

# Preface

Astronomers have studied the heavens for more than two millennia, but in the twentieth century, humankind ventured off planet Earth into the dark vacuum void of space, forever changing our perspective of our home planet and on our relationship to the universe in which we reside.

Our explorations of space—the final frontier in our niche in this solar system—first with satellites, then robotic probes, and finally with humans, have given rise to an extensive space industry that has a major influence on the economy and on our lives. In 1998, U.S. space exports (launch services, satellites, space-based communications services, and the like) totaled \$64 billion. As we entered the new millennium, space exports were the second largest dollar earner after agriculture. The aerospace industry directly employs some 860,000 Americans, with many more involved in subcontracting companies and academic research.

## Beginnings

The Chinese are credited with developing the rudiments of rocketry—they launched rockets as missiles against invading Mongols in 1232. In the nineteenth century William Congrieve developed a rocket in Britain based on designs conceived in India in the eighteenth century. Congrieve extended the range of the Indian rockets, adapting them specifically for use by armies. Congrieve's rockets were used in 1806 in the Napoleonic Wars.

## The Birth of Modern Space Exploration

The basis of modern spaceflight and exploration came with the writings of Konstantin Tsiolkovsky (1857–1935), a Russian mathematics teacher. He described multi-stage rockets, winged craft like the space shuttle developed in the 1970s, space stations like Mir and the International Space Station, and interplanetary missions of discovery.

During the same period, space travel captured the imagination of fiction writers. Jules Verne wrote several novels with spaceflight themes. His book, *From the Earth to the Moon* (1865), describes manned flight to the Moon, including a launch site in Florida and a spaceship named Columbia—the name chosen for the Apollo 11 spaceship that made the first lunar landing in July 1969 and the first space shuttle, which flew in April 1981. In the twentieth century, Arthur C. Clarke predicted the role of communications satellites and extended our vision of human space exploration while

television series such as *Star Trek* and *Dr. Who* challenged the imagination and embedded the idea of space travel in our culture.

The first successful test of the V-2 rocket developed by Wernher von Braun and his team at Peenemünde, Germany, in October 1942 has been described as the “birth of the Space Age.” After World War II some of the Peenemünde team under von Braun came to the United States, where they worked at the White Sands Missile Range in New Mexico, while others went to Russia. This sowed the seeds of the space race of the 1960s. Each team worked to develop advanced rockets, with Russia developing the R-7, while a series of rockets with names like Thor, Redstone, and Titan were produced in the United States.

When the Russians lofted Sputnik, the first artificial satellite, on October 4, 1957, the race was on. The flights of Yuri Gagarin, Alan Shepard, and John Glenn followed, culminating in the race for the Moon and the Apollo Program of the 1960s and early 1970s.

### **The Emergence of a Space Industry**

The enormous national commitment to the Apollo Program marked a new phase in our space endeavors. The need for innovation and technological advance stimulated the academic and engineering communities and led to the growth of a vast network of contract supporters of the aerospace initiative and the birth of a vibrant space industry. At the same time, planetary science emerged as a new geological specialization.

Following the Apollo Program, the U.S. space agency’s mission remained poorly defined through the end of the twentieth century, grasping at major programs such as development of the space shuttle and the International Space Station, in part, some argue, to provide jobs for the very large workforce spawned by the Apollo Program. The 1980s saw the beginnings of what would become a robust commercial space industry, largely independent of government programs, providing communications and information technology via space-based satellites. During the 1990s many thought that commercialization was the way of the future for space ventures. Commercially coordinated robotic planetary exploration missions were conceived with suggestions that NASA purchase the data, and Dennis Tito, the first paying space tourist in 2001, raised hopes of access to space for all.

