

**AERONAUTICS AND ASTRONAUTICS:
A CHRONOLOGY: 2008**

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Author: Marieke Lewis
Project Manager: Alice R. Buchalter
Federal Research Division, Library of Congress

NASA History Program Office
Public Outreach Division
Office of Communications
NASA Headquarters
Washington, DC 20546

PREFACE

This report is a chronological compilation of narrative summaries of news reports and government documents highlighting significant events and developments in U.S. and foreign aeronautics and astronautics. It covers the year 2008. These summaries provide a day-to-day recounting of major activities, such as administrative developments, awards, launches, scientific discoveries, corporate and government research results, and other events in countries with aeronautics and astronautics programs. Researchers used the archives and files housed in the NASA History Division, as well as reports and databases on the NASA Web site.

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JANUARY 2008

11 January

Alliant Techsystems of Edina, Minnesota, announced that Lockheed Martin Space Systems had awarded Alliant a contract to build electricity-generating solar arrays for NASA's *Orion* spacecraft. Because solar arrays are expendable, the contract, valued at over US\$50 million, could extend at least through 2020. NASA had designed *Orion* for use in human space exploration and for transporting crews and cargo to the International Space Station (ISS). NASA had chosen Lockheed as the lead contractor for the *Orion* program in summer 2007.¹

14 January

European Space Agency (ESA) scientists announced that the Ulysses spacecraft had made its fourth pass over one of the Sun's poles. Ulysses, engaged in an 18-year, ongoing joint mission operated by NASA and ESA, had completed an orbit of the Sun every 6.2 years. As it passed over the Sun's poles, Ulysses occupied a unique position enabling the craft to sample solar winds, a vantage point unavailable to any other spacecraft or Earth-based observatory. This most recent flyby of the Sun's north pole had occurred a week after scientists had observed the beginning of a new solar cycle. "This is a wonderful opportunity to examine the Sun's north pole within a transition of cycles," said Arik Posner, a NASA scientist for the Ulysses program.²

15 January

Thuraya Satellite Telecommunications, based in Abu Dhabi, successfully launched its Thuraya-3 satellite aboard Sea Launch's Zenit-3SL rocket, after a November 2007 delay caused by rough seas surrounding the launch site. The launch occurred at 11:49 (UT) from Sea Launch's platform in the Pacific Ocean. Boeing Satellite Systems had built the 11,381-pound (5,162-kilogram) satellite. Thuraya's owner planned for the satellite to come to rest at 98.5° east longitude, allowing the company to expand mobile-communication coverage into East Asia. The launch was the first for the California-based international consortium Sea Launch since a January 2007 disaster had disabled its launch vehicle.³

16 January

NASA announced that its Stratospheric Observatory for Infrared Astronomy (SOFIA) had passed the first round of flight-testing, after the craft successfully flew five times with its external door closed. The external door is a modification of the craft's 747SP fuselage. The craft's 10-foot (3-meter), 19-ton (38,000-pound or 17,237-kilogram) telescope would make observations through the door, collecting data that scientists would be able to use to study the birth and evolution of planets, stars, and galaxies. In addition to confirming SOFIA's aerodynamics, control, handling, stability, and structural integrity, the tests also assessed the

¹ *Salt Lake Tribune* (UT), "Alliant To Build Solar Panels for NASA," 11 January 2008; Erik Borg, "Alliance Gets \$50 M NASA Solar-Array Contract," *Minneapolis/St. Paul Business Journal* (MN), 11 January 2008.

² European Space Agency (ESA), "Ulysses at the North Pole," news release, 15 February 2008, http://www.esa.int/esaSC/SEMILLN3MDAF_index_0.html (accessed 17 December 2010); *Houston Chronicle*, "Ulysses Flies over Sun's North Pole," 15 January 2008.

³ Associated Press, "Satellite Launched from Ocean Platform," 16 January 2008; Peter B. de Selding, "Sea Launch Rocket Successfully Returns to Flight," *Space.com*, 15 January 2008, <http://www.space.com/missionlaunches/080115-sealaunch-thuraya3-liftoff.html> (accessed 14 December 2010); *Spacewarn Bulletin*, no. 651, 1 February 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx651.html> (accessed 6 December 2010).

telescope's tracking abilities. SOFIA, a joint partnership between NASA and the German Aerospace Center, was based at the Aircraft Operations Facility at Edwards Air Force Base, part of NASA's Dryden Flight Research Center (DFRC).⁴

