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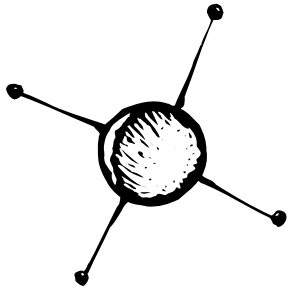

Introduction

"THEY Said It Couldn't Be Done!"

Vioalle Clark Hefferan returned to her Seventh Street apartment, relieved it was finally Friday. All week long, she had helped students get ready for Bulldog Day, Albuquerque High School's annual day of homecoming festivities. Although her students' float, decked out in green and white, did not win any prizes, Hefferan knew that they would forget their disappointment by the time that evening's football game started.

As soon as Vioalle walked in the door, the phone rang. She put down her books and picked up the receiver. An out-of-breath voice exclaimed, "The Russians have launched a satellite!" It was 4:30 P.M. in New Mexico, on October 4, 1957. Only minutes had passed since news of the successful launch had traveled from the Soviet embassy in Washington, D.C., to the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts. Hefferan's mystery caller begged her to assemble her team of amateur satellite spotters and be ready to observe Sputnik's passage in less than an hour.

As the sun started to set, Vioalle Hefferan phoned members of Moonwatch team #041 and passed the word. She realized she might not have any takers. Students from Hefferan's high school astronomy club made up most of her team, and many of them might not want to cancel their dates for that

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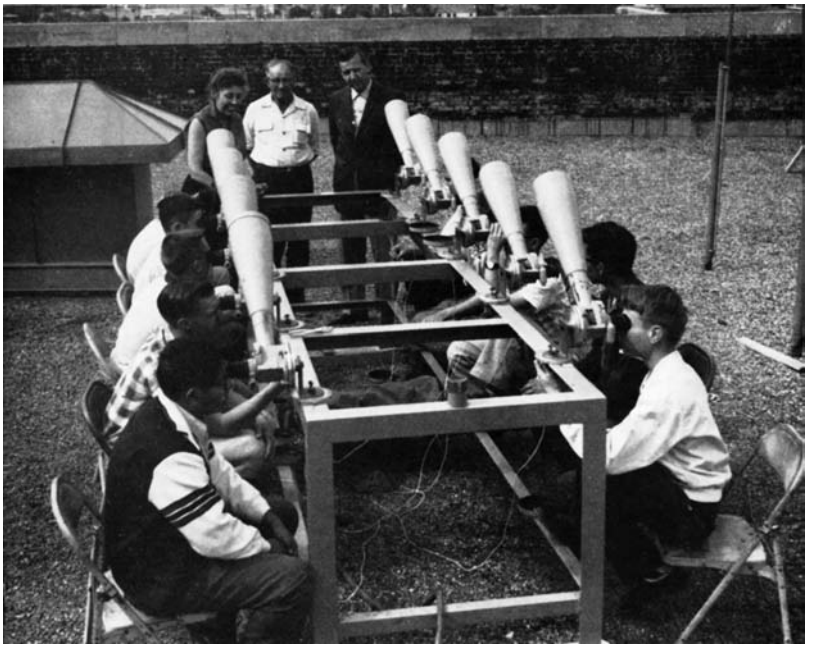

FIGURE I.1. Vioalle Hefferan and her Moonwatch team on the roof of Albuquerque High School, c. 1961.

evening's festivities (fig. I.1). Within two hours, however, two dozen teens rendezvoused with Hefferan on the fourth-floor roof of Albuquerque High School.

The constellation Sagittarius emerged in the twilit sky, hanging between Saturn and the nearly full moon. However, Hefferan's students weren't interested in this particular moon. They had their sights set on spotting the earth's newest satellite, one that no eyes had yet seen in the sky.

