until the time that this unknown type of space object in the galaxy is revealed, it is not unreasonable to suppose it may simply be a supernova.

Dr Nikolai Kardashev holds a more defined opinion: a supercivilization is revealed. However, considering his opinion and others, it is clear that new verifications of the data obtained are needed. –0—

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