17 January

Warner K. Dahm, the last of Wernher von Braun's German rocket team to retire from NASA, died at age 90 in Huntsville, Alabama. A German aerodynamics expert, Dahm had joined von Braun's program during World War II and had later come to the United States with his colleagues to assist in developing American rocketry. He had worked at NASA first as a member of the team for Operation Paperclip in Texas and later at NASA's Marshall Space Flight Center (MSFC). Over the years, Dahm had lent his expertise to the design of the V-2 and Wasserfall anti-aircraft rockets, the Redstone rocket, the Jupiter ballistic missile, Saturn 1, Saturn 1B, the Saturn-5 rocket that flew America's first astronauts to the Moon, Skylab, and the Space Shuttle Transportation System. In 2006, at the age of 89, he had retired from his position as Chief Aerodynamicist at Marshall. Dahm had received NASA's Exceptional Service Medal in 2003.⁵

18 January

NASA announced the appointment of Jaiwon Shin to replace Lisa J. Porter as NASA's Associate Administrator for the Aeronautics Research Mission Directorate. Porter, who had held the position since 2005, was leaving NASA to become the first Director of the Intelligence Advanced Research Projects Activity. Her resignation would become effective on 1 February. Shin was serving as Deputy Associate Administrator for Aeronautics at the time of his new appointment. He had previously worked for NASA's LaRC and GRC, authoring more than 20 papers and receiving numerous professional awards. As Associate Administrator for the Aeronautics Research Mission, Shin would be responsible for guiding NASA's aeronautics research portfolio in areas such as the fundamental aeronautics of flight, aviation safety, and the national airspace system.⁶

At a ceremony during the opening of the Spirit of Innovation exhibition at NASA Headquarters in Washington, DC, NASA recognized the first winners of the Pete Conrad Spirit of Innovation Award, a national competition that challenges high school students to create concepts that advance the personal spaceflight industry. NASA's Innovative Partnership Program sponsored the US\$10,000 prize for the Conrad Award. The Spirit of Innovation exhibition would travel nationwide to highlight the students' achievements. The X Prize Foundation announced that, in addition, a scroll inscribed with the winners' names would travel to the ISS. Michael Hakimi and

⁴ NASA, "SOFIA Completes Closed-Door Test Flights," news release 08-010, 16 January 2008, http://www.nasa.gov/home/hqnews/2008/jan/HQ_08010_SOFIA_Flight_Series_End.html (accessed 7 December 2010).

⁵ *Huntsville Times* (AL), "Von Braun Cohort Dahm Dies," 19 January 2008; Mike Marshall, "German Engineer Was Last of Team at NASA," *Huntsville Times* (AL), 21 January 2008; John Johnson Jr., "Werner K. Dahm, 90; German Aerodynamics Expert Developed Rockets for the U.S. Army and NASA," *Los Angeles Times*, 23 January 2008.

⁶ NASA, "Aeronautics Associate Administrator Departs NASA for New Position," news release 08-002, 9 January 2008, http://www.nasa.gov/home/hqnews/2008/jan/HQ_08002_Porter_Leaves_NASA.html (accessed 30 December 2010); NASA, "NASA Selects Jaiwon Shin To Head Aeronautics Research," news release 08-014, 18 January 2008, http://www.nasa.gov/home/hqnews/2008/jan/HQ_08014_shin_aero.html (accessed 30 December 2010).

Talia Nour-Omid had won the Conrad award in October 2007 for the innovation of a device that could effectively monitor all of an astronaut's vital signs.⁷

21 January

Israel's state-owned Israel Space Industries (ISI) successfully launched a military reconnaissance satellite aboard an Indian Polar Satellite Launch Vehicle from the Sriharikota test site in India at 03:45 (UT). The 300-kilogram (661-pound) satellite TechSAT, or Polaris, carried a Synthetic Aperture Radar (SAR) developed by ISI's subsidiary Elta Systems. The SAR had the capability of producing 1-meter (3-foot) resolution images at all times of day and in all weather conditions. News media reported that Israel's Ministry of Defense, which had already assigned to the satellite a strategic-intelligence-gathering mission, would be the principal user of this technology—the first of its kind for Israel. The launch, repeatedly delayed because of weather and technical problems, marked the first satellite collaboration between Israel and India.⁸

23 January

NASA's Langley Research Center (LaRC) announced that it had selected four companies to compete to supply its orders for developmental test hardware and aerospace model systems for use in ground tests, flight tests, space exploration, and spaceflight. NASA had designated the contracts, which would have a cumulative maximum value of US\$30 million over five years, as awards for reliance-consolidated models and for centralization of design and fabrication practices at NASA's Ames Research Center (ARC), Glenn Research Center (GRC), LaRC, and MSFC. The contract recipients were Advanced Technologies of Newport News, Virginia; ATK Micro Craft of Tullahoma, Tennessee; Tri Models of Huntington Beach, California; and Triumph Aerospace Systems—Newport News of Newport News, Virginia.⁹