While they did not know it at the time, amateur scientists around the world, equipped with homebuilt telescopes and ham radio equipment, were the only groups with the capability to spot and track the first satellites that October night. Although teams of engineers were constructing a global system of sophisticated and expensive satellite tracking cameras, this was unfinished. The Soviets' surprise launch of Sputnik caught these professionally staffed stations, as one Chicago newspaper would chide, "with their telescopes down."[1]

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Hefferan's team and the dozens of other Moonwatch teams mobilizing around the world that evening stood to make history. As the night chill settled in, her students took their places at observing stations and scanned the skies through telescopes they had helped design and build. Their objective was ambitious. A speeding satellite could cross the face of the full moon in less than a second and traverse an entire continent in minutes. A student was ready at a nearby telephone to relay the team's data—exactly when and where they spotted the Soviet satellite in the night sky—to scientists who anxiously waited to plot the course of the world's first satellite. Telescopes pivoted, feet shifted, voices quieted, and eyes strained for a sign that the long-awaited exploration of space had begun.[2]

Satellites, Science, and the IGY

In the weeks that followed, similar scenes repeated at Moonwatch stations all over the globe. Thousands of teenagers, homemakers, longtime amateur astronomers, school teachers, blue-collar workers, and other citizen-scientists took turns scanning the skies in the hopes of spotting one of the first satellites flashing by at 18,000 miles per hour. Despite their all-night vigil, the big prize of being the first team in the United States, perhaps the world, to see Sputnik, eluded Hefferan's students that night. This was not due to lack of training or effort on their part, however. Predicting the orbits of artificial satellites and locating the actual objects in the wide expanse of sky was as much art and luck as science. Hefferan's team soon learned that Sputnik wouldn't be visible over New Mexico for several more days. When it finally did arrive, however, they manned their posts again and won acclaim throughout their school and state for spotting it.

The novelty of what flashed and beeped in the October sky in 1957 is hard to appreciate today. As I write this, thousands of objects of varying size are orbiting the earth. Hundreds of these are functioning satellites. These objects girding the globe are critical links in a modern technological and scientific infrastructure that most people reflect on little, if at all.

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Only when a solar flare or technical glitch knocks a satellite out of commission do we realize how our lives tenuously connect to these objects silently speeding overhead. Global positioning tools in our cars and even watches rely on a system of satellites. Weather satellites help meteorologists predict the path of deadly storms giving people days rather than hours to evacuate. Other satellites send music and television shows to people's homes. Orbiting platforms with sensitive infrared detectors can spot plumes of hot gases coming from a hostile missile launch while others carry cameras that provide real-time intelligence data. Satellites have revolutionized world communications, provided entertainment for billions, and spawned vast multinational companies—all while knitting the world into a global village.

Satellites and orbiting telescopes have also helped revolutionize how science is done. From the first small satellites and solar system probes that helped scientists understand the nature of the earth's immediate environment to multibillion-dollar space telescopes, scientific instruments freed from landbound confines have provided scientists and ordinary citizens with extraordinary new powers of observation. When the amateur scientists of Moonwatch worked with professional scientists to spot and track the first satellites, they also helped humans move toward a new understanding of how we see ourselves, our planet, and our place in the cosmos.

The initial entrée for amateur scientists to take part in this grand adventure came as professional scientists prepared for the International Geophysical Year. The IGY, as it was known in the 1950s, was the most ambitious and complex science project of the twentieth century. Between July 1957 and December 1958, tens of thousands of professional scientists from sixty-seven different nations staffed hundreds of stations around the globe. Together, they researched important topics in fields like geophysics, atmospheric sciences, and oceanography. During the IGY, scientists gained a remarkable new understanding of our planet. For instance, they detected the Van Allen radiation belts around the earth, explored Antarctica, and probed the worldwide system of underwater mountains and ridges to help explain how continents moved.

Most stunning of all, though, and what dominated headlines, political debate, and dining room conversation more than anything else during the IGY, was the launch of the world's first artificial satellites. The ramifications

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of first one and then several satellites affected national politics, influenced pop culture, and transformed international relations.

