

# Astronomy, Cosmology, and Space Travel

## Mysteries of the Universe Explained, Sort of

BY JESSICA TEISCH

**T**HE ALIENS ARRIVED on October 30, 1938, during Orson Welles's national radio broadcast of H. G. Wells's 19th-century novel *War of the Worlds*, a realistic dramatization of a Martian invasion of Earth.

Despite the reputed panic that ensued from this unplanned radio hoax, the Martian invasion never took place—and the search for extraterrestrial life continues. But 80 years after Welles's broadcast, discovering other habitable planets (by “them,” or by “us”) remains a tricky proposition that depends on many unknowns, including the prevalence of life in the galaxy and sheer luck.

As recent missions to Mars have shown, space exploration is extremely complicated, and our understanding of space, time, and the multitudes beyond our own universe is rather uncertain. “We are,” concludes theoretical physicist and string theorist Brian Greene, “most definitely, still wandering in the jungle.”

If the idea of space travel, black holes, quarks, or time traveling in more than one direction is baffling, don't despair. The universe explained through the eyes of an astronomer, astrophysicist, astronaut, or science journalist is a fascinating place, and a good, popular science book intended for the lay reader can provide an excellent glimpse of that world—or worlds. Here we offer some suggestions.

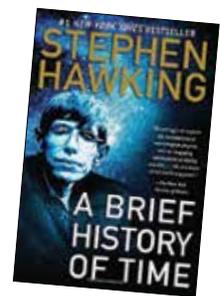
## COSMOLOGY AND THE ORIGINS OF THE UNIVERSE

### A Brief History of Time

From the Big Bang to Black Holes

By Stephen Hawking (1988)

Yes, we must start here. A touchstone of popular science writing, Hawking's number-one *New York Times* best seller explores the origin, structure, development, and directions of the universe, while asking questions about space and time, gravity, general relativity, quantum mechanics, and the uncertainty principle. Throughout, Hawking—English theoretical physicist and cosmologist extraordinaire—reviews all the great theories of the cosmos, from Galileo to Einstein. He hoped, he wrote, to facilitate “the discussion of the question of why it is that we and the universe exist. If we find the answer to that, it would be the ultimate triumph of human reason—for then we would know the mind of God.” Hawking refined some of his ideas in future editions to reflect questions today's physicists ad-



dress. For a layperson's place to start, *A Brief History of Time* remains "a succinct, entertaining and brilliantly lucid account of our relationship with the universe" (*Guardian*). See also: *The Universe in a Nutshell* (2001) and, if you read nothing else, the 176-page *An Even Briefer History of Time* (written with physicist Leonard Mlodinow, 2005).

## Cosmos

By Carl Sagan (1980)

◆ HUGO AWARD FOR BEST NONFICTION BOOK

Like Hawking, Sagan is one of the best science communicators—not to mention one of the first celebrity scientists of our era. He wrote *Cosmos* (surpassed in popularity only by Hawking's book) to accompany the acclaimed 13-part PBS television series

*Cosmos: A Personal Voyage*. In a conversational tone, Sagan reminds readers that "we are all star stuff," as he situates us in a world infinitely larger than the world itself (one that may include extraterrestrial life: see his 1995 science fiction novel *Contact*). Starting with antiquity and covering topics anthropological, cosmological, biological, historical,

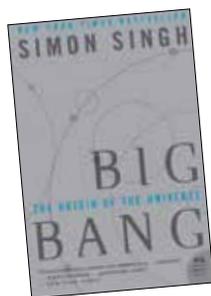
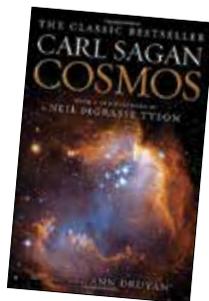
and astronomical in nature, Sagan presents his views on everything, from the development of science and civilization to the future of the cosmos. Some of the material may seem dated, but as James Michener wrote in the *New York Times Book Review*, it is "a cleverly written, imaginatively illustrated summary of his ... ruminations about our universe." Simply put, Sagan reminds us why science matters. Sequel: *Pale Blue Dot: A Vision of the Human Future in Space* (1994).

