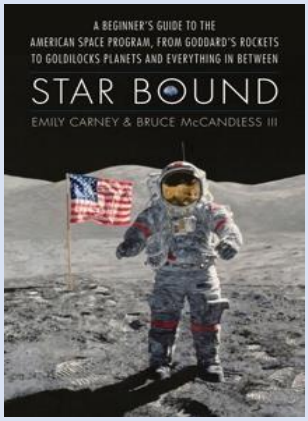

Sources Cited in *Star Bound*

By Emily Carney and Bruce McCandless III

Updated December 17, 2024

You'll find no footnotes in *Star Bound*. Like many publishers these days, the University of Nebraska Press sometimes chooses not to include an index or citations in a narrative history like ours. The aim is to conserve resources and reduce the expenses involved in creating the pricey and increasingly anachronistic paper artefacts we call "books." In our case, additional support for this decision came from the fact that *Star Bound* isn't advancing a set of novel arguments or controversial research results. Rather, it's a primer that reviews and recasts mostly familiar information and updates it with recent developments and some speculation about the future.

But hey, we know you're likely to read something that you're curious about, and maybe you want to follow this little factoid back down whatever rabbit hole it sprang from. In some cases, we've provided the relevant source in the text. If the source isn't there, we hope the notes we're providing here will help you find where our information came from and where you can track down more just like it.

And before we proceed, we'd like to amplify something we say early in the book. Finding information these days is easy. If you have access to the internet, you can swim in a sea of data. Newspapers.com offers hundreds of thousands of newspaper articles

from the last century or so for $21.18 per month. NASA and its constituent centers—the Jet Propulsion Laboratory, for example—have searchable websites and archives full of charts and animation, and sometimes run live feeds of important missions. SpaceX operates a mini-media empire. You can explore the collection of the mighty Smithsonian Air and Space Museum through its website and view online presentations produced by the quirky Kansas-based Cosmosphere about all kinds of space subjects, including Nazi Germany's V-2 rocket. Podcasts like *This Week in Space*, *Space and Things* (currently on hiatus), and *Planetary Radio* review space-related news every week, answer listener questions, and archive their episodes for reference free of charge.

In short, finding information isn't the problem. Making sense of it is. And that's where *Star Bound* comes in. It's a way to get the big picture. It's a look at the ocean before you sprint into the surf.

A couple of notes:

Timing: The big problem with writing a book that references current events in space exploration is that those events aren't current for very long. In the few weeks after this book went to press, for example, Elon Musk announced that he would send a rocket to Mars in the next two years; SpaceX caught a Falcon Heavy booster the size of a destroyer in a pair of mechanical arms outstretched from one of its Boca Chica launch towers; NASA sent the Europa Clipper probe on its way to look for life on a moon of Jupiter; and Boeing began talking about selling off at least part of its space business, presumably due to continued frustration with its balky Starliner space vehicle. Not long after that, Donald Trump won the 2024 presidential election and, with unusual alacrity, announced he would nominate entrepreneur and private astronaut Jared Isaacman to run NASA. It takes a while to make a book. We assure you that we did our best to be timely—and we succeeded, for about 23 minutes.

The Cover. We're lucky to have one of Chris Calle's gorgeous paintings adorning our workmanlike prose. This one's called *Last Man*, and it's a portrait of Apollo 17 astronaut Gene Cernan, adapted from a NASA photograph of Cernan as he stood on the moon. You can find more of Chris's work here: https://artusa.com/artist/chris-calle/.

The Sister of Icarus: We fell in love with this poem when we read it in the online journal *Rattle* in 2022. It probably has no place in a nonfiction book about space exploration, which features lots of big rockets blasting off and guys talking on radios and such, but its quiet expression of the spirit of adventure and wonderment involved in flying struck a chord with us and we decided to use it anyway. The poet, Mary Ellen Redmond, lives in New England.

Acknowledgments: We named a few, but let's face it, there's a hundred other people we should probably thank and offer a tip of our hats, assuming we were to wear hats. You gotta draw the line somewhere. Sorry Neil.

1. First Principles

The launch scenario in the first paragraph of *Star Bound* is an imagining of a future Artemis program mission, in which American astronauts will return to the surface of the moon. Like many space projects, it's taking longer to accomplish than originally advertised, but we're going to keep hoping. We refer to the most powerful rocket *NASA* has ever built because that's what the Space Launch System is; we know that Starship will reportedly be bigger and more powerful. When we started writing *Star Bound*, a first test flight of the SLA/Orion capsule configuration seemed to have shown that the program was on the right track. However, post-flight inspection turned up problems with the capsule's heat shield, and it's unclear whether those problems have been rectified even now. The recent election of Donald Trump to the presidency has got people talking again about whether Artemis is doomed, a victim of not only its own tardiness and huge expense but also of the rocketry successes of SpaceX. Will Artemis survive, as currently envisioned? Will it survive at all? Stay tuned.

"Space is big" is one of the best-known lines in Douglas Adams's hugely successful *The Hitchhiker's Guide to the Galaxy*, which we personally find a little silly but that lots of smart people really like. The "gravity as god" quote comes from Mary Roach's book *Packing for Mars*. And the description of what gravity *does* comes from Brian Clegg's "What is Gravity? A Guide to Nature's Most Mysterious Force (And What We Still Don't Know)," at https://www.sciencefocus.com/space/gravity.

An hour's worth of Taylor Swift songs can be found here: https://open.spotify.com/artist/06HL4z0CvFAxyc27GXpf02. (Caution: It may seem longer.)

2. The Wizard of Worcester

Unsurprisingly, given how long ago it happened, there appears to be no definitive "invention date" for fireworks. Nevertheless, numerous articles and authors place their origin in China well before 1000 BCE.

The "Experts Dumfounded" article regarding Germany's Paris Guns appeared in the March 24, 1918 issue of the (Little Rock) *Daily Arkansas Gazette*—subhead, "U.S. Ordnance Officers Can't Explain Paris Bombardment."

We found a host of interesting details about Robert Goddard's life in David Clary's excellent biography *Rocket Man: Robert H. Goddard the Birth of the Space Age*. The beautiful Charles Lindbergh quote that ends the chapter comes from p. 312 of the Kindle version of Clary's book. Ray Bradbury's quote about Goddard being a "blathering idiot" appears in Bradbury's prologue to *The Collected Works of Buck Rogers in the 25th Century*, which was published by Bonanza Books in 1969 and includes the classic stories "Battle on the Moon" and "The Monkeymen of Planet X." To read about the U.S. government's settlement with Goddard's widow after the Second World War, start with the *New York Daily News*'s August 7, 1960 article "Irony: $1 Million to Rocket Pioneer Who Died Too Soon."