The IGY provided opportunities not only for Moonwatchers but for amateur scientists of all interests. Ham radio operators, meteor spotters, and weather observers participated in IGY-related activities and stimulated interest among ordinary citizens to explore science's seemingly endless frontier. War-surplus equipment, commercially available science kits, and a knack for constructing their own equipment enabled the amateurs' pursuits. The community of amateur scientists blossomed during the heyday of Operation Moonwatch.*

Moonwatch and amateur science were part of the multifaceted bonanza of science popularization that emerged first after the end of World War Two and then again following Sputnik.[3] As the public recognized the role of scientists in winning World War Two, the prestige of scientists rose dramatically. "Physical scientists are in vogue these days," *Harper's* commented after the war. "No dinner party is a success without at least one physicist to explain . . . the nature of the new age in which we live."[4] The postwar media consequently depicted scientists as heroic explorers and science as a majestic adventure.

The symbols of postwar science were indeed grand. The United States Postal Service memorialized the Hale Telescope, perched high atop Palomar Mountain in southern California, on a postage stamp when it was dedicated in 1948. Beneath its graceful, classically shaped dome, the world's largest telescope with its massive 200-inch mirror silently collected the universe's mysteries. Colorful articles in *Time*, *Collier's*, and *Life* presented a romantic image of the lone astronomer exploring the universe with this giant new instrument. The public was fascinated by its size and majesty, some believing that its capabilities transcended even science. The president of the Rockefeller Foundation, which had funded the telescope, even described it as an instrument to help heal an ailing world.[5] Giant telescopes, powerful atom smashers, nuclear-powered submarines, the structure of DNA, the invention

*Throughout its lifetime, the Smithsonian Astrophysical Observatory gave its amateur satellite tracking program various names including (as this book's title indicates) Operation Moonwatch as well as Project Moonwatch. For simplicity's sake, hereafter I refer to it as Moonwatch.

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of the transistor, rockets probing the limits of the earth's atmosphere—all broached the sublime and thrilled a public eager to understand and embrace the transformative potential of science and technology.

What distinguished the citizens around the world who took part in Moonwatch from their curious neighbors was that they were not just passive consumers of science popularization. As dedicated observers, tinkerers, and experimenters, Moonwatchers and other amateur scientists vigorously worked with professional scientists to help produce new scientific knowledge. Moonwatchers were among the most enthusiastic devotees of science and technology in the 1950s. While the first Soviet satellites alarmed many Westerners, Moonwatchers had a different reaction. Their correspondence and newsletters spoke of the great adventure space exploration promised and the broader horizons that beckoned to their children. As one Moonwatcher rhapsodized during the IGY, "One cannot look for very long into the workshop of the Creator without changing his attitude towards life."[6] Before widespread disenchantment with science and technology took hold in the 1960s, launching satellites and exploring space seemed triumphant and glorious endeavors. Moonwatch provided an invitation for amateur scientists and other curious citizens to come along for the ride and actively participate.

What Was Moonwatch?

The imminent availability of satellites in 1957 promised scientists new vistas for research. By knowing, with great accuracy and precision, where a satellite was, scientists could learn far more about their planet than earthbound instruments permitted. Orbiting instruments, for example, could reliably send scientists information about cosmic rays and other forms of radiation that the earth's atmosphere screens out. By sighting the satellite from different points on earth and triangulating the observations, researchers could create a more accurate map of the earth's surface and the planet's actual shape. They could study the motion of satellites to understand how the earth's gravitational field varied with location, such as over the earth's equatorial bulge. In addition, the orbit of satellites could provide scientists with

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much more detailed information about the earth's upper atmosphere, including its density and temperature.

While this research might sound mundane today, in 1957 it was basic information essential for any future space exploration by either people or machines. These data were also valuable for national security. The air force, for example, couldn't accurately launch rockets from Kansas to Kiev if it did not know exactly where on the earth Kiev actually was or how missiles would behave as they zoomed through the earth's atmosphere.

Before orbiting satellites could provide scientists and engineers with this cornucopia of information and applications, they needed to know where the satellites were and how they moved. While today's modern tracking tools and sophisticated computer programs make this a relatively straightforward and incredibly precise operation, the situation was quite different when Sputnik and its brethren first appeared. Importantly, rocket engine and guidance technologies could not guarantee that the first satellites would go exactly where Soviet or American engineers wanted. A rocket burn of a few extra seconds, for an object moving several thousand miles per hour, could put it in an orbit much different from what engineers initially planned.