25 January

A team of scientists led by Hope A. Ishii and John P. Bradley of the Lawrence Livermore National Laboratory announced in the journal *Science* that material they had analyzed from the comet Wild 2 more closely resembled the material composition of an asteroid than they had expected. Using Livermore's scanning transmission electron microscope SuperSTEM, the scientists had assessed a sample of the comet's tail—NASA's Stardust craft had gathered the sample in 2004. Scientists had long thought that primitive outer nebula material composed comets, so the Livermore team had expected to find an abundance of that material. However, they had found very little primitive outer nebula material, instead finding larger-than-expected quantities of the newer, inner solar nebula matter common in asteroids. The researchers pointed out that this surprising discovery emphasized that asteroids and comets do not comprise

⁷ Aero-News Network, "NASA, X Prize Foundation Recognize 2007 Pete Conrad Award Winners," 22 January 2008, <http://www.aero-news.net/index.cfm?ContentBlockID=c8a0d40b-5081-43b6-afcd-f2b876e7408b> (accessed 16 December 2010); NASA, "NASA and X Prize Foundation To Recognize Conrad Award Winners," news release M08-010, 16 January 2008, http://www.nasa.gov/home/hqnews/2008/jan/HQ_M08010_Xprize_HQ_M08010_Xprize_HQ_M08010_Xprize_Conrad_Award.html (accessed 16 December 2008).

⁸ Barbara Opall-Rome, "India Launches Israeli Radar Satellite," *Space.com*, 25 February 2008, <http://www.space.com/news/080122-sn-israel-india.html> (accessed 14 December 2010); *Spacewarn Bulletin*, no. 651.

⁹ NASA, "NASA Selects Companies for Design and Fabrication," news release C08-006, 23 January 2008, http://www.nasa.gov/home/hqnews/2008/jan/HQ_C0806_Contract_model_systems_and_test_hardware.html (accessed 17 December 2010).

distinctly different entities but, instead, exist along a continuum in regard to their material composition.¹⁰

26 January

NASA's ARC signed a memorandum for the record, expressing its intention to cooperate with the Korea Advanced Institute of Science and Technology (KAIST), the top research and education facility in South Korea. KAIST had launched South Korea's first satellite, Uribyeol 1, in 1992. The memorandum initiated a dialogue between the two institutions regarding potential collaboration on topics such lunar science, planetary exploration, and the research and development (R&D) of navigation systems, rovers, satellite communications, and small satellites.¹¹

30 January

The People's Republic of China's Commission of Science, Technology, and Industry for National Defense released the first photographs that China had captured of the Moon's polar regions. The 2,350-pound (1,066-kilogram) Chang'e-1 lunar probe had taken the photographs. Chang'e-1 had been orbiting the Moon at an altitude of 200 kilometers (124 miles) since 7 November 2007. On 4 January 2008, Chang'e-1's cameras had adjusted, enabling them to photograph areas of the Moon above 70° north or south latitude. China intended the probe to produce a three-dimensional lunar-surface survey and to provide data and images for use in other experiments.¹²

In the final planned spacewalk for the Expedition 16 mission aboard the ISS, Commander Peggy A. Whitson and Flight Engineer Daniel M. Tani successfully replaced the Bearing Motor Roll Ring Module, a motor on the starboard side of the ISS that had been malfunctioning since early December. The defect had caused the station's solar panels to fail to pivot toward the Sun, reducing the ISS's supply of electricity and threatening to compromise the ISS's ability to support future Shuttle missions. The 7-hour spacewalk suffered a minor setback when a communication failure left the astronauts briefly without direct contact with Mission Control in Houston. Because of the risk of electrical shock while in contact with the panels, Whitson and Tani had to perform the repair work carefully. They were only able to work during the 33-minute intervals when the Earth eclipsed the Sun during the ISS's rotation around the Earth. The astronauts completed the motor replacement in time to inspect an additional problem with the starboard solar panels—damage to gears from metal debris. Whitson and Tani collected samples of the debris to use in determining future repair plans.¹³

NASA announced that scientists had begun to analyze data returned from the Mercury Surface, Space Environment, Geochemistry, and Ranging (MESSENGER) spacecraft's 14 January 2008

¹⁰ John Johnson Jr., "NASA's Stardust Upends Comet Theory," *Los Angeles Times*, 25 January 2008; see also Hope A. Ishii et al., "Comparison of Comet 81P/Wild 2 Dust with Interplanetary Dust from Comets," *Science* 319, no. 5862 (25 January 2008): 447–450.

¹¹ NASA, "NASA Ames Explores Possible Collaboration with South Korea," news release 08_07AR, 28 January 2008, http://www.nasa.gov/centers/ames/news/releases/2008/08_07AR.html (accessed 17 December 2010).