We're big Goddard fans, but it's worth noting that his secretive ways didn't sit well with some of his peers, who felt like he would have done everyone, including himself, a favor by sharing his research and ideas. Theodore von Karman dismissed Goddard's place in the rocketry pantheon by saying, in his 1967 autobiography *The Wind and Beyond*, that there was "no direct line from Goddard to present-day rocketry. He [was] on a branch that died." The truth is out there somewhere.

3. Rocketry and Death

The single best source regarding the improbable rise to respectability of Wernher von Braun is probably the 2007 biography *Von Braun: Dreamer of Space, Engineer of War* by Michael J. Neufeld. That's where, on page 201, we found the quote from the American G.I. regarding his encounter with what he thought might be Germany's "biggest liar." As important as Goddard, Tsiolkovsky, Oberth, and von Braun were, there are plenty of other space pioneers worth studying; for a sampler, see Bruce's March 21, 2024 piece "Lesser Known Legends" on Medium.com at https://brucemccandless3.medium.com/lesser-known-legends-671874cf0ed3.

The description of one V-2's impact on a Deptford (London) department store is from Martin Gilbert's 1989 book *The Second World War*, an encyclopedic history of the conflict.

It's worth noting that the Japanese used rudimentary rocketry in one of the weapons they deployed near the end of the war, sending out piloted, rocket-powered suicide gliders called the *Ohka* (or "cherry blossom") to damage American ships during the

Okinawa campaign in 1945. See, for example, https://www.history.navy.mil/content/history/museums/nmusn/explore/photography/wwii/ww ii-pacific/okinawa/yokosuka-mxy-7-ohka.html.

4. The SS Major and the Suicide Squad

An excellent play-by-play of the process by which von Braun and his colleagues managed to surrender themselves to the Allies in 1945 is contained in Amy Shira Teitel's 2016 book *Breaking the Chains of Gravity: The Story of Spaceflight Before NASA*. Some of our *Star Bound* "beta" readers have been surprised by both the number of Germans who came to the U.S. under the auspices of Operation Paperclip and the importance of the positions many of them held here.

As noted in the text, the Soviets had their own version of Operation Paperclip. We may never know exactly how much the expatriated (*kidnapped?*) Germans contributed to the Soviet space program. If you're interested in the story, we would until recently have suggested that you check out "The Forgotten Rocketeers: German Scientists in the Soviet Union, 1945-1959" in the online journal *War on the Rocks*. However, that link seems to be broken, and we can no longer find the story on the publication's website, though no reason for the omission is given. Interested readers can review Chapters Two and Three of Assif A. Siddiqi's magisterial *Challenge to Apollo: The Soviet Union and the Space Race, 1945-1974*, a version of which is available through NASA here: https://www.nasa.gov/wp-content/uploads/2023/06/sp-4408.pdf. For a glimpse at the career of Dr. Hubertus Strughold, see Sarah Scoles's article "The Doctor from Nazi Germany and the Search for Life on Mars" in the July 24, 2020 issue of the *New York Times*.

The errant missile that landed near Ciudad Juarez in 1947 is referenced on page 133 of William Burrows's *This New Ocean*. Von Braun's comment that "there's nothing in Texas" shows up at the 42:27 mark of an interview he gave to science writer Willy Ley, a recording of which is available here: https://www.youtube.com/watch?v=wGopunLtuuI.

The saga of the Suicide Squad is unbelievably interesting. Our understanding stems primarily from the Jet Propulsion Laboratory's film, *JPL and the Space Age: The American Rocketeer*, available at https://www.youtube.com/watch?v=Ykl57izCofs and from George Pendle's 2006 biography of Jack Parsons, *Strange Angel: The Otherwordly Life of Rocket Scientist John Whiteside Parsons*. For the circumstances surrounding Qian Xuesen's return to China, see "Order Lets Tsien 'Self-Deport' to China" in the *Baltimore Sun*, September 13, 1955. Expelling Tsien certainly seems to have been a blunder. Indeed, according to former U.S. Secretary of the Navy Dan Kimball, it was "the stupidest thing this country

ever did." Kimball's quote can be found in the BBC's "Qian Xuesen: The Man the U.S. Deported—Who Then Helped China into Space," published on October 26, 2020 and available here: https://www.bbc.com/news/stories-54695598. Not intending to get any weirder with this set of stories, we nevertheless note that Theodore von Karman, mentor to the Suicide Squad, was a descendant of Judah Loew ben Bezalel, the 16th Century rabbi of Prague who reputedly created the *golem*, a supernatural creature conjured from clay to protect Jewish citizens from pogroms by their neighbors.

5. A Starting Gun Called *Sputnik*

The National Security Council's 1958 assessment of the impact of Sputnik can be found starting on page 41 of *The Penguin Book of Outer Space Exploration: NASA and the Incredible Story of Human Spaceflight* (2018). NASA Administrator Keith Glennan's recollection that in the hurly-burly of the early days of NASA, it was a wonder how he "kept anything straight" comes from his book *The Birth of NASA: The Diary of T. Keith Glennan*, as quoted on p. 49 of *The Penguin Book of Outer Space Exploration*. The data point about the popularity of the Buck Rogers ray gun during the Christmas season of 1934 comes from Margaret Weitekamp's 2022 book *Space Craze: America's Enduring Fascination with Real and Imagined Spaceflight*. The disclaimer is of course made up.

6. Shadows in the Sky

A vivid, impressionistic recounting of Chuck Yeager's assault on the sound barrier occupies Chapter 3 ("Yeager") of Tom Wolfe's *The Right Stuff*, first published in 1979. Yeager's quote about "blue suiters" (i.e., Air Force personnel) not wanting to give up control of space exploration to NASA can be found on page 28 of Rowland White's 2016 book *Into the Black*. Details about Lieutenant Colonel John Stapp's life and career, both in the military and beyond, can be found here: https://airandspace.si.edu/stories/editorial/man-behind-high-speed-safety-standards. For a good discussion of Joe Kittinger's adventures in the upper atmosphere, see https://airandspace.si.edu/air-and-space-quarterly/summer-2023/space-jumper. One crazy military space exploration (by instrument, that is) operation that we didn't have time to discuss in *Star Bound* is laid out in Greg Kennedy's "The Two Explorer Stratosphere Balloon Flights," in which Army personnel ventured into the stratosphere to measure cosmic radiation and (barely) lived to tell the tale. You can find Greg's story at https://stratocat.com.ar/artics/explorer-e.htm.

The federal government offers this handy summation of the Genetrix project here: https://history.state.gov/historicaldocuments/frus1955-57v24/d15 .