Once a satellite had been lofted into orbit, it continued to move with stunning speed. A navy scientist in 1956 likened seeing a satellite to catching a glimpse of a golf ball tossed out of a jet plane.[7] This created two challenges to people on the ground. One was finding the satellite—under the best of conditions, scientists imagined, it would appear as a faint star—while it moved against the vast celestial tapestry. The second task, after the object had been acquired, was to continue to track it. Once scientists had established the location of the satellite at several points in its orbit, they could use classical physics to calculate its orbit and thus predict when and where the satellite would be in the future.

While the first satellites would broadcast radio signals, the first radio tracking systems wouldn't produce the precision scientists wanted. Moreover, the transmitters themselves were delicate pieces of equipment, powered at first by short-lived batteries and operating in a harsh new environment scientists were just beginning to understand. In contrast, visual sighting and tracking offered scientists and politicians unquestionable proof that an object was indeed in orbit along with a dependable source of information about its position. Even if newfangled radio devices failed, visual satellite

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observations using the tried and true combination of human-eye-plus-telescope could still reveal to scientists many secrets of the earth's shape and nature of the upper atmosphere.

Other than meteors and comets, scientists had never tried to track such fast-moving celestial objects moving so close to earth. A satellite's speed varies with its apogee and perigee while its path over the earth's surface can continually change over time. The orbit of the first Soviet Sputnik, for example, moved slightly to the west with each revolution while the earth itself moved underneath it. All of these variables made tracking the first satellites a major engineering and scientific accomplishment.

This is where amateur scientists entered the picture. Moonwatchers, scientists initially thought, would assist professionally staffed (and presumably more reliable) optical and radio tracking stations. At least that was the plan. During the opening weeks of the Space Age, however, Moonwatchers and other amateurs became a much more essential part of the global satellite tracking network. Organized, trained, and geared up when the first Soviet sputniks appeared, these heretofore unknown citizen-scientists made critical contributions in the opening days of the Space Age and contributed to the work of "real" scientists and engineers.

Harvard astronomer Fred L. Whipple conceived of Moonwatch when scientists around the world were making plans for the IGY. Whipple was already famous in scientific circles for his study of meteors and comets and for his wartime research on how to defeat enemy radar technology. He quickly transformed the Smithsonian Astrophysical Observatory (SAO), newly moved from Washington, D.C., to Cambridge, Massachusetts, into one of the world's largest organizations for research in astronomy and space science.[8]

For years, Whipple had spoken publicly about the transformative potential of satellites and space exploration. In July 1955, when President Eisenhower announced that the United States would launch an artificial satellite during the IGY, the ambitious Whipple was ready. He quickly proposed that his observatory have the responsibility for spotting and tracking the first satellites. Whipple's bold plan depended on the cooperation and integration of three very different ingredients. First, the SAO would establish a network of a dozen, specially designed cameras that could photograph satellites while simultaneously viewing relatively large swaths of the sky.

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These would be located all around the globe—Hawaii, Iran, Australia, and South Africa all had one—and staffed by trained technicians. Second, these camera stations would send their information and photographs to the SAO in Cambridge, where experts would crunch the numbers and predict the satellites' orbits. All of this depended, however, on having a rough idea of where to look in the first place.

Enter Moonwatch, the critical third piece of Whipple's plan. As Whipple first imagined it, Moonwatchers would perform only a few basic services. During the IGY, amateur volunteers would scan the skies at dusk and dawn, times when satellites are most visible, and send their sightings to the SAO. Serving as a global dragnet for satellites and giving professionally staffed tracking stations a rough estimate of where to start precision tracking, Moonwatchers would provide a valuable service. Amateurs would also maintain so-called death watches when satellites, captured by atmospheric drag and gravity, plunged back to earth. This information could lead, perhaps, to the recovery of satellite fragments while amateurs' observations could help explain how objects like meteors (and incoming missile warheads) behaved in the upper atmosphere.

Whipple and his colleagues did not foresee the public exposure Moonwatch would receive when Sputnik caught the professionally staffed tracking stations and the rest of the world by surprise, nor did they imagine that the program would last for nearly two decades. What Whipple did understand from the outset, however, was that amateur astronomers and other citizens around the world could help gather useful data and actively work with professional scientists.

