"Ahead, Warp Factor Three, Mr. Sulu": Imagining Interstellar Faster-Than-Light Travel in Space Science Fiction

MARGARET A. WEITEKAMP

Fictional spaceships travel at the speed of plot. So says J. Michael Straczynski, creator of the American cable television shows *Babylon 5* (PTEN & TNT, 1994–98) and *Crusade* (TNT, 1999). No matter where imagined spacecraft begin their journeys, he suggests, or how they are powered, or how far they have to travel, in the end they arrive right where and when the writer needs them—either just in the nick of time or tragically a moment too late—to serve the dramatic interests of the story. Straczynski identified this trope when jokingly describing the specifications of one of his television productions' main spacecraft.[1] In doing so, he broke the fourth wall of the show's dramatic stage to address the real mechanism propelling such vehicles: literary creativity. But his comment also highlights a relatively recent addition to the elements of space-themed science fiction: the actual travel across the immensity of space. For hundreds of years, writers imagined cosmic adventures but largely ignored the trips themselves. Stories focused instead on the ends of the journey, skipping quickly from planning the expeditions to the events in other-worldly destinations. That changed in the 1950s. After real-world technologies demonstrated that speed barriers could be surpassed and human beings shot into space, science fiction creators began to offer more detailed fictional explanations of how their adventurers got from place to place. In literature, film, and eventually television, writers envisioned space travel in ways both grounded in practicality and playful in imagination.

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The premise that characters can travel from planet to planet, or star to star, in ways that defy current science and technology has become central to space fiction as a genre. Without it, one can imagine entire seasons of popular space television programs spent dully in transit. As a narrative device, however, interstellar travel remains a background element, rarely called out for study. But the methods invented by writers to traverse interstellar distances have a distinct history in literature and popular culture. Some authors suggested ways for humans to endure the long voyages no matter how long they took. Other science fiction creators postulated technological or natural solutions that shortened the actual trips, including faster-than-light drives, hyperdrives, jump drives, worm holes, and black holes. Examining these imagined—and in some cases, just plain imaginary—kinds of space transportation offers a new way of understanding how popular culture has harnessed real and speculative science for the purposes of storytelling. Popular understanding of contemporary science exists in a dialectic with science fiction writing. For example, the idea of faster-than-light travel came to prominence in space science fiction at a historical moment characterized by significant advances in aeronautical technology. Although some of these ideas predated the space age, after the 1950s, fictional depictions of space travel had to suggest conceivable solutions to the problems of crossing interstellar distances for readers or viewers to consider them plausible.

The Potential and Limits of Taking Faster-Than-Light Technologies Seriously

Science fiction has been ably analyzed as a genre (Aldiss; Roberts), but no systematic study exists of faster-than-light travel as a distinct part of the technological imaginary. Academics working in the robust fields of science fiction studies and popular culture studies tend to dissect particular novels, shows, and/or films, rather than making cross-cutting examinations of the invented technologies in them. Likewise, the parallel literature written for popular audiences by participants or entertainment writers concentrates on particular franchises. In the fields of space history and policy, scholars investigating science fiction's influence on actual spaceflight have investigated the cultural roots of those efforts. Notably, political scientist Howard

McCurdy argued that spaceflight advocates in the United States self-consciously used speculative fiction to make real spaceflight seem realistic and bankable at the dawn of the space age. Studies of Soviet space culture have also focused on the roots of such imagery in the Russian tradition of cosmism (Siddiqi). And two recent volumes have investigated the complex interplay between "Astroculture" and the real history of science and technology, particularly in Europe (Geppert, *Imagining*; *Limiting*).

When fictional spaceship designs have gotten analytical attention, they have sometimes been treated as if they were real-life vehicles. For instance, *Haynes Owner's Workshop Manuals*, which have been well-known to automobile and motorcycle enthusiasts as authoritative references describing maintenance and repair techniques for specific makes and models, also created light-hearted guides to fictional spacecraft. Haynes manuals exist for *Star Trek*'s starship *Enterprise* (Robinson and Riley) and the Klingon Bird of Prey (Robinson and Sternbach), as well as *Star Wars*' Imperial Death Star (Windham and Reiff) and the *Millennium Falcon* (Windham, Reiff, and Trevas). Various reference books that assemble canonical elements of fictional universes also adopt a similar point-of-view, explaining how imagined spacecraft systems function in great detail. For instance, to cite just one example, the flagship of the television show *Star Trek*: *The Next Generation*, the *U.S.S. Enterprise* NCC-1701-D, received a system-by-system analysis in a well-illustrated volume aimed at the show's fans (Okudas).