Walter A. McDougall writes about the creation of the two "parallel space programs," civilian and military, in his 1985 book *…The Heavens and the Earth: A Political History of the Space Age*. Interestingly, McDougall refers to neither the National Reconnaissance Office nor the Corona project in the book, presumably because both the agency and the operation were still classified and thus largely unknown, at least by name. If you're interested in early military plans for space warfare, including the Air Force's Lunex Project, check out Rod Pyle's 2017 book *Amazing Stories of the Space Age: True Tales of Nazis in Orbit, Orphaned Martian Robots, and Other Fascinating Accounts from the Annals of Spaceflight*. Homer Boushey's 1958 speech advocating for establishment of a military presence on the moon is discussed in David S.F. Portree's article "Who Controls the Moon Controls Earth (1958)," in *Wired.com* dated March 31, 2012. And Wernher von Braun was a notable proponent of bomb-carrying military space stations in the early fifties, well before the launch of Sputnik 1.

If there's anything that surprised us in writing *Star Bound*, it was discovering—or at least getting a glimpse of—the breadth and scope of America's secretive national defense-related space empire…er, *regime*. William Burrows's excellent 1999 book *This New Ocean* traces the origins of America's spy satellite program. (Note: Burrows's book is not to be confused with the NASA book *This New Ocean: A History of Project Mercury*, published in 1966.) One source for information about the National Reconnaissance Office is *The National Reconnaissance Office at 50 Years: A Brief History*, by Bruce Berkowitz and Michael Suk. However, as the book was published by—you guessed it—the National Reconnaissance Office, don't look for any major revelations. America's secret space program is just not an easy thing to write about.

For information about the NRO's "lost" $2 billion, see "A Secret Agency's Secret Budgets Yield Lost Billions, Officials Say," an article by Tim Weiner in the January 30, 1996 issue of the *New York Times*; link here: https://search.app/KuCTYDLggTGgk49J6. For a taste of how ordinary citizens try to keep tabs on the machinery of the super-secret American spy satellite fleet, see Leonard David's article "Anatomy of a Spy Satellite," in the January 3, 2005 edition of *Space.com*: https://www.space.com/637-anatomy-spy-satellite.html. And for a glimpse of the Pentagon's flirtation with offensive anti-satellite weaponry, read Robert Windrem's 2004 article on NBCnews.com titled "What is America's Top-Secret Spy Program?" Link here: https://search.app/iAE3xMF2qaziMeLp7.

7. Project Mercury

Our description of Yuri Gagarin's flight is based on a number of sources, including Colin Burgess's elegant 2022 history *Soviets in Space: Russia's Cosmonauts and the Space Frontier*. Another look at Gagarin's flight is Stephen Walker's 2021 bio *Beyond: The Astonishing Story of the First Human to Leave Our Planet and Journey into Space*, noteworthy not only for its vivid recounting of events during the early Soviet space program but also for its ruminations on the program's cash-starved latter days.

We'd like to know *more* about Max Faget, frankly, but there's some good information in *Into the Black*, Rowland White's book about the first flight of the space shuttle (including the detail about America's chief spaceship designer doing headstands when he needed to refresh his brain). The comparison of the Mercury capsule's air volume to that of a large adult casket is on page 288 of Burrows's *This New Ocean*. Chris Kraft's quote ("What's a computer?") can be found at the 12:49 mark in the 2017 documentary *Mission Control: The Unsung Heroes of Apollo*, which was inspired by Rick Houston's book *Go, Flight! The Unsung Heroes of Mission Control, 1965-1992*. The computing firepower offered by the mighty IBM 7094 is considered in Phil Goldstein's article "How the IBM 7094 gave NASA and the Air Force Computing Superiority in the 1960s," published in the October 11, 2016 issue of *FedTech Magazine*.

Alan Shepard's famous "candle" quote shows up in slightly different forms in different sources. For example, William Burrows quotes Shepard as follows: "Why don't you light the damned candle, 'cause I'm ready to go." This is almost certainly wrong, though it captures the spirit of the moment.

Support for the statement that the Pentagon was planning to blame Cuba can be found in the *Washington Post* article "Military Had Plan to Blame Cuba if Glenn's Space Mission Failed," by George Lardner, Jr. and Walter Pincus, November 18, 1997.

8. Gemini's Forgotten Flights

Our spiel in the chapter heading about the Gemini flights being forgotten by everyone except a small cadre of space freaks is of course hyperbole, but it contains a nugget of truth. Exhibit A: The Gemini project takes up all of twelve pages of William Burrows's 646-page *This New Ocean* (and some of those pages are devoted to discussion of Soviet efforts during the same period, so Gemini actually gets *less than* 12 pages). The exception is Gemini IV, on which mission Ed White made the first American spacewalk and Commander Jim McDivitt took a series of stunning color photographs of White

suspended above the Earth. These shots were breathtaking then and continue to amaze even today. Alexei Leonov accomplished a similar feat—i.e., a "spacewalk") just a few weeks before White. While photos of the event aren't particularly good, Leonov's words ("My feeling was that I was a grain of sand") still carry some weight. We read them in Colin Burgess's 2022 book *Soviets in Space: Russia's Cosmonauts and the Space Frontier*.

For further reading about Gemini, try Michael Collins's engaging memoir *Carrying the Fire: An Astronaut's Journeys*, in which he discusses his own flight on Gemini X, and the Gene Cernan 1999 autobiography *The Last Man on the Moon: One Man's Part in Mankind's Greatest Adventure*, in which Gemini IX astronaut Cernan wrestles with his tether as he attempts to test the Astronaut Maneuvering Unit, a predecessor of the jetpack called the Manned Maneuvering Unit that eventually flew on the tenth shuttle mission, STS-41B.

The story of Jim LeBlanc's close call with death in a no-pressure environment can be found on page 61 of Paul Parsons's nifty little book *Space Travel*, published in 2020.

9. The Rise and Fall of the American Astronaut

Details about Slayton's early life—like being tied to a tree, for example—are set out in his plainspoken autobiography, *Deke! U.S. Manned Space from Mercury to the Shuttle*, which he wrote with Michael Cassutt. George Abbey gets a bum rap in at least one astronaut account, Mike Mullane's memoir *Riding Rockets: The Outrageous Tales of a Space Shuttle Astronaut*. Mullane clearly disliked Abbey. He indicated in the book that several of his colleagues did too. Some discontent was probably inevitable, as Abbey took over a job from a legend, Deke Slayton, and had to deal with astronaut crew assignments at a time when there were many more would-be fliers than there were missions. A more balanced assessment of Abbey's long and generally successful tenure at NASA is presented in Michael Cassutt's 2018 book *The Astronaut Maker: How One Mysterious Engineer Ran Human Spaceflight for a Generation.* Also helpful: Dave Giles and Emily Carney's podcast interview of Cassutt at https://spaceandthingspodcast.com/podcast/stp189-rememberinggeorge-abbey-with-michael-cassutt.