To help organize this immense undertaking, he recruited like-minded optimists: J. Allen Hynek, a professional astronomer from Ohio State University and UFO investigator who coined the term "close encounters of the third kind"; Armand N. Spitz, whose planetariums educated thousands of adults and children about the heavens; and Leon Campbell, Jr., a tireless and kindly science enthusiast well acquainted with the amateur astronomy community.

Together, these four men launched Moonwatch in 1956, but only after overcoming several serious hurdles. They had, for example, to convince skeptics in the professional science community and Washington political establishment that amateurs were up to the task. As Whipple recalled, in mild

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language that belies the tensions surrounding the IGY's satellite program, "Some of my colleagues were convinced that too few amateurs would volunteer, and that those who did would not always perform satisfactorily."[9] Understandably, perhaps, U.S. scientists and politicians were loath to take chances as millions of dollars, professional careers, and national prestige rested on the success of the American satellite effort. Whipple's campaign to include amateur scientists in the action was indeed a bold gamble.

During the opening months of the Space Age, Moonwatchers around the world proved Whipple's instincts right. Amateurs exceeded expectations and made a meaningful contribution to one of the largest science enterprises in history. During the opening months of the Space Age, in fact, their services were essential. Using telescopes hand-built or purchased from vendors like Radio Shack, Moonwatchers nightly monitored the skies while radio hams recorded Sputnik's short-lived radio transmissions. Moonwatchers' prompt response was due to their extensive training and participation in widely publicized national alerts. This preparation paid off. Within Moonwatch's first two years, thousands of volunteers at more than two hundred stations worldwide joined the program. During the IGY, Moonwatchers made more than 10,000 satellite observations. As Whipple happily crowed years later to the global community of Moonwatchers, "THEY said it couldn't be done! THEY said it couldn't work! . . . And THEY were dead wrong!"[10]

Moonwatch succeeded for several reasons. Whipple and his SAO colleagues provided invaluable support and encouragement. The best performing teams had skilled and dedicated team leaders, people like Vioalle Hefferan in New Mexico and Richard Emmons in Ohio who organized, trained, and motivated their teams. Moonwatchers actively participated in science, making them more than eyewitnesses to the global satellite craze that exploded with the opening of the Space Age. Regardless of their background—participants came from rural areas and large cities of the United States and dozens of locales around the world—the enthusiasm of Moonwatchers caught the attention of average citizens interested in science and space exploration. Moreover, the thousands of amateur scientists who participated in Moonwatch were not merely passive data collectors. Devoted amateurs refined their equipment, developed new techniques, and formed local and regional networks to communicate their work.

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The influence of Moonwatch extended beyond the data that amateurs collected and shared. Dozens of teenagers entered science fairs and boasted of their Moonwatch experience when applying for college admission. Moonwatch, and amateur science in general, helped expand the horizons of young amateur scientists and encouraged them to consider professional research in astronomy or other fields. For some participants, Moonwatch helped launch their careers. For others, Moonwatch fulfilled a more personal need by providing an opportunity to study the heavens, learn new skills, and interact with people from their communities. People were proud of their participation. When the Smithsonian discontinued the program in 1975, one longtime Moonwatcher likened his participation to receiving an award for wartime valor.

Just as importantly, Moonwatch stimulated interest in science and space among ordinary citizens. Dozens of local newspaper articles featured Moonwatch teams standing vigil in the community. Journalists, especially those in smaller towns, relied on information amateurs provided to help explain satellites and rockets to their eager readers. Moonwatchers, consequently, served not only as amateur scientists and civic-minded volunteers but also as ambassadors for science to their local communities. Through open houses, science fairs, and evening viewing sessions, they presented the significance of the first satellites to intrigued and concerned citizens.