The terrorist attacks on the United States on September 11, 2001 and the U.S. recession led to a re-evaluation of the entrepreneurial optimism of the 1990s. Many private commercial space ventures were placed on hold or went out of business. Commentators suggested that the true dawning of the commercial space age would be delayed by up to a decade. But, at the same time, the U.S. space agency emerged with a more clearly defined mandate than it had had since the Apollo Program, with a role of driving technological innovation—with an early emphasis on reducing the cost of getting to orbit—and leading world class space-related scientific projects. And military orders, to fill the needs of the new world order, compensated to a point for the downturn in the commercial space communications sector.

It is against this background of an industry in a state of flux, a discipline on the cusp of a new age of innovation, that this encyclopedia has been prepared.

## Organization of the Material

The 341 entries in *Space Sciences* have been organized in four volumes, focusing on the business of space exploration, planetary science and astronomy, human space exploration, and the outlook for the future exploration of space. Each entry has been newly commissioned for this work. Our contributors are drawn from academia, industry, government, professional space institutes and associations, and nonprofit organizations. Many of the contributors are world authorities on their subject, providing up-to-the-minute information in a straightforward style accessible to high school students and university undergraduates.

One of the outstanding advantages of books on space is the wonderful imagery of exploration and achievement. These volumes are richly illustrated, and sidebars provide capsules of additional information on topics of particular interest. Entries are followed by a list of related entries, as well as a reading list for students seeking more information.

## Acknowledgements

I wish to thank the team at Macmillan Reference USA and the Gale Group for their vision and leadership in bringing this work to fruition. In particular, thanks to Hélène Potter, Cindy Clendenon, and Gloria Lam. My thanks to Associate Editors Nadine Barlow, Leonard David, and Frank Sietzen, whose expertise, commitment, and patience have made *Space Sciences* possible. My thanks also go to my husband, Julius, for his encouragement and support. My love affair with space began in the 1970s when I worked alongside geologists using space imagery to plan volcanological field work in remote areas of South America, and took root when, in the 1980s, I became involved in systematic analysis of the more than 3,000 photographs of Earth that astronauts bring back at the end of every shuttle mission. The beauty of planet Earth, as seen from space, and the wealth of information contained in those images, convinced me that space is a very real part of life on Earth, and that I wanted to be a part of the exploration of space and to share the wonder of it with the public. I hope that *Space Sciences* conveys the excitement, achievements, and potential of space exploration to a new generation of students.

*Pat Dasch*  
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# Volume 2 Index

Page numbers in **boldface type** indicate article titles; those in *italic type* indicate illustrations. A cumulative index, which combines the terms in all volumes of Space Sciences, can be found in volume 4 of this series.

## A

- Acceleration, law of, 119  
Action and reaction, law of, 119  
Active galaxies, 53–54, *54*  
Adams, John, 116  
Adaptive optics, in telescopes, 122  
Adler Planetarium, 140  
Advanced degrees, in astronomy, 17–18  
Advanced Satellite for Cosmology and Astrophysics (ASCA), 13  
Aerobraking, 45–46  
Air resistance, gravity and, 63  
Aldrin, Edwin E. Jr. “Buzz,” 42, 193–194  
Allen telescope array, 178  
ALMA (Atacama Large Millimeter Array), 126  
Alpha Centauri, 170  
Alpha proton X-ray spectrometer, 162  
Alvarez, Louis, 25  
Alvarez, Walter, 25  
Amalthea (Moon), 92, 175  
Amateur astronomers, 8  
American Astronomical Society, 19  
Andromeda, 54, 56  
Antimatter, 129  
Antiope (Asteroid), 4  
Apollo, 142, 191–192, 193–194  
    humans on Moon, 42  
    robotics and, 160  
Arecibo radio telescope, 171  
Ares Vallis, 45  
Ariane rocket, 59  
Arianespace, 59  
Ariel (Moon), 212  
Aristotle  
    geocentric system, 9  
    on gravity, 63  
Armstrong, Neil, 42, 193–194  
Arrays, 121, 121*t*, 124*t*  
    Atacama Large Millimeter Array, 126  
    SETI use of, 178  
Artemis satellites, 59  
ASCA (Advanced Satellite for Cosmology and Astrophysics), 13  
Association of Science and Technology Centers, 142  
Asteroids, **3–7**, 4, 5, 6  
    classification of, 176–177  
    close encounters with, 23–30, 24, 26, 29  
    from meteorites, 105–106  
    Near Earth asteroids, 6  
    near Earth space and, 185  
Astrobiology, 22  
Astrology, *vs.* astronomy, 8  
Astrometry, 50  
Astronomers, **7–9**, 8, 21  
    *See also* specific names  
Astronomical units, 23, 176, 221  
Astronomy  
    careers in, **16–20**, 17  
    history of, **9–10**  
    kinds of, **10–14**, 11, 12*t*  
    optical, 120  
Astrophysics, 17  
Atacama Large Millimeter Array (ALMA), 126  
Atlantis, 128  
Atmosphere  
    of Earth, 10–11, 38  
    of Jupiter, 77  
    of Neptune, 115  
    of Pluto, 149–150  
    of Saturn, 164  
    of Triton, 117  
Atmospheric probes, 154  
Auger, Pierre, 31  
Auroras, 180