Rebel astronaut Brian O'Leary wrote about his experiences in the astronaut program in his 1970 book *The Making of an Ex-Astronaut*, which is (a) like illicit pharmaceutical products to space nerds like us and (b) also like illicit pharmaceutical products, difficult to find at a decent price. The quote about Rusty Schweickart sitting on a stage, surrounded by dancers comes from the article "Ex-Astronaut Warns as Dancers Chant," published on April 15, 1979 in the *Los Angeles Times*. Emily is trying (desperately) to find a picture of

the event. Bruce located Tom Stafford's October 8, 1969 memo to his colleagues in Bruce McCandless II's papers.

Statistics related to the gender and nationality of the world's astronauts can be found here: https://www.worldspaceflight.com/bios/stats1.php#. American women hold a healthy lead over their Russian and Chinese counterparts. We note, by the way, that on November 22, 2024, Emily Calandrelli ascended on a Blue Origin New Shepard rocket to become the became the 100th woman to reach space.

List: America's 11 Coolest Astronauts

This ranking isn't based on anything, really, other than a few beers and some animated discussions with friends. We're pretty sure your list is as good as ours. It's the conversation that counts. And someone better have the very excellent Fred Haise in their Top Three, or this whole exercise will have been a farce.

10. Apollo and the First Man on the Moon

If you want to know about Soviet probes on the moon and Venus, the man to see is space historian Jay Gallentine. Check out his excellent book *Infinity Beckoned: Adventuring Through the Inner Solar System, 1969-1989*, one of our sister publications in the *Outward Odyssey* series. Jay also provides an excellent and detailed history of the Viking Mars probe program (*see below*) and is a strong supporter of Gil Levin's astrobiology experiments on the Red Planet. Elon Musk's comment about Venus being inhospitable can be found in a speech he gave in 2016, a transcript of which can be read here: https://speakola.com/ideas/elon-musk-big-mars-iac-2016.

Many people have written about the Apollo program and many more will no doubt do so in the future, but for now the gold standard is *A Man on the Moon* by Andy Chaikin. The chief authority on Neil Armstrong is James R. Hansen, whose magisterial *First Man: The Life of Neil A. Armstrong* contains everything you ever wanted to know about America's lunar pioneer. Sir Patrick Moore's interview of Armstrong can be found at https://www.youtube.com/watch?v=EIPn_iuLPA4. A transcript of communications during the Apollo 11 lunar landing, with video clips accessible as well, is here: https://www.nasa.gov/history/alsj/a11/a11.landing.html.

Wernher von Braun's statement comparing the lunar landing with a crucial link in evolution shows up in various places, but we found it in Robin McKie's story "Apollo…The Dream that Fell to Earth," published by *The Guardian* on June 20, 2009; see https://www.theguardian.com/science/2009/jun/21/apollo-fallen-dream#:~:text=It%20was%20the%20most,set%20foot%20on%20another%20world.

President Nixon's characterization of the week of the Apollo 11 mission as the greatest week in the history of mankind since the Creation came in his remarks to the astronauts upon their return from space; see https://www.presidency.ucsb.edu/documents/remarks-apollo-11-astronauts-aboard-the-usshornet-following-completion-their-lunar.

The events in Thailand and Italy during the lunar landing and moon walk are detailed in Air & Space Museum curator Teasel Muir-Harmony's 2020 book *Operation Moonglow: A Political History of Apollo.* Carl Sagan's valedictory words about the program come from his 1997 book *Pale Blue Dot: A Vision of the Human Future in Space.*

11. Skylab and the Renaissance of American Science

Landsat is a quiet program that continues to produce valuable results. The explanation of its origins we reproduce on page 134 can be found on the U.S. Geological Survey's website here: https://search.app/wXrC8vhg4Y2K2nnz6.

Emily has written and spoken extensively about the Skylab program and recommends David Hitt's 2011 book *Homesteading Space: The Skylab Story*, which he wrote with several of the astronauts who participated in the program, as the go-to source. Emily found Phil Chapman's hortatory August 6, 1970 memorandum to his colleagues ("Icebergs Ahead," it's titled) during a review of the papers of astronaut Bill Thornton at the University of Texas Medical Branch— Galveston.

The story of NASA's scramble to find tools that would be useful to effect repairs on the damaged Skylab is told by some of the participants in Dwight Steven Boniecki's award-winning indie film *Searching for Skylab* (2021).

A webpage explaining what NASA knows about the eye issue known as SANS is available here: https://www.nasa.gov/directorates/esdmd/hhp/risk-of-spaceflight-associated-neuroocular-syndrome/.

Julie Gibson's plaintive question at the end of our Skylab chapter comes from Molly Ivins's article "Ed Who?" in the June 30, 1974 issue of *New York Magazine*.

NASA's continued interest in Earth science can be seen here: https://science.nasa.gov/climate-change/causes/.

12. Probes, Rovers, and the Golden Record

A sampling of the sort of cultural criticism (Nudity! Sexism! Is that a Nazi salute?) the Pioneer 10 and 11 plaques attracted appears in astronomer Frank Drake's chapter (Chapter 4) of the 1978 publication *Murmurs of Earth: The Voyager Interstellar Record* and can also be found on page 82 of Mark Wolverton's 2004 book *The Depths of Space: The Story of the Pioneer Planetary Probes*. A sampling of the criticism the plaque *continues* to attract can be found here: https://www.theguardian.com/science/2015/sep/10/aliens-modern-messages-earths-equalitydiversity-seti-yuri-milner.

Jay Gallentine writes extensively about the Viking landers in *Infinity Beckoned: Adventuring Through the Inner Solar System*, 1969-1989. The wonderful quote about Voyager (really, the two Voyagers, plural) living on as "saga" comes on p. 100 of the e-book version of Stephen J. Pyne's *Voyager: Seeking Newer Worlds in the Third Great Age of Discovery*. Billy Miossi's 2023 documentary *It's Quieter in the Twilight* isn't about vampires, as the title might suggest, but rather about the dedicated crew of earthbound engineers who keep the Voyager probes traveling and talking after all these years. It's an inter-ethnic group that includes two immigrants, and its makeup and dedication will make any reasonable American proud of what the nation's space program can accomplish right here on Earth. Some of the crew have been working on the project for decades. "As long as Voyager needs me," says Korean-born Sun Kang Matsumoto, "I can never, ever, not answer."