Despite experts' initial claims that Moonwatch could never work, the Smithsonian continued the program long after the IGY ended. After the Eisenhower administration created the National Aeronautics and Space Administration (NASA), hundreds of dedicated amateur scientists maintained their participation and helped NASA track satellites. Continuing their tradition of maintaining satellite "deathwatches," Moonwatchers in Milwaukee had a front-row seat in 1962 when the five-ton satellite Sputnik 4 plunged to its fiery fate. Amateurs' observations allowed American scientists to recover significant pieces of the debris. During Moonwatch's twenty years of existence, it helped provide an opportunity for an entire generation of citizen-scientists and space buffs to play a role in the Space Age. Undaunted by its official end in 1975, a small, tight-knit community of satellite watchers continued to observe satellites and is posting their results on the World Wide Web even today.

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Who Was an Amateur Scientist?

"Amateur" — the word itself comes from the Latin for "lover." And, like lovers, amateur scientists varied in intensity and the degree to which they were consumed. A broad continuum of citizens participated in Moonwatch, and a wide array of terms may describe them: dabbler, hobbyist, recreation seeker, devotee, and serious amateur scientist.[11]

Imprecise and flexible labels challenge our attempts to strictly separate amateur scientists from their professional counterparts. Historians have devoted considerable attention to the study of amateur scientists, their interaction with professional science communities, and the extent of amateur contributions to research. Most of this historiography focuses on the nineteenth and early twentieth centuries.[12] This makes sense, as during that time scientists established their professional identities and set boundaries that delineated major research disciplines. By the time of the IGY, the traditional tensions historians have noted between professional scientists and amateurs were generally not an issue.

Credentials, institutional affiliation, and access to major equipment and other resources have all offered ways to distinguish amateurs from professional scientists. Commitment and motive for participating in scientific activities also matter. Moonwatch, for example, naturally attracted many people intrigued by its Space Age novelty. Their contributions were indeed often "amateurish." Quite often a person would read a newspaper article or hear a radio show about Moonwatch or the IGY satellite program and become intrigued, then captivated. But while perhaps not of much use to scientific research, their participation in Moonwatch or other amateur science programs often served valuable civic or educational purposes.

Throughout this book, we will see how the amateurs of Moonwatch spanned a continuum of interest, motivation, and ability. Curiosity seekers and joyriders caught up in the IGY's excitement joined more serious amateur scientists who wanted to help further scientific knowledge. As Moonwatchers, however, all of these people shared the goal of wanting to see satellites, regardless of motive. To achieve this end, amateurs established and followed standards and practices necessary for successful satellite spotting.

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Many amateurs became part of a larger community that circulated news and technical tips and met with other groups of amateur scientists or interacted with professional scientists.

The varied roster of Moonwatch participants makes it clear that the identity of amateur scientists is more nuanced than one might first suspect. Along with high school students and those enthusiasts astrophysicist Neil deGrasse Tyson calls "blue collar intellectuals," many people with backgrounds in science, engineering, or some other technical area took part in Moonwatch or other amateur IGY activities.[13] Therefore, I use "professional scientist" and "amateur scientist"—terms commonly used in the 1950s, while today "citizen scientist" is gaining popularity—with the recognition that the boundaries between them were sometimes indistinct and occasionally overlapped.

However, in this book, one characteristic distinguishes the "amateurs" of Moonwatch from professionals. When doing amateur science, they were all unpaid volunteers.[14] Instead of a paycheck, fame, or career advancement, remuneration came in the form of pride, peer recognition, the satisfaction of learning new skills, and the feeling that one was contributing, in however seemingly small a way, to the larger edifice of science. While some went on to build careers in science fields, they started as unpaid Moonwatch volunteers.

Discovering Moonwatch's History

Despite its long lifetime and many successes, Moonwatch is almost forgotten today. When television shows and Hollywood movies depict the opening years of the Space Age and the moon race that followed, they rarely take the participation of amateur scientists and other curious citizens into account. In the 1995 Oscar-winning film *Apollo 13*, the heroes are astronauts and managers at Mission Control. Ordinary citizens are relegated to spectators and passive witnesses. When the National Geographic Society released its television documentary *Space Race: The Untold Story* in 2006, familiar names like von Braun, Gagarin, and Armstrong once again took center stage.