## B

- Baade, Walter, 153  
Bachelor’s degrees, in astronomy, 19  
Bacon, Roger, 190  
Ballistic missiles, 108, 192  
Basalt, in planetary crust, 38  
Beidou Navigation Test Satellite-1, 61  
Bell, Jocelyn, 151  
Big Bang theory, 32–33  
    cosmic microwave background radiation and, 131  
    evidence for, 14  
    Hubble, Edwin P. and, 1  
Biomedicine, 21–22  
BL Lac objects, 54  
Black dwarf stars, 200  
Black holes, *15*, **15–16**  
    Chandra X-Ray Observatory and, 130  
    collisions of, 16  
    for galaxy energy, 54  
    Hawking radiation and, 34  
    Heavy stars and, 15–16  
    Hubble Space Telescope on, 73  
    study of, 200  
Blazars, 129  
Boeing Cyberdome, 141  
Borrelly nucleus, 28  
Brahe, Tycho, 81  
Brazil, space program in, 62  
*A Brief History of Time* (Hawking), 34  
Brightness measurements, 148  
*Brilliant Pebbles* (Defense system), 109

- Brown dwarf stars, 13, 130  
 Brownian motion, 39  
*The Buck Moon* (Hale), 191  
 Buhl Planetarium, 140  
 Buses (Spacecraft), **188–189**  
 Bush, George H.W., 109  
 Bush, George W., 109  
 Butler, Paul, 48
- C**
- C-type asteroids, 4  
 Callisto, 76, 80  
 Canada, space program of, 61  
 Canadian Space Agency, 61  
 Carbonate minerals  
   on Mars, 96  
 Careers  
   in astronomy, **16–20**, 17  
   in space sciences, **20–22**, 21  
 Carnegie Space Center, 140  
 Cassini, 46, 145, 158, 159, 168  
 Cassini, Giovanni Domenico, **23**  
 Cassini Division, 23  
 Cassini Program, 23, 46, 75  
 Cat's Eye Nebula, 72  
 Cepheid variables, 1, 2, 55, 56, 67, 173  
 Ceres (Asteroid), 4  
 CGRO (Compton Gamma Ray Observatory), 129–130  
 Chandra X-Ray Observatory, 11, 13, 129–130, 130, 131  
 Chandrasekhar, Subrahmanyan, 129  
 Charon (Moon), 148–149  
 Chassignites, 96  
 Chicxulub Crater, 25, 29  
 China, space program in, 60, 61, 62  
 CHON (Comet composition)  
   29  
 Clarke, Arthur C., 137  
   spaceguard surveys and, 26  
 Clarke orbits, 137, 182  
 Clementine (Project), 45  
 Close encounters, **23–26**, 24, 26, 55  
 Clouds, 37, 38  
 COBE (Cosmic Background Explorer), 131  
 Cocconi, Giuseppe, 170  
 Colleges, space science employees in, 22  
 Collins, Michael, 193–194  
 Collisions, of black holes, 16  
   *See also* Cosmic impacts  
 Columbus space laboratory, 59  
 Comet Wild-2, 46  
 Comets, **27–30**, 28, 29  
   in Kuiper belt, **81–83**  
   near Earth collisions of, 24  
   in near Earth space, 185  
   orbits of, 136  
   Shoemaker-Levy 9, 174  
 Communications, 108  
 Composition, of comets, 28–29  
 Compton, Arthur Holly, 129  