13. The Butterfly and the Bullet

If you're curious about the origins and development of the Space Shuttle, you might want to start with *Into the Black*, Rowland White's account of *Columbia*'s first spaceflight. The book is not only a fine introduction to America's long-running space transportation program but also a good way to understand how NASA interacts (or not) with the nation's covert space security and surveillance regime. Also worth checking out is the new (November of 2024) podcast 16 Sunsets, a detailed study of the origins and history of the shuttle program, available here: https://sixteensunsets.com/. Note: While the

authors of Star Bound contributed to production of the podcast, we have no financial stake in its success. We just think it's good—and frankly, it's worth the price of admission just to hear Chris Kraft's assessment of the Nixon Administration at around the 20:24 mark of Episode 1.

The shuttle was a radically new spaceship, and not everyone was convinced it would fly. Bob Crippen's comment that he thought it was "never going to work" appears at the 0:56 mark of Episode 5 ("The Shuttle") of the documentary series *When We Left Earth*. Gene Kranz's statement that he "prayed a lot" during the first shuttle flight appears in the same episode at about the 9:27 mark. John Young's estimate of his odds of surviving the first flight, as well as his wife's, comes from a conversation Bruce had with Susy Young. Young's enthusiastic remarks at the conclusion of STS-1 are recorded in the Chicago Tribune's April 15, 1981 article "New Era Ushered in by Shuttle." Max Faget's quote to the effect that Columbia was outdated by the time it was launched can be found in Peter Larson's article "Shuttle Inventor Sees Some Gear as Obsolete Now" in the July 5, 1982 issue of the *Orlando Sentinel*.

The Rogers Commission produced an achingly detailed report on the Challenger disaster, which you can access here: https://sma.nasa.gov/SignificantIncidents/assets/rogers_commission_report.pdf. The quote from Joe Kerwin regarding NASA's reputation after the *Challenger* disaster comes from an oral history interview he gave to Kevin Rusnak on May 12, 2000, available here: https://historycollection.jsc.nasa.gov/JSCHistoryPortal/history/oral_histories/KerwinJP/KerwinJ_P_5-12-00.htm.

We found Ray Dell'Osso's October 27, 1982 memo relating General James Abrahamson's desire to increase extravehicular activities, in part to impress potential customers, in Bruce McCandless II's papers. We found Don Puddy's contradictory 1988 memo cautioning against EVAs in the McCandless papers as well. The contrasting views of EVAs in the two documents illustrates that NASA's corporate culture changed markedly between 1982 and 1988, chiefly as a result of the *Challenger* disaster.

The Hubble Space Telescope continues to provide amazing information and images. As astronaut Jon Grunsfeld put it on Planetary Radio's May 27, 2020 episode celebrating the 30th anniversary of the instrument, "I don't want to make it sound like a cult, but Hubble really may well be by almost any metric, the most productive scientific instrument humans have ever created." See https://www.planetary.org/planetary-radio/0527-2020-john-grunsfeld-hubble-30th. America's first female spacewalker, Kathy Sullivan, wrote a

great book about the design and deployment of America's robotic space celebrity called *Handprints on Hubble: An Astronaut's Story of Invention*.

Eileen Collins and our friend Jonathan Ward teamed up to produce the best source of information about Eileen's life and career, *Through the Glass Ceiling to the Stars: The Story of the First Woman to Command a Space Mission*, which was published in 2021. We learned about Kalpana Chawla's upbringing, ethos, and love of the American West chiefly through the biography written about her by her husband, Jean-Pierre Harrison, called *The Edge of Time: The Authorized Biography of Kalpana Chawla* (2011).

We would be remiss if we didn't recommend viewing Graeme Ferguson's *The Dream is Alive*, the wonderful 1985 IMAX documentary about the go-go space shuttle years. Finally, former astronaut Tom Jones recently published *Space Shuttle Stories*, a lavishly illustrated coffee table book with first-hand reminiscences from the astronauts about each and every shuttle mission— all 135 of them!

14. Sleeping With the Russians

A contemporary story regarding creation of the International Space Station is Steven A. Holmes's "U.S. and Russians Join in New Plan for Space Station," in the September 3, 1993 issue of the *New York Times*. The "looking at stars, pissing in jars" quote shows up on p. 5 of Brian Burrough's 1998 book *Dragonfly: NASA and the Crisis Aboard Mir*, a fascinating study of the USSR's second-gen space station and the Americans who lived and worked there alongside their Russian counterparts. The instruction to American astronaut Norm Thagard that he could eat anything but his crewmates appears on p. 320. For a counterpoint to *Dragonfly*'s generally dismal portrait of life on *Mir*, read astronaut Shannon Lucid's self-published book *Tumbleweed*, which describes her experience on the Russian station in largely neutral terms. John Pike discussed the "crud" in *Mir*'s plumbing system in "Heat, Humidity, Fumes Plague Crew on *Mir*," by Ralph Vartabedian in the April 12, 1997 issue of the *Los Angeles Times*.

Cosmonaut Valeri Polyakov's statement about humankind's ability to go (or "fly") to Mars is repeated in Loretta Hall's February 9, 2015 article "Setting the Record: 14 Months Aboard Mir Was Dream Mission for Polyakov," in *Rocket Stem*, available here: https://search.app/oiEJGzsqxRbK8tsz5. NASA's International Space Station tracker is available here: https://spotthestation.nasa.gov.

15. False Starts, Missteps, and the Promise of Artemis

We are of course making some big assumptions in this chapter—chiefly, in claiming to know better than NASA (and by extension the U.S. Congress) which projects should have been continued rather than canceled. For information about the X33 VentureStar, see https://airandspace.si.edu/collection-objects/model-x-33-venturestar-reusable-launchvehicle/nasm_A20060581000 and https://www.spaceflighthistories.com/post/x-33-venturestar.

An enlightening discussion of the NASA budgeting process with Planetary Society expert Casey Dreier can be found in Episode 177 ("Space Policy AKA How Things Happen in Space") of the currently-on-hiatus *Space and Things* podcast, available here https://spaceandthingspodcast.com/podcast/stp177-space-policy-aka-how-things-happen-inspace-with-casey-dreier. Budgeting has a lot to do with any ambitious space project, especially something as big as Artemis.

Andy Chaikin's quote about the virtues of Artemis comes from an email to the authors dated November 8, 2023.

List: America's Eleven Biggest Space Losses

Bruce wrote Chris Kraft's quote about Apollo 1 ("It was like we murdered them, almost") in his notes but has been able to find the source. However, Kraft says something very similar at the 27:01 mark of the documentary film *Mission Control: The Unsung Heroes of Apollo*, where he reminisces that, "I think…we killed those three men. It was almost murder." It's unclear whether Bruce was paraphrasing in his notes or if there is actually a separate statement somewhere that matches the notes. Nevertheless, the point of the statement, and the poignance of Kraft's regret, are the same in either case.