Such earnest analyses belie the ironic or light-hearted treatment that fictional spacecraft sometimes receive. Famously, the creators of *Dr. Who*'s TARDIS cheekily sidestepped the fundamental questions of travel through space and time by postulating a machine that could do both without any visible mechanisms for either. Douglas Adams parodied the conventions of spaceflight stories and faster-than-light technologies in his absurdist novel, *The Hitchhiker's Guide to the Galaxy*. An "infinite improbability drive" powered the starship *Heart of Gold* (Adams 77). In *Spaceballs* (Metro-Goldwyn-Mayer 1987), Mel Brooks's spoof of the *Star Wars* trilogy and other related films, Lord Dark Helmet comically overreached—and lampooned faster-than-light travel—when he ordered his ship to achieve "ludicrous speed." Even within the veil of straightforward fiction, writers have self-consciously poked fun at the scientific improbability of their imagined

technologies. In *Star Trek: The Next Generation* (syndication 1987–94), the transporters included "Heisenberg compensators," black-box mechanisms asserted to fix the real problems that make matter transporters impossible. In spaceflight stories, methods of faster-than-light travel function as narrative compensators, solving the fundamental problems of long-distance spaceflight.

No effort to take the imagination of such technologies seriously can hope to be comprehensive. The worldwide proliferation of space-themed science fiction stories in multiple forms—novels, short stories, comic books, television, film, graphic novels, and even online videos—creates far too large a body of work to assess thoroughly. Nevertheless, certain themes emerge in these works, and some of the solutions can be analyzed without attempting to list every possible example. Nor does this analysis, which focuses on fictional spacecraft not time machines, include time travel. Although traveling faster than the speed of light would involve time travel, most space adventures ignore this fact. Evidence of faster-than-light travel exists in American, British, and continental fiction, but the undeniable bulk of the examples originate in the United States. Beginning in the twentieth century, the United States became a major exporter of popular culture, whether in films or through television. As Brian W. Aldiss concludes in his authoritative chronicle of science fiction, the genre is "largely—in emphasis and in fact—an American art form" (13). This seems to be particularly true for space-oriented tales. Stories about adventurers traveling to distant worlds at great speeds have been a particularly, although not exclusively, American preoccupation.

The Earliest Imagining of Spaceflight

The origins of space science fiction can be traced to the first comprehension of space-based places as possible destinations (Messeri). In 1638, John Wilkins, later the bishop of Chester, published thirteen propositions about the physical properties of the Moon. The treatise's page headers summarized the argument: "That the Moon may be a World." In later editions, Wilkins developed his suppositions about the Moon as a geographical place with known features. He even added a fourteenth proposition, that the Moon could be visited:

"That 'tis possible for some of our Posterity, to find out a Conveyance to this other World; and if there be Inhabitants there, to have Commerce with them" (113). He looked forward to the possibility, speculating "how happy shall they be, that are first successful in this Attempt?" (133). The idea that the Moon could be habitable—or even inhabited—was a part of a larger contemporary cultural and scientific debate about whether God's creation included worlds in addition to Earth.

The Copernican Revolution's fundamental rethinking of the solar system, as well as Johannes Kepler's publications in the early 1600s, and awareness of the native populations living in the New World prompted a debate in England and throughout Europe in the 1630s about the plurality of worlds (Cressy). The roots of those arguments dated back to antiquity (Crowe 3). Also in 1638, Bishop Francis Godwin published, under a pseudonym, *The Man in the Moone; or, A Discourse of a Voyage Thither by Domingo Gonsales*. The fanciful book spun a tale about a Spanish adventurer who harnessed wild "gansas" (large birds akin to swans or geese) for a twelve-day voyage to the Moon via chariot (Godwin). Together, these works represent some of the earliest examples of what came to be known as science fiction.

French playwright Cyrano de Bergerac responded to Godwin's work in a series of three linked novels collectively titled, *Voyage dans la Lune*. Written in 1648, these stories were initially published in French in 1657 after the author's death (Bergerac, *Voyage dans la Lune*). De Bergerac's narrator began by restating the understanding of the Moon as a place, "I believe that the Moon is a world like ours, to which this of ours serves likewise for a Moon" although his fictional audience reacted skeptically: "This was received by the general Laughter of the Company" (*Voyage to the Moon* 11). The literary genre that first imagined space travel developed gradually. Almost a century later, French philosopher and satirist Voltaire published *Micromégas* in 1752. His fantastic tale envisioned a gigantic man named Micromégas who traveled to Saturn from a planet orbiting the star *Sirius*. Joining an enormous Saturnian, the two behemoths then visited the comparatively small Earth—whose self-centered occupants were too tiny to detect (Voltaire).