¹² Xinhua News Agency, "Chang'e-1 Captures Pictures of Moon's Polar Areas," 31 January 2008, http://news.xinhuanet.com/english/2008-01/31/content_7532773.htm (accessed 14 December 2010).

¹³ Tariq Malik, "Spacewalkers Bring Space Station a Step Closer to Full Power," *Space.com*, 30 January 2008, <http://www.space.com/missionlaunches/080130-expedition16-eva5-wrap.html> (accessed 9 December 2008).

flyby of the planet Mercury. The craft, which had flown more than 2 billion miles (more than 3 billion kilometers) since its launch in 2004, had swooped down to 124 miles (200 kilometers) above the planet's surface, giving scientists the first close-up view of Mercury since Mariner 10's flyby in 1975. MESSENGER's seven data-collecting instruments had obtained 1,213 photographs depicting 30 percent of Mercury's surface, as well as making observations of the planet's magnetic field, mineral terrain, and exospheric tail. Among the most striking of the many findings from the photographs was a unique geographical feature, which the scientists dubbed "The Spider," a 25-mile-diameter (40-kilometer-diameter) impact crater in the Caloris basin, radiating over 100 flat-bottomed troughs. NASA intended MESSENGER to begin orbiting Mercury in 2011. Johns Hopkins University's Applied Physics Laboratory (APL) in Maryland had built MESSENGER and was managing the craft for NASA.¹⁴

FEBRUARY 2008

4 February

The Islamic Republic of Iran announced that it had launched a research rocket to celebrate the opening of its new space center in Semnan Province. The quasi-official Fars News Agency reported that Iran had launched the research rocket Kavoshgar 1 in advance of the anticipated launch of Iran's first domestically manufactured satellite. Although Iran did not announce the altitude that the rocket had reached, media reports stated that Iran had fired Kavoshgar 1 into space. Scientists generally consider that space begins at an altitude of approximately 60 miles (97 kilometers).¹⁵

5 February

Russia announced the launch of the uncrewed cargo ship Progress 28, also known as Progress M 63, aboard a Soyuz rocket at 13:02 (UT) from the Baikonur Cosmodrome in Central Asia. Progress 28 carried 2.5 tons (2,268 kilograms or 5,000 pounds) of supplies to the ISS, including 100 pounds (45 kilograms) of oxygen, 925 pounds (420 kilograms) of water, 1,165 pounds (528 kilograms) of rocket propellant, and approximately 2,925 pounds (1,327 kilograms) of food, clothing, and equipment. The previous cargo ship, Progress 27, had undocked from the ISS on 4 February 2008 in preparation for the arrival of Progress 28. Russia had planned to allow Progress 27 to fall to Earth and to burn up in the atmosphere.¹⁶

8 February

Robert Jastrow, one of NASA's founding administrators and a popular commentator on NASA's missions to the Moon, died from complications of pneumonia at the age of 82. Jastrow had spent his early career at Yale and at the U.S. Naval Research Laboratory. When NASA formed in 1958, Jastrow had become Chief of the Theoretical Division. In 1961 he had become Director of NASA's Goddard Institute for Space Studies (GISS), where he had worked on the Pioneer,

¹⁴ NASA, "NASA Spacecraft Streams Back Surprises from Mercury," news release 08-027, 30 January 2008, http://www.nasa.gov/home/hqnews/2008/jan/HQ_08027_Messenger_Mercury.html (accessed 24 November 2010); Warren E. Leary, "Pictures Reveal Mercury's Tumultuous Past," *New York Times*, 31 January 2008.

¹⁵ Nazila Fathi, "Iran Launches Rocket To Commemorate New Space Center," *New York Times*, 5 February 2008.

¹⁶ *Spacewarn Bulletin*, no. 652, 1 March 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx652.html> (accessed 28 December 2008); Tariq Malik, "New Cargo Ship Launches Toward Space Station," *Space.com*, 5 February 2008, <http://www.space.com/missionlaunches/080205-expedition16-progress28-launch.html> (accessed 30 December 2010).

Voyager, and Galileo probes. He had held positions at Columbia University and Dartmouth College before becoming chair of the Mount Wilson Institute in 1992. Jastrow had cofounded the George C. Marshall Institute in 1984 and still held the position of Chair Emeritus of the Institute at the time of his death. The public knew Jastrow well for his ability to explain science and space exploration in easily understood terms. Besides being a frequent guest on network television, he was the author of the 1967 best seller *Red Giants and White Dwarfs* and of the controversial *How To Make Nuclear Weapons Obsolete*—the 1985 defense of President Ronald W. Reagan’s Strategic Defense Initiative. Over the course of his career, Jastrow had received the NASA Medal for Exceptional Scientific Achievement, the Arthur S. Fleming Award for Outstanding Service to the U.S. Government, and the Columbia University Medal of Excellence.¹⁷