16. The New Space Race

Mao Zedong's statement about his country's inability to launch potatoes is referenced in a number of sources, including this one: https://www.cnbc.com/2021/06/30/china-space-goals-ccp-100th-anniversary.html

Those days are long gone. Every week brings another article or opinion piece about the looming threat of Chinese dominance in space. One of the most recent, at least as this list of sources is being written, is former NASA head scientist Thomas Zurbuchen's op-

ed "NASA Needs a 'Lunar Marathon' to Match China on the Moon" in the *Washington Post* on October 1, 2024; see https://www.scientificamerican.com/article/nasa-needs-a-lunar-marathon-to-match-china-onthe-moon/. Another is Mike Wall's July 13, 2023 article "How China Will Land Astronauts on the Moon by 2030" in Space.com, available here: https://www.space.com/china-astronauts-moonlanding-2030-plan. Frank Kendall's statement that when he thinks about threats to the United States, he thinks about China, China, and China, can be found in John Tirpak's October 8, 2021 article in Air & Space Forces Magazine titled "USAF's Three Priorities: China, China, China," available here https://www.airandspaceforces.com/article/usaf-three-priorities-china-china-china/.

Project Chestnut and America's short-lived rapprochement with China during the Sino-Soviet split is reflected in a June 18, 1981 article in the *New York Times*, "U.S. and Peking Join in Tracking Missiles in Soviet," at https://www.nytimes.com/1981/06/18/world/us-and-peking-joinin-tracking-missiles-in-soviet.html. A lively discussion of the space exploration ambitions of both China and India can be found in the February 6, 2024 episode ("NASA is Losing the Race") of Rick Tumlinson's "The Space Revolution" podcast at https://thespacerevolution.podbean.com/e/episode-26-nasa-is-losing-the-race-with-dr-namratagoswami/. China has not traditionally been an expansionist power. However, some observers see concerning strains of nationalism and xenophobia in current Chinese culture. For a glimpse at these trends, see Li Yuan's October 14, 2024 piece in the *The New York Times*, "Killing of Japanese Boy Leaves Chinese Asking: Is This My Country?"

17. The Commercialization of Space

Details about Houston-based space entrepreneur David Hannah, Jr. and the flight of Ticonderoga 1 come mostly from Stephen Harrigan's wonderful article "Mr. Hannah's Rocket" in the November 1982 issue of *Texas Monthly*. A diligent researcher can find any number of newspaper and magazine articles talking about the prospects for space tourism, past and present; Googling will get you a gaggle. A representative sample is Don Irwin's "$1 Million Far-Out Tourist Flights Seen" in the April 20, 1985 issue of the *Los Angeles Times*.

It's also easy to find material on Elon Musk and SpaceX, but perhaps the best single source about the company's early days is Eric Berger's book *Liftoff: Elon Musk and the Desperate Early Days of SpaceX*, which only occasionally lapses into hagiography. The quote from retired colonel Gary Minar is not meant as technical analysis but to illustrate the way that SpaceX has created a fan following among even hardened NASA veterans;

people dig SpaceX's machines in a way that replicates the way others feel about Shelby Mustangs or Collings guitars. The company's ability to catch one of its super-heavy boosters with a pair of mechanical "chopsticks" attached to the spaceship's launch tower, a feat accomplished just a few days after this book went to print, will only feed the fires of fandom. Rod Pyle and Tariq Malik muse on the phenomenal success of SpaceX in the September 13, 2024 episode of their podcast *This Week in Space*, titled "Starliner is Back! What Now?" As the two point out, SpaceX's success in servicing the International Space Station seems especially striking in light of the problems Boeing has experienced in getting its Starliner vehicle operational. We've purposefully avoided diving into the SpaceX Crew Dragon vs. Starliner controversy, as well as conflicting assessments of the wisdom of the SLS/Artemis system vs. SpaceX's Starship, because the heat generated by such discussions tends to be greater than the light. At this point, though, it seems obvious that the recent election of Donald Trump, along with the ascension to insider status of Elon Musk and Jared Isaacman, both staunch private sector advocates, may spell the doom of both the SLS and Starliner. We wish all the players involved good luck and great launches. America needs rockets!

Our statement on p. 196 that United Launch Alliance took an "early lead" in commercial space launches is misleading and deserves clarification. When it made its debut in 1981, America's space shuttle was meant to be all things to all people—NASA transport and science lab, commercial satellite deployment vehicle, and top-secret-mission Pentagon workhorse. In its early days, the shuttle successfully deployed American, Canadian, Indian, and Indonesian satellites, as well as, in 1985, an Air Force surveillance satellite (we *think* that's what it deployed, anyway—details are still classified). In the wake of the *Challenger* disaster in 1986, however, President Reagan ordered NASA to get out of the commercial satellite launch business and let private industry take over.

At the time (or shortly thereafter), three American companies had rockets that could launch commercial satellites: Martin Marietta, which quickly modified its military Titan booster into something called the CT-3, or "Commercial Titan" rocket; General Dynamics, with its Atlas-Centaur rocket; and McDonnell Douglas, with its Delta family of rockets. Northrop Grumman's air-launched Pegasus rocket went operational in 1990 and was used to launch a modest number of small commercial satellites over the next decade and a half as well. Texas start-up Space Services, Inc. of America successfully tested a sub-orbital rocket in 1982, but had both production and marketing difficulties afterward, and never launched a satellite.

Even before the *Challenger* accident, the ESA had started to present a stiff challenge to the marketability of commercial launch opportunities on the space shuttle, which was rejected by some American customers as too expensive and subject to frequent launch postponements. ESA's Ariane rockets, which take off from Kourou in French Guiana, in the northeastern corner of South America, were simpler and cheaper to fly than the shuttle. Unlike the Swiss army knife that was the shuttle, the Ariane was really only good for one thing—satellite launches.

The first Ariane rocket to reach orbit was launched on December 24, 1979—what we'll call Ariane's "birthday." ESA, through its semi-public consortium Arianespace, launched its first *American* satellite (Spacenet F-1) for GTE in May of 1984. *See* Julian West, "The Shuttle Has Challenger," *The Province* (Vancouver, B.C.), October 23, 1984. And while Arianespace launches proceeded apace—the ESA launched several more GTE payloads and, in September of 1988, launched not one but two American communication satellites on an Ariane 3 rocket—American companies were caught flat-footed by President Reagan's sudden creation of a domestic launch market. In fact, the first American commercial satellite launch didn't take place until August 27, 1989, when McDonnell Douglas sent up a British television broadcasting satellite manufactured by Hughes Aircraft Company. (McDonnell Douglas was supposed to launch an Indian communications satellite earlier that summer, but a launchpad accident damaged the satellite, and the launch was postponed.) *See* William J. Broad, "Private Company Lofts a Satellite into Earth Orbit," *The New York Times*, August 28, 1989—subhead, "A First in Space History." By this time, according to another *Times* story, the ESA controlled over half of the worldwide commercial launch market. See William J. Broad, "Some Fear U.S. Rocket Industry Will Fizzle Out," *The New York Times*, September 19, 1989, at https://timesmachine.nytimes.com/timesmachine/1989/09/17/issue.html.