In each of these instances, authors imagined travel to extraterrestrial places without paying much attention to the actual voyages. Wilkins speculated about Moon travel without any consideration of

transportation while Godwin envisioned bird-drawn chariots. De Bergerac's narrator rose to the Moon propelled by rockets, but only inadvertently and almost instantly. The actual travel through space remained incidental. Voltaire described Micromégas's voyage as quick and easy:

> Our traveler had such a marvelous acquaintance with the laws of gravitation, and all the forces of attraction and repulsion, and made such good use of his knowledge, that, sometimes by means of a sunbeam, and sometimes with the help of a comet, he went from one world to another as a bird hops from bough to bough. He traversed the Milky Way in a short time. . .
>
> (Voltaire)

The distances between celestial locations seemed easily crossed.

Scientists began to quantify those expanses in the nineteenth century. In 1838, Prussian astronomer Friedrich Bessel first calculated the distance to a star. Bessel measured the slight change in a star's observed position as the Earth moved, a phenomenon called parallax. He concluded that the star, 61 Cygni, was 66 trillion miles away from Earth. To make that measurement more relatable, he suggested that "light employs 10.3 [10.3] years to traverse this distance" (Bessel 160). Bessel's calculations added a new degree of specificity to astronomers' stargazing. More important, the concept of a light year—a comprehensible way to understand immense distances—became widely accepted.

Just over twenty-five years later, French novelist Jules Verne wrote the first fiction that included a conceivable voyage to the Earth's nearest neighbor. Published in French in 1865, *De la terre à la lune* (*From the Earth to the Moon*) became available to English language readers in the United States in 1867. Verne imagined members of the Baltimore Gun Club casting a giant cannon dubbed "Columbiad" to shoot a complex projectile carrying three men, two dogs, and ample supplies on a five-day trip to the Moon. Verne's novel focused more on the planning than the flight itself. After dedicating hundreds of pages in twenty-six chapters to the preparations, Verne explained the actual voyage in just the final two chapters. The book also changed perspective in that section, being told from the point-of-view of the public left behind on Earth (138). The dramatic ending left the fictional

observers—and readers—unsure whether the intrepid travelers had reached their destination (allowing Verne to write a sequel).

Likewise, George Méliès's innovative silent film, "Le Voyage dans la Lune" (1902), depicted a cannon launch and lunar adventures with little attention to the intervening trip. As Verne's travelers had, Méliès's astronomers flew to the Moon aboard a large metal projectile shot by a giant cannon. The fictional spacefarers reached their destination, but, in the thirteen-minute movie, the trip itself only occupied sixteen seconds. Méliès also changed the point-of-view away from the travelers during the voyage, depicting instead the projectile's vantage point. After the cannon's firing, the Moon loomed larger in the frame. The vehicle only reappeared in the iconic image of the projectile lodged in the eye of the Man in the Moon. The rest of the action took place on the lunar surface before returning to Earth for a great celebration.

Well into the twentieth century, readers accepted space-themed fiction that simply skipped over the actual voyage. For instance, Edgar Rice Burroughs completely avoided the question in *A Princess of Mars*, the first of eleven volumes in the Barsoom series. After a spectral John Carter left his paralyzed body in an Arizona cave and gazed up at Mars in the night sky with his arms outstretched, his character was simply "drawn with the suddenness of thought through the trackless immensity of space" (20). The next chapter opened with the character standing on the Martian surface.

Beginning in the 1920s, writers coalesced on rocketry as the probable vehicle of human spaceflights, but the resulting stories did not change much. Historian Frank Winter has argued that, after Robert H. Goddard's speculative writing about the potential of rocket launches received public attention, rocket propulsion eclipsed ornithoptors, projectiles, and other vehicles in fiction written about reaching space (4). Despite this shift, subsequent comic strips and pulp fiction still focused on rollicking adventures rather than travel narratives. *Buck Rogers*, whether in the initial short story in 1928, the subsequent comic strip beginning in 1929, or the radio program in 1932, includes characters that zoom all over space, showing up for adventures without much, if any, consideration about how the rocket-propelled space planes got them there (Dille). Likewise, competitor *Flash Gordon*'s hardware, drawn by Alex Raymond beginning

in 1934, evokes aeronautical streamlining but reveals little about any practical mechanisms.

Generation and Sleeper Ships

Before examining authors' ideas for increased spacecraft speeds, it is worth considering two other innovative ways that science fiction creators envisioned humans crossing interstellar distances despite having relatively short life spans. Generation ships offer one answer. This concept reworks the capacity and longevity of the imagined vehicle, not the means of propulsion or pace of travel. The ship is so large and complex—a self-contained world—that its occupants can survive inside for generations. Traveling at the limited speeds provided by conventional chemical or even nuclear power, the transit requires multiple human lifetimes. At the distant destination, the descendants of the original travelers disembark to begin their lives on a new world. Alternately, sleeper ships rely on the imagination of advanced biomedical technologies to put the crew into suspended animation. When the automated vehicle arrives at its destination, the occupants awaken.