## Big Bang

**The Origin of the Universe**

By Simon Singh (2004)

If you find Hawking slightly heavy on the physics, try Singh's more people-driven approach. Written with a nod to Sagan, Singh tells the story of the universe's origins—not a new one, but one well told through the philosophers and scientists who, over 2,000 years, discarded, accepted, and built on each other's theories. Singh introduces us to the movers and shakers of cosmology, from ancient Greek philosophers who believed in a changeless universe to modern-day



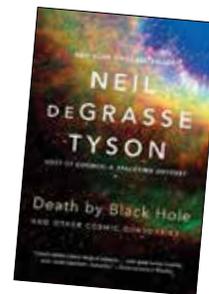
"mavericks of the cosmos." Einstein's theories of relativity contributed to our knowledge, as did contributions from lesser-known scientists like Henrietta Leavitt, who, in 1912, developed a way to measure galactic distances. At heart, *Big Bang* illustrates how scientific theories are tested, rejected, and accepted. "Singh is a very gifted storyteller," wrote the *Independent*. "Abstract entities are infused with character, such as the luminiferous ether, a strange substance that was once thought to be all over the universe, conducting light." (★★★★ May/June 2005)

## Death by Black Hole

**And Other Cosmic Quandaries**

By Neil deGrasse Tyson (2007)

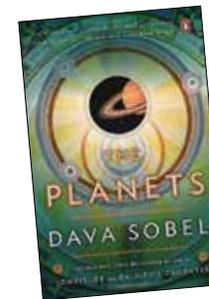
It was hard deciding which of Tyson's books to highlight, so we opted for breadth. Tyson, the director of New York City's Hayden Planetarium, claims Sagan as his mentor, which shows in these essays—by turns humorous, informative, and fascinating. Host of the documentary television series *Cosmos: A Spacetime Odyssey*, a successor to Sagan's series, and host of the *StarTalk* podcast, Tyson guides readers through mysteries of the universe and beyond: what would happen if you fell into a black hole, the conditions necessary for life to evolve in a planetary system, the collision of science and religion, the astronomical gaffes in Hollywood films, and intelligent design. "Readers of *Natural History* magazine will be familiar with many of the 42 essays collected here," wrote *Publishers Weekly*, "while newcomers will profit from Tyson's witty and entertaining description of being pulled apart atom by atom into a black hole, and other, closer-to-earth, and cheerier, topics." See also: *Origins: Fourteen Billion Years of Cosmic Evolution* (2004), *Astrophysics for People in a Hurry* (2017), and *The Pluto Files: The Rise and Fall of America's Favorite Planet* (2008).



## The Planets

By Dava Sobel (2005)

A former science reporter, Sobel pays homage to each member of the solar system by drawing on astronomy, poetry, mythology, history, and pop culture. While "Jupiter" meditates on astrology, "Sun" reflects the Genesis account of creation, and "Mars" is written from the perspective of a Martian meteorite found in Antarctica. The planets are, Sobel writes, "precious gems in a little private cabinet of wonder—portable, evocative, and swirled in beauty." "For newcomers to planetary astronomy," noted the *New York Times*, "*The Planets* offers a nimble summary of the latest findings on each planet's features and geology. For those who avidly followed the journeys of the Mari-



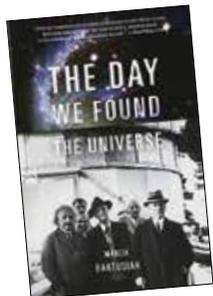
ners, Voyagers and Vikings through interplanetary space, it lets us fall in love with the heavens all over again.” See also: *The Glass Universe: How the Ladies of the Harvard Observatory Took the Measure of the Stars* (★★★★ Mar/Apr 2017) and *Galileo’s Daughter: A Historical Memoir of Science, Faith, and Love* (1999).

## The Day We Found the Universe

By Marcia Bartusiak

◆ HISTORY OF SCIENCE SOCIETY’S DAVIS PRIZE

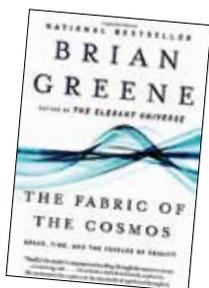
In this people-oriented book, Bartusiak, an award-winning science writer, tells the incredible story behind the discovery that expanded our understanding of the universe far beyond the Milky Way: Edwin Hubble’s 1925 finding of our expanding universe. Hubble immediately became famous, but as Bartusiak explains, his discovery built upon evolving knowledge, from Henrietta Leavitt’s study of variable stars to Harlow Shapley’s position of the Earth within the Milky Way. Bartusiak charts the beginning of modern astronomy and its key players, insights, missed opportunities, technology, and research. “A science writer of rare gifts. . . . Bartusiak manages to convey the mind-bending complexity of the astronomers’ task . . . while never losing sight of the human elements” (*San Francisco Chronicle*). See also: *Einstein’s Unfinished Symphony: The Story of a Gamble, Two Black Holes, and a New Age of Astronomy* (2017) and *Through a Universe Darkly: A Cosmic Tale of Ancient Ethers, Dark Matter, and the Fate of the Universe* (1993).