13 February

The House Committee on Science and Technology held its first hearing to review NASA’s proposed fiscal year (FY) 2009 budget request and FY 2008 Operating Plan. NASA Administrator Michael D. Griffin provided testimony in support of NASA’s US\$17.6 billion request, which would allocate US\$5.78 billion for Space Shuttle and ISS programs, US\$4.44 billion for science, US\$3.5 billion for development of new crewed spacecraft, and US\$447 million for aeronautics research. Griffin devoted much of his oral testimony to NASA’s request for an extension of a statutory waiver, which permits funding for payments to Russia for crew transport to the ISS. The current waiver had been a provision of the Iran, North Korea, and Syria Non Proliferation Act (Pub. L. No. 106-178, as amended). Griffin stated that NASA needed legislative authorization for the funding in 2008, because Russia required 36 months to fabricate new transport vehicles; therefore, NASA needed to finalize contractual agreements by late 2008, so that Russia could complete the vehicles by 2012.¹⁸

15 February

Judge Jeffery A. Malak, of Cook County, Illinois, declared James Stephen “Steve” Fossett legally dead after search-and-rescue missions failed to find the missing 63-year-old adventurer. Fossett had disappeared on 3 September 2007, never to return, after taking off in his single-engine airplane from a ranch near Yerington, Nevada. Fossett had not filed a flight plan. A wealthy retired commodities trader, Fossett had set more than 100 world records with his exploits. Among his other feats, he had won a 2002 record as the first person to fly alone around the world in a hot-air balloon; a 2005 record as the first airplane pilot to circumnavigate the globe without stopping to refuel; a 2006 record for nonstop distance flight in an aircraft; and a 2006 altitude record for reaching the stratosphere in a glider.¹⁹

¹⁷ John Schwartz, “Robert Jastrow, Who Made Space Understandable, Dies at 82,” *New York Times*, 12 February 2008; Thomas H. Maugh II, “Robert Jastrow, 82; Astrophysicist Helped Shape NASA’s Space Exploration,” *Los Angeles Times*, 17 February 2008.

¹⁸ U.S. Congress, House of Representatives, Committee on Science and Technology, “Committee Examines FY09 NASA Budget,” press release, 13 February 2008, <http://sciencedems.house.gov/press/PRArticle.aspx?NewsID=2088> (accessed 4 January 2010); United Press International, “NASA Proposes \$17.6 Billion Budget,” 4 February 2008; U.S. Congress, House of Representatives, Committee on Science and Technology, “NASA’s Fiscal Year 2009 Budget Request,” 110th Cong., 2nd sess., 13 February 2008, <http://origin.www.gpo.gov/fdsys/pkg/CHRG-110hhrg40598/pdf/CHRG-110hhrg40598.pdf> (accessed 4 January 2011).

¹⁹ Margalit Fox, “Steve Fossett, Missing Adventurer, Is Declared Dead at 63,” *New York Times*, 16 February 2008.

19 February

NASA announced that it had signed a Space Act Agreement with Orbital Sciences Corporation of Dulles, Virginia, for a contract to develop a commercial launch system that would be capable of ferrying cargo and crew to the ISS. NASA had funded the contract, worth US\$170 million, under the Commercial Orbital Transportation Services Project (COTS), an initiative designed to encourage private enterprise to create space transport systems that would be available for use after the retirement of the Space Shuttle. NASA had collaborated with seven other corporations through COTS, including SpaceX of El Segundo, California, the only other company to receive NASA funding.²⁰

20 February

Atlantis landed at Kennedy Space Center (KSC) at 14:08 (UT) after a 13-day journey to the ISS, successfully completing the Shuttle mission STS-122, to deliver and install ESA's microgravity science laboratory Columbus. The seven-member crew included American astronauts Stephen N. Frick, Alan G. Poindexter, Leland D. Melvin, Rex J. Walheim, and Stanley G. Love, and ESA astronauts Hans W. Schlegel and Léopold Eyharts. The mission had begun with a 19:45 (UT) launch on 7 February 2008 from KSC and had included three spacewalks. Crew members had docked the Columbus laboratory to the Harmony module of the ISS; installed power, data, and cooling cables to the laboratory; replaced a spent nitrogen tank; placed two science experiments on the laboratory's exterior; retrieved a broken gyroscope; installed a solar monitor; and positioned the European Technology Exposure Facility. STS-122 had also exchanged Eyharts for American astronaut Daniel M. Tani, who had been aboard the ISS for almost four months.²¹