In 1941, early in his career, Robert Heinlein published a story considered to be one of the first literary expositions about a generation ship. "Universe" appeared first in *Astounding Science Fiction* and was later reprinted in 1951 as a standalone Dell paperback. Heinlein set his story on a generation ship that had been in space for so long that its occupants had forgotten it was a vehicle. Instead, the characters worshiped the "Ship" as part of their religion. The controlling "scientists" and "officers" maintained the vehicle through ritualistic gestures without understanding their true purpose. Moreover, mutants, or "muties," had developed, occupying whole levels in the immense vehicle. One such character was the two-headed Joe Jim Gregory. Each of the two heads had a separate personality, and in this case, two heads were literally better than one. Gregory realized the truth; they were living on a space ship. The mutants then captured an apprentice scientist, who learned what Gregory knew. That seemingly heretical insight ignited a mutiny that drove the rest of the adventure story. As a Naval Academy graduate with a lifelong interest in science and engineering, Heinlein extrapolated many of his

story ideas from concepts being discussed by contemporary researchers.

Speculative nonfiction about interstellar travel also featured generation ships. For instance, *The Complete Book of Outer Space* from 1953 contained articles from recognized experts including science writer Willy Ley, rocket engineer Dr. Wernher von Braun, physicist Dr. Heinz Haber, and science fiction editor Hugo Gernsback. Published by a magazine on pulp paper, the book popularized the views of "serious men of science [who] are right now working on plans that will soon be realized" (3). After pieces on spaceships, orbiting stations, human physiology, spacesuits, and rocket engines, the anthology offered an article speculating on "Interstellar Flight" written by the Technical Director of the British Interplanetary Society, Dr. Leslie R. Shepherd, and first published in that organization's journal in 1952. Touted as "one of Britain's foremost scientists in the field of space travel," Shepherd explained that "we are concerned with the problem of getting small colonies across the almost endless interstellar gulfs" (93). The solution, he suggested, "may demand a completely new philosophy of exploration. . . . Indeed, interstellar colonization may call for *the sacrifice of whole generations* in the lonely reaches of space" (94, emphasis original). The vehicle could be constructed inside a meteor, carrying a "self-contained civilization in miniature" (94). Such a transport would be powered by "the present-day chemical rocket," a nuclear reactor, or even the "ion-rocket principle" (96–97).

As a physicist, Shepherd focused on the mission's science, but the diagram accompanying the article illustrates how a generation ship would replicate an idealized version of contemporary society. The illustration shows a flawless sphere hollowed out of an irregular meteor. Inside, straight horizontal layers linked by elevators organize the community. Near the top of the massive vehicle, homes, playgrounds, parks, and an assembly hall share the upper layers with a university, three schools, a swimming pool, a theater, and a library. In the lower levels of this society, literally at the bottom by the water processing plant, sheep, hogs, and cattle graze in pastures. Several layers of agricultural fields provide grains, cotton, sugar cane, and vegetables to the central kitchens and bakeries near the top. All other services, whether municipal, trade, or medical, exist in the middle levels (95). The hierarchical microcosm could theoretically endure for thousands of years.

Generation ships also appeared in prominent science fiction universes in the 1960s. Notably, the fifth serial of the third season of *Dr. Who*, "The Ark" (1966), involved a four-episode plot in which the First Doctor visited a generation ship once—and then traveled forward in time, arriving on that same ship 700 years in the future. In the elapsed time, the hierarchies on the ship had changed entirely. Using his knowledge of the earlier state of "the Ark," and with the aid of the highly evolved Refusians, the Doctor helped to resolve the crisis at the destination. Likewise, the original *Star Trek* television series (NBC, 1966–69) had two episodes involving generation ships. In "By Any Other Name," (original airdate February 23, 1968), Captain Kirk and the away team were captured by two travelers whose generation ship had been destroyed after their exodus from the Andromeda galaxy's Kelvan Empire. The generation ship provided the show's premise but the plot focused on the aliens' takeover of the *Enterprise*. In contrast, "For the World is Hollow and I Have Touched the Sky" (original airdate November 8, 1968) took place almost entirely aboard a generation ship. When the *Enterprise* crew intercepted a seeming asteroid on a collision course with a populated planet, they found that its occupants did not understand their world's true nature. Naturally, the *Enterprise* crew helped to repair the computer, delivering the vehicle to its destination. Before everything reset at the end of the hour—as was customary in episodic television at the time—Dr. McCoy even married the high priestess of the religion that worshiped the ship's malfunctioning main computer.