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The participation of amateur scientists has, until now, been left out of the picture as historians and journalists have largely viewed the IGY and the start of the Space Age from the top down. While prominent scientists and politicians appear here, Moonwatch's story and that of amateur science in general is history from the bottom up. At its heart, Moonwatch's success rested not on professional scientists but on ordinary people, some with experience in science and others who brought only their excitement and enthusiasm. Therefore, it is to these previously unexamined lives that we must turn to understand this particular tributary of the scientific enterprise.

The exclusion of amateurs is partly due to the vagaries of the historical record. Compared to the archival evidence that informs us about the lives of professional scientists, their communities, and their activities, amateur scientists often leave little behind to record their tinkering and experimenting. Perhaps because they often worked in contented isolation or participated in relatively obscure local clubs, reconstructing the world of modern amateur scientists presents special challenges for the historian. While national newspapers featured comments and stories about professional scientists like Fred Whipple, the lives and labors of amateur scientists were often known only to their local communities and within their own group of like-minded hobbyists.

Fortunately—and in comparison to many other amateur science activities from the Sputnik era—a wealth of materials detailing Moonwatch's history has survived and is accessible to exploration and investigation. Because Whipple and his colleagues at the SAO managed Moonwatch, for instance, letters, reports, and photographs are carefully preserved in dozens of large boxes at the Smithsonian Institution Archives in Washington, D.C. It is not just Moonwatch's official records—the budget requests, travel invoices, carbon-copied office memos that detail the SAO's management of amateur scientists—that have been preserved, though. To look only at these would reveal just part of the story and diminish the role of the thousands of Moonwatchers worldwide.

Present in these well-cataloged files, many of which have not been examined comprehensively before, are also letters, telegrams, and other correspondence from the global network of Moonwatch team leaders and members. Indicating the pride these teams had in their accomplishments, amateurs also regularly forwarded newspaper clippings, informal newsletters, artwork,

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and even self-written team histories to the SAO, and the Smithsonian has carefully preserved them. In addition to these official records are the more ephemeral and much harder-to-locate sources that come from the basements and closets of former Moonwatchers. Personal correspondence, photographs, observing logs, and homemade scrapbooks—all of these supplement the documents kept by the Smithsonian and other professional archives.

Finally, many people who participated in Moonwatch are still alive. Through email queries, phone calls, and face-to-face meetings, I was fortunate to have been able to interact with dozens of former Moonwatchers, some of whom continue to do amateur science. Their personal recollections and anecdotes complemented and added clarity to the information and stories preserved in the written record while providing fascinating insights into the past worlds of amateur science. This full range of materials has provided a richer picture not only of Moonwatch but also of amateur science and its interaction with the professional science establishment.

Moonwatch's Importance

To explore Moonwatch's history through these diverse and compelling sources is also to rediscover vanished features of an American society typically seen through Baby Boomers' nostalgic eyes. Moonwatch existed when the Cold War's frigid tides surged through the United States. Indeed, like the IGY itself, it was very much a product of Cold War competition and concerns. Americans in the 1950s looked to the skies for many reasons. Hundreds of thousands of American citizens volunteered for the Ground Observer Corps in the 1950s in an effort to spot incoming nuclear-armed Soviet bombers. Coincidentally, reports of UFOs reached an apex in the 1950s, reflecting people's fears of a surprise Soviet attack.

Sputnik and its pulsing "beep-beep" appeared mysterious, suspicious, even frightening to many Americans' ears. In 1957, there was good reason for these fears as evermore powerful nuclear weapons entered the Soviet and American arsenals. To Western military and political observers, Sputnik's launch signaled that the Soviets possessed rocket technology sufficient to

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hurl large objects over thousands of miles. The unholy combination of rocket-plus-nuclear-bomb meant that these fearsome weapons could now reach their targets via missiles in minutes, not hours. America's hope for postwar security was first eroded by the threat of Soviet bombers and then devastated by Sputnik.[15]

A schedule of Sputnik 2's overhead passage published by the *New York Times* in November 1957 gave vivid proof of how quickly disaster could come: "Key West 2:55, Savannah 2:57, Atlantic City 2:59, . . ." The great oceans surrounding North America no longer barred a sudden attack on the U.S. heartland as they once had. Politicians and newspapers even connected Sputnik with a potential Soviet nuclear strike from outer space. As Senator Lyndon Johnson warned, in spite of scientists' more sober appraisals, "Soon they will be dropping bombs on us from space like kids dropping rocks on cars from an overpass."[16] General anxiety persisted, diluted only somewhat by pride after the United States finally launched its first satellites in 1958.