21 February

The X Prize Foundation and Google announced the names of the first 10 teams to qualify to compete in the Google Lunar X Prize competition, which would award US\$20 million to the first team to send a rover to the Moon. The winning team must build a rover that would land on the Moon, transmit a data signal back to Earth, travel at least 500 meters (1,640 feet), and then transmit another data signal. The X Prize Foundation would also give US\$5 million to the second team to accomplish this goal, as well as offering additional prizes for other lunar achievements, such as the detection of lunar ice. The teams qualifying for the competition were Aeronautics and Cosmonautics Romanian Association (ARCA) of Romania; Astrobotic Technology of the United States; Chandah of the United States; FREDNET, a multinational team; LunaTrex of the United States; Micro-Space of the United States; Odyssey Moon of the Isle of Man; Quantum3 of the United States; Southern California Selene Group of the United States; and Team Italia of Italy.²²

²⁰ NASA, "NASA Partners with Orbital Sciences for Space Transport Services," news release 08-058, 19 February 2008, http://www.nasa.gov/home/hqnews/2008/feb/HQ_08058_COTS_Selection.html (accessed 28 December 2010); Brian Berger, "Orbital Wins \$171 Million Space Station Re-Supply Demo Deal," *Space.com*, 19 February 2008, <http://www.space.com/4995-orbital-wins-171-million-space-station-supply-demo-deal.html> (accessed 14 January 2011).

²¹ *Spacewarn Bulletin*, no. 652; NASA, "Shuttle Atlantis Crew Returns Home After Successful Mission," news release 08-061, 20 February 2008, http://www.nasa.gov/home/hqnews/2008/feb/HQ_08061_Atlantis_Lands.html (accessed 28 December 2010).

²² Google Lunar X Prize, "The X Prize Foundation Announces Official Contenders in Private Moon Race," news release, 21 February 2008, <http://www.googlelunarxprize.org/lunar/press-release/the-x-prize-foundation-announces-official-contenders-in-private-moon-race> (accessed 6 January 2011), Brad Stone, "A Google Competition, with a Robotic Moon Landing as a Goal," *New York Times*, 22 February 2008.

The U.S. Navy cruiser Lake Erie fired a missile interceptor that struck down a disabled American spy satellite over the Pacific Ocean. The National Reconnaissance Office (NRO) managed the 5,000-pound (2,268-kilogram) satellite, which was orbiting 130 miles (209 kilometers) above Earth's surface, at over 17,000 miles per hour (27,359 kilometers per hour), when it was hit at 22:30 (EST). The satellite had been inoperative since shortly after its launch in December 2006. Officials had been concerned that its fuel tank, filled with 1,000 pounds (454 kilograms) of toxic hydrazine, could pose a risk to humans if the satellite fell in a populated area. A heat-seeking missile interceptor, retooled to track the frozen satellite, had accomplished the strike. Military officials had timed the strike to occur after Space Shuttle *Atlantis*'s 20 February 2008 return to Earth, but before 1 March 2008, when the satellite's fall into the upper atmosphere would disrupt its orbit, making it more difficult to hit. Officials stated that they believed that the impact had been strong enough to incinerate the fuel tank, although they would not know for 24 hours whether that had actually occurred.²³

22 February

NASA announced the appointment of N. Wayne Hale Jr. as NASA's Deputy Associate Administrator for Strategic Partnerships. Hale had begun his three-decade career with NASA in 1978 in Flight Operations at NASA's Johnson Space Center (JSC). Hale had headed the Propulsion Systems Section of Mission Control from 1985 to 1988 and had overseen flight-control teams in Mission Control during all aspects of 40 Space Shuttle missions. He had served as Manager of the Space Shuttle Program (SSP) since 2005. In his new position, Hale would work in the Space Operations Mission Directorate to build alliances across the public and private sectors. John P. Shannon, who had served as Hale's deputy since 2005, would succeed him as SSP Manager. Shannon had begun his career with NASA in 1988. When NASA appointed him Space Shuttle Flight Director in 1993, Shannon had become the youngest person in NASA's history to hold that post. After Shannon served as Deputy Director of the *Columbia* Task Force in 2003, NASA had selected him to create the SSP's Flight Operations and Integration Office.²⁴

27 February

NASA announced that it had exhibited a new robot rover that would be able to drill into the lunar surface to find water and oxygen-dense soil. The rover, Scarab, would not travel to the Moon itself. Instead, NASA had designed Scarab as a research rover, to give scientists an opportunity to study drilling technologies that they could use in the difficult environment of the Moon, noted for its continuous darkness, minimal gravity, and extremely abrasive and dense soil. The rover was a joint effort among many institutions. NASA's ARC had built Scarab's navigation system, the Canadian Space Agency (CSA) had funded a camera; NASA's GRC had been responsible for its power-management system; the Northern Centre for Advanced Technology had built its drill; and Carnegie Mellon University had overseen the rover's design and testing. The Human Robotic Systems and In-Situ Resource Utilization projects at NASA's JSC, part of the

²³ Thom Shanker, "Missile Strikes a Spy Satellite Falling From Its Orbit," *New York Times*, 21 February 2008.