Alternately, sleeper ships solve the real problems of long-distance space travel with fictional biomedical technologies. Writers imagine pods or beds that slow human biological processes until the crew achieves a hibernation-like state. In *Star Trek*, Federation officers discover Khan Noonien Singh and his crew of genetically modified Human Augments adrift in space aboard a sleeper ship, the *S.S. Botany Bay*. This popular plot exists in both the original prime universe timeline ("Space Seed"; *Star Trek: The Wrath of Khan*) and the alternate Kelvin timeline initiated by J. J. Abrams's *Star Trek* (2009). In Stanley Kubrick's *2001: A Space Odyssey* (1968), cowritten by Sir Arthur C. Clarke, the *Discovery One* traveling to Jupiter carries two active crew members and three others in suspended animation. Their immobility leaves them vulnerable. The terrifyingly inhuman logic of HAL 9000, the sentient computer controlling the ship's systems,

is revealed when, in addition to killing one astronaut and locking the other outside the pod bay door, Hal turns off the hibernation compartments' life support. A different sleeper ship, the space tug *Nostromo*, carries the crew in Ridley Scott's path-breaking film *Alien* (1979). The movie opens with the seven-person crew in stasis. When the ship's computer, Mother, detects a distress signal, however, the crew are awakened, sparking the adventure. Although hungry and cranky, they suffer no other ill effects.

Spaceships that endure long voyages continue to feature in recent science fiction. Kim Stanley Robinson's novel *Aurora*, published in 2015, begins its adventure with a generation ship departing Saturn. Although the plot focuses on the destination planet one hundred and sixty years in the future, the proposition that a giant vessel could transport people over great distances for decades sets up the book's central conflicts. As imagined technologies, generation ships predated the beginning of the space age. But writers soon imagined propulsion methods that accelerated ships to multiples of the speed of light.

Faster-Than-Light Travel

Faster-than-light travel had been suggested in fiction as early as the 1910s and published by the 1920s. E. E. "Doc" Smith included the idea of spaceships traveling many times faster than the speed of light in his "Skylark of Space" stories. Conceived in 1915 when he was a young government chemist and written during his doctoral studies in chemical engineering, Smith's work was the cover story for the same issue of *Amazing Stories* in 1928 that included Philip Francis Nowlan's first short story about Anthony (later "Buck") Rogers. Smith and other scientists recognized that even traveling near the speed of light was only a desirable fiction.

Scientific understanding of light speed as an absolute natural limit derives from Albert Einstein's publications on special relativity in 1905, confirmed by his work on general relativity in 1916. In classical physics, speed has no limits. But relativistic theory shows that mass increases with acceleration until mass becomes infinite at light speed. As a result, speculative writing respects that limit. For instance, in his generation ship article in 1953, Dr. Shepherd declared, "Clearly, the attainment of velocities *close to* that of light

would make interstellar travel a much more promising proposition than would the speeds which we have considered in the first part of this discussion" (104, emphasis added). Shepherd recognized that light speed could barely be approached, however, let alone exceeded.

Regardless, the fictional idea of faster-than-light travel made intuitive sense to a public familiar with recent supersonic flights. In 1947, Chuck Yeager broke the speed of sound aboard the Bell X-1 *Glamorous Glennis*. The speed of sound ceased to be a barrier, becoming instead a measurement of velocity: Mach 1. In 1953, the same year as Shepherd's publication, Scott Crossfield flew twice that speed: Mach 2. The North American X-15 experimental rocket plane flew as fast as Mach 6, considered a hypersonic speed (greater than Mach 5) by the end of 1961, a feat recognized publicly with the Collier Trophy that year (Kay). Writers extrapolated supersonic speeds into the idea of spacecraft traveling at multiples of the speed of light.

One of the earliest uses of faster-than-light travel occurs in the British comic *Dan Dare*. Beginning in 1950, Frank Hampson created the illustrated space-themed panels for *The Eagle*, a boy's paper. Dare's adventures as the chief pilot of the Interplanet Space Fleet take place in long story arcs on inhabited planets in the Earth's solar system. From the beginning, vehicles in *Dan Dare* combine human, Venusian, and other technologies. In 1955, after a hiatus in which other writers stepped in, Hampson returned as the author and introduced interstellar travel in "The Man from Nowhere" trilogy. When an extraterrestrial called Lero the Crypt lands on Earth looking for someone to help his peaceful world withstand an attack, Dare chooses a crew to accompany him on the Crypt vessel, which travels faster than the speed of light. The technology is inherently alien, however, and faster-than-light travel is not a regular feature afterward.