Sputnik did not just stir Americans' fear of a Soviet-instigated "Pearl Harbor." The shiny new objects orbiting the earth during the IGY trespassed into a region that, for many, was traditionally sacred and inviolate. Outer space meant celestial space. In Harpers Ferry, West Virginia, for example, a small crowd gathered in front of the Reverend Charles E. Roberts's small church. They asked the minister to explain Sputnik and what it meant. Why, for example, wouldn't it collide with angels in the celestial firmament? Roberts calmly assured them that God could take care of his own.[17]

Fear alone, however, did not shape Moonwatch's context. More positive forces brought people out of their homes at dusk and dawn to look for satellites. In the 1950s, Americans joined civic and volunteer groups like the Kiwanis or Rotary Clubs in record numbers. Moonwatch presented science-minded Americans with yet another opportunity to join a local group, express community pride, and participate in civic life, something that Americans valued especially in the 1950s.[18]

This book shows how Moonwatch ably supported the Smithsonian's mission, which dated to its founding in the early nineteenth century: "for the increase and diffusion of knowledge among men." In the United States and abroad, teams organized themselves to do just that. They raised funds from local sponsors, built their own equipment, and learned how to contribute to science in a meaningful way.

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In the United States and elsewhere, such contributions translated into national prestige and local civic duty. When one Moonwatch leader thanked her group, all of high school age and younger, for their "contribution to helping the United States," she also noted that they contributed to "its position as a world leader in Science and progress."[19] Moonwatch provided a way for citizens in the United States as well as overseas to participate in what was a cutting-edge international science project. Near Philadelphia, a sixty-seven-year-old grandmother and schoolteacher organized a Moonwatch team. When a local paper asked her why, she replied: "I wanted to do something practical for the IGY. I felt this was the best way to help."[20]

Moonwatch was the IGY's most successful amateur activity and became the public face of a global satellite tracking network. After the IGY ended, Whipple capitalized on Moonwatch's popularity and the eventual success of the SAO's professionally staffed telescope stations to secure a multiyear contract from NASA for satellite tracking. Worth millions of dollars annually, these agreements helped enable Whipple to rapidly expand the SAO's efforts into promising new areas of research such as space studies, planetary science, and astrophysics. As a result of its successful growth, Whipple's observatory attracted prominent scientists (including celebrity-to-be Carl Sagan) and engaged in groundbreaking research.

What is the legacy of Moonwatch, and what can its history tell us about the role of amateur scientists today? Moonwatch affected the lives of its participants in ways that cannot be expressed simply by the number of members the program had or how many observations they made. With teams in over two dozen countries during the IGY, Moonwatch helped people recognize the international nature of space research, an important factor at a time of intense Cold War tensions.

Moonwatch introduced people to the possibility of careers in science. Viewed more broadly, Moonwatch helped boost science programs at high schools and small colleges throughout the country during the Cold War. This occurred at a time when the United States, in the wake of Sputnik's shock, frantically revamped science education in a concerted effort to train more scientists and engineers. In 1957, science and technology were seen as means to increase national security, and amateur participation in science was part of this larger national agenda.

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Fifty years ago, Moonwatch provided opportunities for active learning for students and anyone else interested in science and technology. If hands-on education is the key to inspiring a new generation of scientists and engineers, then Moonwatch transcends its place as a curious episode of the early Space Age. Exploring Moonwatch's history and the hitherto hidden services ordinary citizens performed can provide a valuable lesson about how people's delight and fascination with science might be fostered once again.

But to appreciate the chain of events that made Vioalle Hefferan's phone ring and compelled her students to go up to their high school's roof to peer into the sky, we must first return to the 1950s before the world had ever heard of Sputnik. Here, at the dawn of the Space Age, we will see how, in the minds of those who would join Moonwatch, enthusiasm for space exploration and amateur science fused with an imperative for vigilance and civic duty.

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