## The Fabric of the Cosmos

By Brian Greene (2004)

Don’t let scary ideas deter you, because Greene, a theoretical physicist, mathematician, and string theorist at Columbia University, explains complex concepts using analogies from everyday life, from Larry King and Homer Simpson to earthworms. Guiding us through Newton’s experiments and Einstein’s ideas about relativity and M-theory, Greene argues that our universe remains a big mystery. It’s a world of superstrings: tiny membranes that vibrate in 10 different dimensions, link black matter, and suggest the existence of theoretically countless universes. Mind boggling? It should be. “We are,” Greene concludes, “most definitely, still wandering in the jungle”—one where time and space may have little or no meaning. Greene’s dazzling overview of physical reality is aimed at general readers, and his enthusiasm and “excitement for science on the threshold of vital breakthroughs,” noted the *New York Times*, “is supremely contagious.” See also: *The Elegant Universe: Superstrings,*



*Hidden Dimensions, and the Quest for the Ultimate Theory* (1999) and *The Hidden Reality: Parallel Universes and the Deep Laws of the Cosmos* (2011). (★★★★ SELECTION May/June 2004)

## Further Reading

**BLACK HOLES AND TIME WARPS: EINSTEIN’S OUTRAGEOUS LEGACY** | KIP THORNE (1994)

**365 STARRY NIGHTS: AN INTRODUCTION TO ASTRONOMY FOR EVERY NIGHT OF THE YEAR** | CHET RAYMO (1982)

**COMING OF AGE IN THE MILKY WAY** | TIMOTHY FERRIS (1988)

**THE HUBBLE COSMOS: 25 YEARS OF NEW VISTAS IN SPACE** | DAVID H. DEVORKIN (2015)

**A UNIVERSE FROM NOTHING: WHY THERE IS SOMETHING RATHER THAN NOTHING** | LAWRENCE M. KRAUSS (2012)

**THE ACCIDENTAL UNIVERSE: THE WORLD YOU THOUGHT YOU KNEW** | ALAN LIGHTMAN (2013)

**BEYOND EINSTEIN: THE COSMIC QUEST FOR THE THEORY OF THE UNIVERSE** | MICHIO KAKU (1987)

**THE PARTICLE AT THE END OF THE UNIVERSE: HOW THE HUNT FOR THE HIGGS BOSON LEADS US TO THE EDGE OF A NEW WORLD** | SEAN CARROLL (2012)

**SEVEN BRIEF LESSONS ON PHYSICS** | CARLO ROVELLI (★★★★ July/Aug 2016)

## SPACE EXPLORATION HISTORY AND TRAVEL

### Packing for Mars

**The Curious Science of Life in the Void**

By Mary Roach (2010)

In case you thought life in space was a picnic, think again. As popular science writer Roach discovers via a variety of bizarre space simulators here on Earth, problems abound. Everything, from eating and drinking, going to the bathroom, basic hygiene, and solid waste management to keeping astronauts alive, is far more complicated in zero gravity far from home. Roach explains these bodily function issues one by one, with hilarious and enlightening digressions into the laboratories of the many earthbound scientists who made astronaut life possible. She also delves seriously into the physiological and psychological effects of spaceflight and the ways in which astronauts, doctors, and engineers prepare to meet such challenges. “Packing for Mars, Roach has shown, can be entertaining here on Earth,” wrote the *New York Times*. “But no way are humans ready to make the actual trip.” (★★★★ Nov/Dec 2010)



## Lost Moon

### The Perilous Voyage of Apollo 13

By Jim Lovell and Jeffrey Kluger (1994)

If you're looking for a true-life thriller, this is it. Lovell, commander of Apollo 13, dramatically recalls NASA's nearly catastrophic fifth moon mission in 1970. The world held its breath as, 55 hours into the mission, an oxygen tank explosion aboard the spacecraft left its astronauts—Lovell, Fred Haise, and John Swigert—with little power and only two hours' supply of oxygen. As Mission Control in Houston aborted the lunar landing and tried to reposition the spacecraft back to Earth, the astronauts jumped ship into the lunar excursion module (a space lifeboat) before returning to the command module and crash-landing in the Pacific. In this race against time, anything could have gone wrong—and the three men would have been entombed in a spacecraft destined to orbit, and reorbit, the Earth. "This is a gripping and frightening book that commands rapt attention," wrote *Publishers Weekly*. It's no wonder that Ron Howard and Tom Hanks made a blockbuster movie based on this terrifying drama.