The first film to depict a fictional faster-than-light spaceship created by humans is *Forbidden Planet* (1956). Although best remembered for plotlines that echo William Shakespeare's *The Tempest* and the debut of Robby the Robot, the film opens by showing the United Planets cruiser C-57D. As it zooms across the screen, the announcer explains,

> In the final decade of the twenty-first century, men and women in rocketships landed on the Moon. By 2200 A.D., they had reached the other planets of our solar system. Almost at once, there

> followed the discovery of hyperdrive, through which the speed of light was first attained, and later greatly surpassed. And so at last, mankind began the conquest and colonization of deep space.

From the exterior, the C-57D is an undifferentiated flying saucer, without any visual suggestion of a new propulsion system. Inside, the ship's helmsman sits at an electronic workstation, looking into a viewfinder while the console's buttons blink. The visualization of faster-than-light travel occurs as the crew prepares to withstand the deceleration to sublight speeds. After an announcement over the ship's speakers, the crew positions themselves in "DC stations," depicted as columns of light that hold them immobile while the ship slows. As the film's electronic score suggests the ship's braking, the helmsman announces, "All right, we're down to .3896 of light speed." The ship's rapid travel delivers them to the film's real focus, the crew's adventures on Altair IV.

By the mid-1960s, however, as both the United States and the Soviet Union made regular human spaceflights, science fiction audiences became more intuitively aware of the time that it took to travel in space. For instance, when NASA astronaut John Glenn became the first American to orbit the Earth aboard *Friendship* 7 on February 20, 1962, the launch, duration, and landing were all publicized in real time. The general public knew that the flight took just under five hours (four hours and fifty-six minutes to be precise) to make three Earth orbits. Spaceflights made the news regularly in the next few years. In 1965 alone, in addition to multiple launches of satellites or planetary probes, both the Soviet Union and the United States made multiple multiday orbital human spaceflights. Science fiction creators answered these real-life advances with more sophisticated fictional concepts.

A major leap occurred with the *U.S.S. Enterprise* created for *Star Trek* (NBC, 1966–69). The form of the imagined spaceship with the famous call letters NCC-1701 began on the drawing boards of Walters "Matt" Jefferies, the art director for Gene Roddenberry's proposed television show. As a starship, the *Enterprise* needed to look like it regularly crossed immense distances with ease. Roddenberry had two requirements. The new craft should not look like previous fictional designs, nor like any forthcoming aerospace vehicles in real life (Whitfield and Roddenberry 79). Roddenberry rejected several designs. Ultimately, Jefferies, a WWII flight engineer and private

pilot, used "aircraft logic" (Okudas qtd. in Robinson and Riley 6) to create a vehicle with components that visually communicated their purpose: a command bridge, crew compartments, futuristic weapons, and external engines. In designing the two engine nacelles, Jefferies effectively invented warp drives, fictional engines that could propel the ship at multiples of the speed of light.

As the original television series was being planned, the language of warp drive was still developing. In the first pilot, "The Cage," which was rejected by NBC and never aired in full until 1988, Captain Pike (Jeffrey Hunter) calls for the *Enterprise* to travel at "Time warp, factor seven." However, in the first episode aired, "The Man Trap" (original airdate September 8, 1966), Captain Kirk (William Shatner) gave what became a familiar order, "Warp one, Mr. Sulu," the command to travel at the speed of light. The expectations for how faster-than-light travel worked in the *Star Trek* universe became part of what media studies scholar Daniel Bernardi has identified as the "mega-text": continuities that made *Star Trek*'s many different films and television series into a consistent oeuvre (7).

Warp drives illustrate both the continuity of the *Star Trek* universe and the freedom that writers take to elaborate upon the canon. In the original series, warp factors increase speed in a geometric progression: the speed of light times the warp factor cubed. The equation was adjusted for *Star Trek: The Next Generation*, and the question of maximum speeds still elicits debate. No matter how their speeds are calculated, warp drives remain a signature piece of *Star Trek* technology. Over time, writers elaborated the specificity of the internal workings. Powerful matter-antimatter reactions generate warp fields that distort the local space-time, allowing ships to travel far in excess of the speed of light. As seen in *Star Trek: First Contact* (1996), which depicts the first flight of Zephram Cochran's warp-capable *Phoenix*, in the *Star Trek* universe, the successful demonstration of such technology marks a culture as ready for participation in interstellar civilization.

Star Trek's methods for faster-than-light travel ultimately influenced not only science fiction but also the wider culture. The term "warp speed" became part of everyday speech, used by editorialists or reporters as evocative shorthand for the rapid acceleration of news cycles or economic shifts. More so, however, the revolutionary design of the first *Enterprise* set a new standard for fictional spacecraft.