²⁴ NASA, "NASA Selects New Deputy Associate Administrator of Strategic Partnerships and Space Program Manager," news release 08-065, 22 February 2008, http://www.nasa.gov/home/hqnews/2008/feb/HQ_08065_New_Shuttle_Manage.html (accessed 28 December 2010).

Exploration Technology Development Programs that LaRC managed, had collaborated on the project.²⁵

NASA announced that it had generated the highest-resolution topographical data of the lunar south pole to date, using the Goldstone Solar System Radar (GSSR) in the Mojave Desert in California. Scientists at NASA's Jet Propulsion Laboratory (JPL) had generated the data over six months during 2006, when the Moon's axis was tilted at a relatively rare alignment, allowing for a good view of the pole. The GSSR had gathered the data using its 70-meter (230-foot) radar dish, which bounced 500-kilowatt radar signals, at 90-minute intervals, off an area of the lunar surface measuring 400 miles by 250 miles (644 kilometers by 402 kilometers). The resulting images showed a resolution of up to 20 meters (66 feet) per pixel, close enough to identify a feature the size of a house. They revealed that the topography of the area, located near Shackleton Crater, was extremely rugged, with craters 2.5-miles deep (4-kilometers deep) and mountains as high as Mt. McKinley. NASA scientists claimed that the newest data had more than 3 times the resolution and 10 times the vertical accuracy of the best mapping data acquired previously—data that the GSSR had captured during a 1997 study.²⁶

NASA announced that it had awarded a contract for program planning and support services for the Constellation Program to Stinger Ghaffarian Technologies (SGT) of Greenbelt, Maryland. NASA expected SGT to contribute to the program's business management, schedule management, configuration and data management, requirements analysis and integration, and integration and technology protection. SGT would perform the majority of the work at NASA's JSC and possible additional work at NASA's KSC, LaRC, and MFSC. The contract stipulated an indefinite-delivery, indefinite-quantity, cost-plus-award fee base of US\$60 million for three years, beginning on 11 April 2008, as well as two optional one-year extensions, which could bring the contract's total value to US\$100 million. The Constellation fleet included the *Altair* human lunar lander, the Ares-I launch vehicle, the Ares-V launch vehicle, and the *Orion* crew exploration vehicle (CEV).²⁷

MARCH 2008

5 March

NASA Administrator Michael D. Griffin testified before the House Appropriations Subcommittee on Commerce, Justice, Science and Related Agencies regarding NASA's FY 2009 budget. During the hearing, several members of Congress expressed concern that the president's budget request of US\$17.6 billion was insufficient to fund NASA's programs adequately. Griffin defended the request, stating that NASA had expected lower funding levels

²⁵ NASA, "NASA Demonstrates Robot Technology for Moon Exploration," news release 08-067, 27 February 2008, http://www.nasa.gov/home/hqnews/2008/feb/HQ_08067_lunar_robot.html (accessed 28 December 2010); *CBC News*, "NASA Shows Off Rover Armed with Canadian-Made Drill," 27 February 2008, <http://www.cbc.ca/technology/story/2008/02/27/tech-rover-drill.html> (accessed 5 January 2011).

²⁶ NASA, "NASA Views Landing Site Through Eyes of Future Moon Crew," news release 08-071, 27 February 2008, http://www.nasa.gov/home/hqnews/2008/feb/HQ_08071_goldstone_radar.html (accessed 28 December 2010); Kenneth Chang, "The Moon's Craggiest Stretch Comes into Focus," *New York Times*, 28 February 2008.

²⁷ NASA, "NASA Awards Constellation Program Support Contract," news release C08-007, 27 February 2008, http://www.nasa.gov/home/hqnews/2008/feb/HQ_C08007_constellation_contract.html (accessed 28 December 2010).

and that the president's budget was sufficient. Discussing the future of NASA, Griffin stated, "in the wake of the very wrenching transitions we have had over the past several years and in view of the transition yet to come, what we need is stability and a sense of purpose."²⁸

7 March

A team of scientists, led by Geraint H. Jones of the Millard Space Science Laboratory in London, announced in the journal *Science* that NASA's Cassini spacecraft had gathered evidence of the presence of rings around Saturn's moon Rhea. Cassini had flown close to Rhea in November 2005. Using a set of six instruments to take samples and measurements of Rhea's atmosphere, Cassini had detected a decrease in the number of electrons on either side of the moon. The team believed that a ring of debris orbiting Rhea had absorbed the electrons—the first time scientists had detected the presence of a ring of debris around a moon. The researchers estimated that the particles comprising the ring ranged in size from pebbles to boulders. NASA's JPL was managing the Cassini project, a joint mission of NASA, ESA, and the Italian space agency (Agenzia Spaziale Italiana—ASI).²⁹