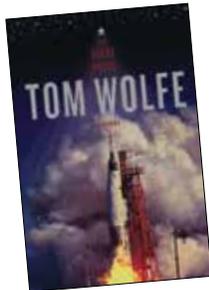


## The Right Stuff

By Tom Wolfe (1979)

- ◆ AMERICAN BOOK AWARD
- ◆ NATIONAL INSTITUTE OF ARTS AND LETTERS HAROLD VURSELL AWARD
- ◆ COLUMBIA JOURNALISM AWARD

"America's nerviest journalist" (*Newsweek*) first became interested in the U.S. space program—and the space race—when he covered the launch of NASA's moon mission, Apollo 17, in 1972. *The Right Stuff* delves into the risks, ambitions, achievements, failures, and politics of this endeavor. Inserting himself headlong into the story of the Mercury astronauts, the test pilots, and the space race of the 1950s, Wolfe concludes that these men needed *the right stuff*—the capacity to triumph over "a seemingly infinite series of tests ... the idea was to prove at every foot of the way up that pyramid that you were one of the elected and anointed ones who had *the right stuff* and could move higher and higher." "Wolfe's depiction of these intensely competitive men—who worried more about making a pilot error than that their rockets might explode, and who were more concerned about the respect of their peers than the adulation of the public—makes the Mercury seven more human, while in no way diminishing our admiration for their courage" (*New York Times*).

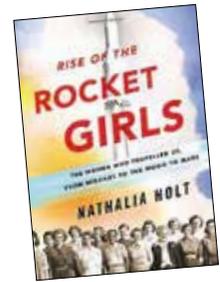


## Rise of the Rocket Girls

### The Women Who Propelled Us, from Missiles to the Moon to Mars

By Nathalia Holt (2016)

News: it wasn't all men's doings. Many of us are vaguely familiar with the brilliant American scientists and mathematicians—the "rocket men"—who, in the 1940s, worked at NASA's Jet Propulsion Laboratory in Pasadena, California. But when Holt, a biologist and science writer, started to investigate, she found that even NASA was hard pressed to identify their female employees in archival photographs. Based on extensive research and interviews, *Rise of the Rocket Girls* honors the young, female, human "computers" who, denied other jobs as physicists or mathematicians, solved the math behind the men's rocket science. Holt follows their successes and failures, frustrations and challenges, and dual responsibilities at home and at work, as the U.S. space program took shape. While peppering her story with histories of divorce law and the Pill, oxidizers and experimental fuels, Holt illuminates a pivotal moment in American history from a perspective never before told. "Illuminating," wrote *USA Today*. "[T]hese women are vividly depicted at work, at play, in and out of love, raising children—and making history. What a team—and what a story!"



## A Man on the Moon

### The Voyages of the Apollo Astronauts

By Andrew Chaikin (1994)

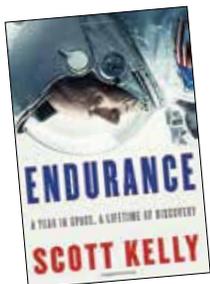
Released upon the 25th anniversary of the first lunar landing on July 20, 1969, Chaikin's book examines NASA's Apollo program. A science journalist and space historian, Chaikin interviewed 23 of the 24 of the Apollo astronauts—including Buzz Aldrin and Neil Armstrong—and their words give his book a rare immediacy. He also relays conversations from recently declassified transcripts from the on-board voice recorders. The result is a comprehensive, in-depth look at the space program, its historical context, and, most of all, the experiences of its key lunar players. "Even readers who followed the moon program at the time will find surprises (Buzz Aldrin's celebrating communion after the first lunar lander touched down) as well as nostalgic reminders of how much fun it was (Alan Shepard's smuggling along golf balls and a club head to try a few swings in lunar gravity)," wrote *Kirkus*. "Essential reading for anyone interested in the history of space flight: well written, full of fascinating characters and facts, and above all worthy of its subject."