Over the next twenty years, the ESA and the Soviets (later the Russians), with their Proton and Dnepr vehicles, continued their successful commercial launch businesses, with the Chinese making marketing inroads with their evolving Long March rockets as well. Thus, in the mid-1990s, as strange as it might now seem, American satellite owners could choose from among Russian, Chinese, ESA, and American launch options. Cost-per-launch was only one factor that tended to hurt the U.S. Early on, American rocket companies were also saddled with delays because they used military launch facilities. Military launches had priority, which meant that commercial launches could and often were delayed in favor of DOD missions. This didn't help with marketing.

American entrepreneurs like George Koopman, co-founder in 1985 of the now-defunct American Rocket Company, or AMROC, recognized the need for smaller,

cheaper rockets like the Ariane, but had trouble (a) attracting capital and contracts; and (b) actually building rockets that would fly. Understandably, such entrepreneurs complained that they were competing against not only government-funded entities, like the ESA, but also American companies that had developed their launch vehicles as military hardware through cost-plus contracts funded by the American taxpayer. The Commercial Titan was too big and expensive to compete effectively and made only a small number of launches. But the Atlas (which was acquired by Lockheed Martin when it bought the Space division of General Dynamics) and Delta (acquired by Boeing when it bought McDonnell Douglas) rockets were almost the only American game in town all through the nineties and early years of the twentieth century. According to the U.S. Board of Statistics, for example, American companies made 108 commercial launches during the years 1990-1999; 84 of these were accomplished by either Atlas (43) or Delta (41) rockets. The European Space Agency meanwhile accomplished 76 commercial launches, all on its Ariane 4 rocket. For statistics, see https://www.bts.gov/content/worldwide-commercial-space-launches.

American commercial launches declined significantly in the first years of the 21st Century. From 2000 through 2010, for example, there were only 35 commercial Atlas and Delta launches, compared with 67 by ESA/Arianespace's Ariane 4 and 5 rockets. Fighting cost pressures, eventually even Lockheed Martin and Boeing partnered with Russian, Ukrainian, and other companies to market their commercial launch services.

In 2006 Lockheed Martin and Boeing joined forces to create United Launch Alliance, or ULA. They formed the joint venture as a sort of defensive measure to keep from competing each other to death for Pentagon projects. While this enterprise might seem like an obvious anti-trust problem, the federal government was willing to overlook the anti-competitive aspects of the deal in the interest of national security; it wanted to have two trusted DOD rocket makers around instead of one and thus assure U.S. access to space. The rocket makers in turn seemed to have locked in a continual source of lucrative DOD contracts, which helped to keep the companies healthy as they offered commercial launches as well. Thus, ULA inherited a lead in the dwindling American commercial launch market from its constituent partners. Would-be participants in the commercial launch market like real estate mogul cum rocketeer Andy Beal, whose fledgling aerospace company called it quits in 2000, complained that the obstacles to their success weren't so much technological as they were political, since government policy and practice so obviously favored the established "legacy" rocket makers. See, for example, https://www.nytimes.com/2006/02/05/business/yourmoney/a-bold-plan-to-go-where-men-have-gone-before.html.

But ULA's privileged position didn't last long. Elon Musk's startup company, SpaceX, which had complained bitterly about the formation of ULA, achieved its first orbital flight of a Falcon 1 in 2008 and rapidly moved on from there to development of the Falcon-9 and the first delivery of cargo to the International Space Station in 2012. Fueled by founder Musk's deep pockets and early seed money from DARPA, the company preached simplicity and reusability and soon proved itself able to underprice even ESA and other foreign entities. It launched its first commercial satellite in 2013 and quickly eclipsed ULA as the nation's commercial launch leader. By 2014 the ESA had recognized the threat and began to "restructure" its pricing to compete with SpaceX. It was too little, too late. In 2017, the company launched 17 commercial flights, while ESA launched 6. This year SpaceX is on pace to launch over 120 commercial missions (counting its own Starlink deployment missions), while ESA, suffering from a "launcher crisis" related to its retirement of the Ariane 5 and testing of the Ariane 6, has launched one, notching only a test flight of Ariane 6 and the launching of an ESA research satellite on a Vega-C rocket.

SpaceX has a current market valuation of some $350 billion. Numerous other companies have tried over the years to do what Elon Musk's company has done, with very little success. Some are still with us: Blue Origin, for example, Rocket Lab, and Northrop Grumman, maker of the Antares rocket. ULA is still alive as well and is now marketing commercial launches on its new Vulcan vehicle. However, a number of other ambitious enterprises—Rocketplane Kistler, Xcor, Armadillo Aerospace, and Beal Aerospace, to name a few—have fallen by the wayside.

Foreign competitors like Arianespace or, more likely, one of the several Chinese start-ups that appear to be trying to copy SpaceX's secret sauce, may yet pose market challenges in the future. In the meantime, though, and regardless of one's feelings about Elon Musk personally, it's nice to reflect on the billions of commercial launch dollars that SpaceX has managed to keep right here in the U.S. by means of its successful competition with that global menace, France.

The eye-popping number of satellites we report as being slated for launch in the future—431,713—shows up in a number of sources, including: https://www.nytimes.com/2023/03/02/science/hubble-spacex-starlink.html.

18. Curse You, Gene Roddenberry!

This chapter was initially intended to be an ambitious recitation of the science behind possible alternative means of rocket propulsion. Every attempt we made, though, ended up being too long and too complicated for a survey like *Star Bound*. The basic problem is simple: *In order for astronauts to travel beyond our closest neighboring planets and live to tell about it, we need to be able to generate way more energy to power our spaceships than we know how to do at present.*

We illustrate the dilemma with some hypothetical "travel times" to other solar systems. The numbers related to traveling to the TRAPPIST-1 system come from the February 23, 2027 Space.com article "TRAPPIST-1: How Long Would It Take to Fly to 7-Planet System," by Hanneke Weitering. https://www.space.com/35796-trappist-1-alien-planets-travel-time.html.

The figure for a jaunt to Proxima Centauri comes from NASA, and is available at https://imagine.gsfc.nasa.gov/features/cosmic/nearest_star_info.html#:~:text=If%20Voyager%20 were%20to%20travel,take%204.22%20years%20to%20arrive!