Developed in a moment when real spacecraft regularly made news, Jefferies's design raised the bar for imagined vehicles. After *Star Trek,* undifferentiated flying saucers and flame-spewing pointed rockets largely disappear from fictional depictions, and other fictional propulsion devices, which either bend space-time or traverse alternate dimensions, become more prevalent.

Jump Drives, Hyperdrive, Worm Holes, and Black Holes

Rather than having the vehicles fly faster, some science fiction suggests ways of traveling through or outside of normal four-dimensional space (including time), either by jumping within ordinary space, utilizing hyperspace, or exploiting natural or artificial shortcuts through space. Like warp drives, jump drives work from the premise of bending space-time, but instead of creating a path for faster-than-light speeds, jump drive travel is almost instantaneous. In 1962, Madeleine L'Engle explains the idea in her novel, *A Wrinkle in Time*, by having one of the characters imagine an ant walking across her skirt. If the wearer brings together the skirt's two points, instead of traveling the long line across, the ant can move straight from point to point (73). Alternately, hyperspace offers vehicles an alternate dimension that allows a spacecraft to navigate from point to point at rapid speeds. A hyperdrive combines a propulsion system with a sophisticated computer that allows a spacecraft to enter, negotiate, and exit this alternate dimension safely. Finally, the fictional idea of a wormhole represents the imagination of a conduit through space that somehow links one region of space with another. Speculation about wormholes must be distinguished, however, from black holes, which are real astronomical phenomena. In the late 1960s, the calculations and observations of astronomers first convinced scientists that black holes existed (Bartusiak). Even as scientists debated the possibility of such gravitationally dense singularities, science fiction suggested ways that traveling near such features might affect spaceships.

Beginning in the 1940s, Isaac Asimov included jump drives in the short stories that later became his *Foundation* (1951) series of novels. Because fictional jump drives turn long flights into direct hops, allowing ships to disappear from one place and reappear in another, they facilitate storytelling without interrupting it. The reimagined

Battlestar Galactica uses the same kind of travel but calls the mechanisms "FTL drives." In the stories that began in a two-part miniseries in 2003 and became a weekly television series on the Sci Fi Channel from 2004 to 2009, robotic Cylons pursue human Colonists through the galaxy in a renewal of their long-standing war. The precise mechanism of FTL drives is never explained but several of its characteristics fuel dramatic tension. For instance, the imagined technology requires time to "spool up" before each jump, leaving the ships vulnerable while they wait. Moreover, ships can only jump certain distances each time. Cylon ships travel farther and more accurately than the Colonial ships they chase, an imbalance that builds suspense.

In the *Star Wars* universe, the creators postulate a hyperdrive, a computer-guided system that allows spacecraft to enter hyperspace at faster-than-light speeds and navigate to a successful exit at a distant destination. According to *The Star Wars Album*, a companion book copublished with the release of the first film in 1977, "the most stunning effect in Star Wars was the Millennium Falcon's jump into hyperspace" (Watson 55). The initial explanation ignores any technological rationale, focusing instead on the visual effects work that created the onscreen depiction. As the book revealed, "The secret to hyperspace jump was only semicomplex, but required months of tedious camera work. The camera was used to film a backdrop of outer space dotted with stars. The film was shot one frame at a time, moving the camera and the backdrop simultaneously after each shot" (55). The result, as the unabashedly promotional book explains, "was so dazzling that audiences all over unanimously break into cheers each time it's seen" (55). In *Star Wars* and the subsequent films in this universe, the hyperdrive computer illustrates Straczynski's "speed of plot" trope well. The imagined technology is frequently unreliable—or disabled—at key junctures in ways that added drama. Like the warp drives in *Star Trek*, about which more detail developed as the franchise expanded, the backstory of *Star Wars*' hyperdrive has also been elaborated. *Solo: A Star Wars Story* (2018) reveals that the extensive navigational maps and rapid calculating ability of the *Millennium Falcon*'s hyperdrive computer are actually the downloaded memories of L3–37, a spirited and female-identified droid pilot. Although *Star Wars* emphasizes archetypal adventures over technological details, at least three different books have recently addressed the real science illustrated in the *Star Wars* universe (Cavelos; Brake and Chase;

Johnson). Such volumes represent a robust publication category of "The Science of. . ." books that leverage popular culture to educate readers.