## Endurance

**A Year in Space, A Lifetime of Discovery**  
By Scott Kelly, with Margaret Lazarus Dean (2017)

Kelly, who commanded the International Space Station on three different expeditions, spent almost a year on the ISS in 2015 and 2016, a zero-gravity journey of “unprecedented” duration whose purpose was to understand the long-term physical and mental risks of space travel. In this honest, insightful memoir, Kelly chronicles his personal development, from a blue-collar New Jersey child fascinated with Wolfe’s *The Right Stuff* (qualities he admittedly initially lacked) to a naval test pilot and astronaut. While lauding his comradeship with the Russians on board as well as his adventures living and conducting science experiments in the capsule (including attempting to grow fresh produce for future expeditions to Mars), Kelly reveals the daily risks of dust, lost bone mass, carbon dioxide buildup, social isolation, and more. “*Endurance* is filled with minutiae on the ISS’s modules and equipment, which space aficionados will probably lap up, yet it remains a fascinating read,” wrote Marcia Bartusiak in the *Washington Post*.



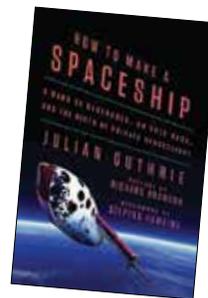
## How to Make a Spaceship

**A Band of Renegades, an Epic Race, and the Birth of Private Spaceflight**  
By Julian Guthrie (2016)

Finally, for the aspiring-but-unconventional astronaut: NASA doesn’t fund all space flight. Guthrie, a journalist, chronicles the path of Peter Diamandis, the entrepreneur who initiated the privatization of space travel. His Ansari X

Prize offered a \$10 million reward to the first privately financed team that could build and launch a manned spacecraft twice in two weeks.

Guthrie follows the entrepreneurs, designers, and aviators involved, while recording the setbacks, triumphs, and obsessions for the 26 teams competing. (The prize was won in 2004 by Burt Rutan and financed by Microsoft cofounder Paul Allen.) Guthrie writes with a dramatic, here-and-now flair, while weaving in scientific fact. Is commercial space flight intriguing? Yes. Is it a pipe dream? Perhaps. “*How to Make a Spaceship* offers a rousing anthem to the urge to explore,” wrote the *Wall Street Journal*. “But with access to orbit absurdly expensive and chemical fuels seemingly already maxed out—no contemporary rocket engine differs substantially from those used in the moon race—grand ambitions won’t make sense until there is a new way to place pounds into orbit.” Sorry.



## Further Reading

- THE ASTRONAUT WIVES CLUB** | LILY KOPPEL (2013)
- RETURN TO EARTH** | BUZZ ALDRIN WITH WAYNE WARGA (1973)
- HIDDEN FIGURES: THE AMERICAN DREAM AND THE UNTOLD STORY OF THE BLACK WOMEN MATHEMATICIANS WHO HELPED WIN THE SPACE RACE** | MARGOT LEE SHETTERLY (2016)
- MOON SHOT** | ALAN SHEPARD AND DEKE SLAYTON (1994)
- SPACE CHRONICLES: FACING THE ULTIMATE FRONTIER** | NEIL DEGRASSE TYSON AND AVIS LANG (2012)
- SALLY RIDE: AMERICA’S FIRST WOMAN IN SPACE** | LYNN SHERR (2014)
- AN ASTRONAUT’S GUIDE TO LIFE ON EARTH** | CHRIS HADFIELD (2013)
- RIDING ROCKETS: THE OUTRAGEOUS TALES OF A SPACE SHUTTLE ASTRONAUT** | MIKE MULLANE (2006)
- MAKING CONTACT: JILL TARTER AND THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE** | SARAH SCOLES (2017)
- CHASING SPACE: AN ASTRONAUT’S STORY OF GRIT, GRACE, AND SECOND CHANCES** | LELAND MELVIN (2017)
- THE SKY BELOW: A TRUE STORY OF SUMMITS, SPACE, AND SPEED** | SCOTT PARAZYNSKI (2017)
- THE CASE FOR MARS: THE PLAN TO SETTLE THE RED PLANET AND WHY WE MUST** | ROBERT ZUBRIN (1996)
- CARRYING THE FIRE: AN ASTRONAUT’S JOURNEYS** | MICHAEL COLLINS (1974) ■