Having basically punted when it comes to explaining how a nuclear-powered ion thruster engine works, we can at least refer you to some helpful sources so you can figure it out for yourselves. Research and development of thermal nuclear propulsion is indeed happening, and engineers are working as we speak…er, *type*. *See* https://www.nasa.gov/news-release/nasa-darpawill-test-nuclear-engine-for-future-mars-missions/. The *This Week in Space* podcast interview of former astronaut and current rocket power guru Franklin Chang-Diaz (Episode 80, "On to the Stars") provides a good introduction to ion plasma engines, and can be found here: https://twit.tv/shows/this-week-in-space. The official website of the Breakthrough Starshot Initiative is at https://breakthroughinitiatives.org/initiative/3. Author Paul Parsons touches on matter/anti-matter drives and Alcubierre engines at the conclusion of his *Space Travel*, but, like us, leaves detailed explanation to the experts.

19. Looking Outward

Bacteria living in a nuclear reactor? Check out "Bacteria Living in Nuclear Reactors Might Help Us Make Vaccines," in the July 21, 2020 issue of *Forbes*, https://www.forbes.com/sites/jamesconca/2020/07/21/if-extremophile-bacteria-can-live-innuclear-reactors-maybe-they-can-help-us-make-vaccines/. Or in outer space? See

"Scientists Discovered Exposed Bacteria Can Survive in Space for Years" in *Smithsonian Magazine*, August 26, 2020.

For the latest count and classification of exoplanets, check out the website of NASA's Exoplanet Archive at https://exoplanetarchive.ipac.caltech.edu. And remember, astronomers only spotted the first exoplanets back in 1992—this entire inventory is very new and is partly responsible for a surge of interest in the possibility of finding extraterrestrial life.

Adam Frank's *The Little Book of Aliens* (2023) is a concise, well-written review of humankind's fascination with the idea that We're Not Alone, with discussions of the Great Flying Saucer Craze of 1947, the Roswell Fixation, and the work of various NASA-funded astrobiologists—people who try to imagine the unimaginable. Astronomer Avi Loeb is disliked by many in the scientific community, who see him as a grandstander, but we're not in that community and we find him and his work far-out but interesting. His 2021 book *Extraterrestrial: The First Signs of Intelligent Life Beyond Earth* is a good place to start. That's where we found his thoughts about 'Oumuamua, the first recorded 'interstellar object," and statistical musings on the possibility of life elsewhere.

The quote about whether we should be looking for little green men or microbes comes from Meghan Bartels's December 10, 2021 article "The Kardashev Scale: Classifying Alien Civilizations" in Space.com, available here: https://www.space.com/kardashev-scale. Finally, while there is currently a fair amount of enthusiasm informing the search for extraterrestrial life, not everyone shares the optimism. For a contrarian view, listen to the interview of former Planetary Society president Lou Friedman on the September 20, 2023 episode of *Planetary Radio*. For the view that we may not recognize alien life when we see it, see the work of the NASAfunded Laboratory for Agnostic Biosignatures at https://search.app/1CJxWpH93tULvqiS9.

The Chelyabinsk Meteor event in 2013 has been widely studied. For a thumbnail sketch, see https://www.planetary.org/articles/what-was-the-chelyabinsk-meteor-event. There seems to be some disagreement about the number of injuries (chiefly from broken glass) the event caused. NASA says 1600. Space.com says 1200. The Planetary Society goes with 1500, and that's the figure we use.

As you can see in the text, various astronomers have different ideas regarding how many stars there are in our galaxy and how many planets orbit around them. The numbers are so large that it's hard to know who's right or whether it matters; it's all a sort of mental Monopoly money, as the *New York Times* piece cited in the text suggests. (The

article, by the way, is Jon Gertner's "The Search for Intelligent Life is About to Get a Lot More Interesting," in the September 15, 2022 issue of the *Times*.) Dr. Ed Lu provides interesting details about the hunt for killer asteroids in an interview with Rod Pyle and Tariq Malik in the June 30, 2023 episode of *This Week in Space*, available here: https://twit.tv/shows/this-week-in-space.

It's hard to tell how seriously to take descriptions of faraway planets that rain glass, iron, diamonds, or rubies. It sounds cool, but descriptions of the weather on planets light years away from our own are of course highly speculative. In the meantime, though, the dreaming is exquisite. For a description of a gem-sodden planet, see Chelsea Gohd's article "Metal Clouds and Liquid Gems Spotted in the Atmosphere of Hot Jupiter WASP 121-b" in the February 21, 2022 issue of Space.com, at https://www.space.com/metal-clouds-rain-hot-jupiter-exoplanetwasp121b

20. Why It's Worth It

In their 2023 book *A City on Mars? Can We Settle Space, Should We Settle Space, and Have We Really Thought This Through?*, Zach and Kellie Wienersmith lay out some of the technological, logistical, physiological, and, yes, legal challenges involved in actually moving humanity off Earth. The Wienersmiths are worried about things like international law and governance of future space settlements, and, while it's all an exercise in speculation at present, the questions may take on real weight in the not-too-distant future. What will happen, for example, if the Chinese claim sovereignty over a sizeable chunk of the lunar south pole? While *A City on Mars* is a little less optimistic than we are, it poses important questions about everything from off-planet sex and human reproduction to the looming philosophical and political conflicts that will come when nations try to exert control of regions of the moon, asteroids, or other planets.

Bruce McCandless II's statement regarding the Overview Effect can be found in Nadia Drake's story "First Person to Walk Untethered in Space Gives a Final Interview," in the February 7, 2018 issue of *National Geographic* magazine, available here: https://www.nationalgeographic.com/science/article/first-untethered-spacewalk-brucemccandless-astronaut-space-science.

Mike Massimino's thoughts are here: https://www.christianunion.org/publications-media/christian-union-the-magazine/pastissues/spring-2019/2326-thomas-merton-lecture-"views-from-space".

Ed Mitchell's Institute of Noetic (i.e., "inner knowledge") Sciences is still around, and can be visited at: https://noetic.org.

Finally, our suggestion that the interested reader should join "a space society" was a little vague. Here's a stronger and completely unsolicited hint: Join the National Space Society! It lives right here: https://nss.org. Another winner: The Planetary Society, at https://www.planetary.org/.

Errata

Mistakes happen. In addition to the mangled Chris Kraft quote mentioned above and the hugely simplified characterization of the post-shuttle commercial launch market in Chapter 17, here are the goofs we've identified (so far) in *Star Bound*:

We appear to say on p. 57 that Neil Armstrong won his astronaut's wings by virtue of his X-15 flights in the early sixties. This is not the case, as (a) Neil never exceeded the 50-mile mark during his X-15 flights, and (b) he won his astronaut wings instead for his Gemini VIII mission in 1966.

We say on p. 173 that the Russian Federation emerged in 1990. This is a little early, as the Soviet Union didn't officially break up until late December of 1991. The "emergence" of the Russian Federation is thus more accurately said to have occurred in either 1991 or, as we have it, 1992.