 Compton Gamma Ray Observatory (CGRO), 129–130  
 Computer modeling, in astronomy, 18–19  
 Congrieve, William, 190  
*Contact* (Sagan), 163  
 Convection, 38, 107  
 Copernicus, Nicholas, 7, 9, **30**, 57  
 Coronal holes, 220  
 Coronal mass ejections, 178, 179, 186, 220  
 Corrective Optics Space Telescope Axial Replacement (COSTAR), 70  
 Cosmic Background Explorer (COBE), 131  
 Cosmic impacts, 23–27, 24, 26, 29, 36–37  
 Cosmic microwave background, 33  
 Cosmic microwave background radiation, 131  
 Cosmic origins spectrograph, 71  
 Cosmic rays, **30–32**  
 Cosmological constant, 33–34  
 Cosmology, **32–35**, 33  
   evidence in, 14  
   heliocentric system of universe, 9  
   Hubble, Edwin P and, 14  
   *See also* Big Bang theory  
*Cosmos* (Sagan), 163  
 COSTAR (Corrective Optics Space Telescope Axial Replacement), 70  
 Crab Nebula, 152, 153  
 Crash-landers, 154  
 Craters  
   impact, 24, 95, 105–106, 118, 216, 217  
   lunar, 142–143  
 Crust, of Earth, 37–38  
 Curtis, Heber, 173
- D**
- Dark matter  
   Chandra X-Ray Observatory and, 130  
   of galaxies, 50  
 Data assistants, 19  
 Dating methods. *See* specific names of methods  
*De revolutionibus orbium coelestium* (Copernicus), 30  
 Debris, space, **182–183**, 183  
 Deep Space I, 46  
 Defense, from Near Earth objects, 186  
 Defense Meteorological Satellite Program, 108–109  
 Defense Space Communication System, 108  
 Deimos (Moon), 92, 175–176  
 Desaguliers, Thomas, 190  
*Dialogo sopra i due massimi sistemi del mondo* (Galileo), 57  
*Dialogue on the two great world systems* (Galileo), 57  
 Dinosaurs, cosmic impact and, 25  
 Discovery missions, 45, 128  
 DNA, extraterrestrial life and, 86  
 Doctoral degrees. *See* Ph.D.  
 Doppler technique, for extrasolar planets, 47–48  
 Dornberger, Walter, 192  
 Drake, Frank, 170, 170–171  
 Drake equation, 172  
 Duncan, Martin, 82  
 Dwarf ellipticals, 52
- E**
- Earth, **35–39**, 36, 37  
   astronomy careers and, 20–21  
   electromagnetic spectrum in, 10–11, 12†  
   geocentric system and, 9  
   impact craters and, 24, 174  
   magnetosphere in, 181  
   meteorites on, 145  
   near Earth space, 183–184  
   orbits of, 182  
   planetary defense of, 186  
   *See also* Cosmic impacts; Low Earth Orbit  
 Earth Resources Observation Satellite, 62  
 Earthquakes, 37–38  
 Eclipses, solar, 202, 203  
 Education, in astronomy, 17–18  
 Einstein, Albert, 1, 2, 39, **39–40**, 73  
   on cosmological constant, 33–34  
   on special relativity, 31  
   as theoretical physicist, 15  
   *See also* General relativity