In *Star Wars*, the hyperdrive exists within the spacecraft; in the years following the original film, two television shows suggested ways of jumping into hyperspace by means of external portals. For instance, the two-season program *Buck Rogers in the 25th Century* that aired between 1979 and 1981 shows interstellar travel being accomplished using stargates. Prompted by *Star Wars*' success, Universal revived the comic strip and radio characters from the 1920s but in the reimagining of the premise added an explicit explanation for how the spaceships accelerated. On screen, four lights appear in space arranged in a diamond shape indicating that the stargate has opened, offering access to hyperspace. A similar concept has a more physical presence in Straczynski's *Babylon 5*. In that show, external jumpgates create a physical infrastructure for generating stable vortices to hyperspace. In the show's five-season arc about the evolving relationships between various warring races, the devices represent neutral territory. Straczynski's show used computer-generated imaging to create complex effects. Four separate V-shaped struts float in space facing each other and generate a swirling vortex through which spacecraft can travel. In addition to cutting-edge effects, Straczynski's well-thought-out storytelling and compelling universe building lent the program enough credibility that NASA's Jet Propulsion Laboratory agreed to help design vehicles in his next show, *Crusade*.

The idea that artificial vortices could be created in space-time drew power from the volume of theoretical speculations published on the concept in technical and popular literature. In theory, a stable wormhole could become a conduit through space. Such a path would allow travelers to bypass longer routes just as a worm could chew through an apple rather than crawling along the peel. The idea of artificially manipulating or creating such interstellar byways as conduits from one part of a galaxy to another has great narrative potential. In the two-part premiere of *Star Trek: Deep Space 9* (syndication, 1993–99), for example, the revelation that the show's primary setting—a space station—is located near a stable wormhole immediately reframes the following action as deeply relevant to the interstellar traffic in that universe.

The real science behind the astronomy of black holes only solidified in 1967. Even as scientists debated the counterintuitive phenomenon, however, science fiction had already embraced it. In the *Star Trek* episode "Tomorrow Is Yesterday" (original airdate January 26, 1967), the *Enterprise* passes an unseen "black star," which pulls the starship back through time (Bartusiak 137). Although time machines remain a distinctly fictional technology, stories involving black holes often include time dilation. Einstein's theories—including special and general relativity—explain that a person traveling near a massive gravitational field experiences time more slowly. Drawing on that knowledge, the plot of director Christopher Nolan's *Interstellar* (2014) also employs time differences for dramatic purposes. The screenplay, cowritten with Nolan's brother, Jonathan, tells a complex story of humanity's attempts to save itself from ecological destruction through space travel. A key plot point revolves around the idea of time moving differently for characters who encounter the massive gravitational well of a rapidly spinning black hole near Jupiter.

Interstellar also represents a giant leap in visualizing such phenomena. Previously, the fictional conduits for interstellar travel appeared as swirling vortices, akin to waterspouts, tornados, or hurricanes set in space. To create the visual effects of the rapidly spinning black hole for *Interstellar,* however, scientist Oliver James and effects specialist Eugénie von Tunzelmann worked with the theoretical astrophysicist Kip Thorne. Because computerized visual effects also rely on mathematical expressions, Thorne gave the effects team his calculations to fuel their rendering. As Thorne describes it, the results were a revelation: "You cannot imagine how ecstatic I was when Oliver [James] sent me his initial film clips. For the first time ever—and before any other scientist—I saw in ultrahigh definition what a fast-spinning black hole looks like" (12). The black hole appears as a three-dimensional, spherical hole in space-time, drawing in all of the light around it. A flattened, ring-like accretion disk surrounds it. Recently, as the international Event Horizon Telescope project worked to compile an image of a real black hole, *Interstellar*'s fictional visualization shaped popular expectations. The scientists combined signals from eight telescopes around the globe to construct the first image of a real black hole. Before the public announcement in April 2019, however, the simulation that team members published in articles about their prospects greatly resembled *Interstellar*'s rendering

(Psaltis and Özel). When the final fuzzy donut image became public, reporters compared the scientific image with the fictional imagination (Mandelbaum). Such coverage illustrates the dialectic between current science and science fiction writing.

Although writers have been imagining travel to space-based destinations for hundreds of years, the use of faster-than-light travel as a narrative device remains relatively young. As the sound barrier disappeared and the space age dawned, writers began imagining methods to allow interstellar travelers to cross the immensity of space. Audiences also came to expect plausible explanations of faster-than-light travel in order to consider the stories credible. Examining stories about imagined space transportation technologies reveals how real and speculative science have both influenced and been driven by popular culture storytelling.

Note

1. Straczynski, who was an early user of Internet communication and bulletin boards to connect with fans, has repeated this joke in his Twitter feed, using the handle @straczynski. See also, "Traveling."

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Margaret A. Weitekamp is chair of the Space History Department at the Smithsonian's National Air and Space Museum and curator for the Social and Cultural History of Spaceflight collection. She is currently completing a new book project, a social and cultural history of space memorabilia.