9 March

ESA's first Automated Transfer Vehicle (ATV), known as Jules Verne or ATV 1, launched aboard an Ariane-5 rocket from Guiana Space Center in Kourou, French Guiana, at 04:03 (UT). The ATV was carrying 4.6 tonnes (4,600 kilograms or 10,141 pounds) of supplies to the ISS, including 150 kilograms (331 pounds) of dry cargo, 856 kilograms (1,887 pounds) of propellant, 270 kilograms (595 pounds) of drinking water and 21 kilograms (46 pounds) of oxygen. The ATV Jules Verne, which measured 10.3 meters (34 feet) high and 4.5 meters (15 feet) wide, was the first spacecraft in the world to have an optical laser-based automated docking system. On 29 March and 31 March 2008, ESA intended to put the ATV through two orbital testing demonstrations. If the tests proved successful, ISS managers planned to allow it to dock with the ISS on 3 April 2008.³⁰

13 March

The House Science and Technology Subcommittee on Space and Aeronautics received testimony from S. Alan Stern, Associate Administrator for NASA's Science Mission Directorate (SMD), and from a panel of research scientists, regarding the FY 2009 budget request for science programs. The president's budget request had provided US\$4.4 billion in direct funding for science programs, an amount representing 25 percent of NASA's total budget request.

²⁸ Mark Matthews, "Griffin Defends His Budget on the Hill," *Orlando Sentinel* (FL), 6 March 2008; U.S. Congress, House of Representatives, Committee on Appropriations, Subcommittee on Commerce, Justice, Science, and Related Agencies, "Commerce, Justice, Science, and Related Agencies Appropriations for 2009," 110th Cong., 2nd sess., 5 March 2008, http://democrats.appropriations.house.gov/images/stories/pdf/cjs/Hearing_Volumes/CJS-FY09-Pt7.pdf#page=45 (accessed 10 February 2011).

²⁹ NASA, "Saturn's Moon Rhea Also May Have Rings," news release 08-074, 6 March 2008, http://www.nasa.gov/home/hqnews/2008/mar/HQ_08074_Rings_Around_Rhea.html (accessed 13 January 2011); Associated Press, "Saturn Moon Rhea May Have Rings," 7 March 2008; G. H. Jones et al., "The Dust Halo of Saturn's Largest Icy Moon, Rhea," *Science* 319, no. 5868 (7 March 2008): 1380–1384.

³⁰ ESA, "Europe Launches Its First Re-Supply Ship—Jules Verne ATV—to the ISS," press release no. 15-2008, 9 March 2008, http://www.esa.int/esaCP/Pr_15_2008_p_EN.html (accessed 13 January 2011); *Spacewarn Bulletin*, no. 653, 1 April 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx653.html> (accessed 13 January 2011); Tariq Malik, "European Cargo Ship Begins Maiden Voyage," *Space.com*, 9 March 2008, <http://www.space.com/5079-european-cargo-ship-begins-maiden-space-voyage.html> (accessed 13 January 2011).

Subcommittee Ranking Member Thomas C. Feeney (R-FL) called the budget “essentially flat,” but Stern testified that the budget accomplished all of the SMD’s objectives, including starting seven new missions, increasing research analysis, accelerating the suborbital program, beginning a lunar program, and initiating the Earth Science Decadal Survey.³¹

14 March

A Russian Proton-M rocket launched an American AMC-14 communications satellite at 02:18 (MST), from Baikonur Cosmodrome in Kazakhstan, but failed to bring it into correct orbit. The Breeze-M booster on the rocket failed 10 minutes after launch, leaving the satellite 8,000 kilometers (4,971 miles) below geostationary orbit. SES Americom owned the satellite, and Lockheed Martin had built it. The failed satellite had featured a new telecommunications technology that allowed changes in coverage while the satellite was in orbit. The satellite’s design would have enabled it to achieve a higher altitude using its own engine, although this would use up the satellite’s fuel supply and significantly shorten its lifespan.³²

15 March

George David Low, a former NASA astronaut who had flown on three Space Shuttle missions, died at the age of 52 from colon cancer. Low, who was the son of former NASA Director George M. Low, had worked at NASA’s JPL from 1980 to 1984 before NASA selected him to train as an astronaut. During his 12 years as an astronaut, Low had spent more than 714 hours in space and had circled Earth more than 540 times. After retiring as an astronaut, Low had continued to serve NASA on the Russian Integration Team and in the Legislative Affairs Office. In 1996 he had joined Orbital Sciences Corporation, and in 2006 he had become the Senior Vice President and Program Manager for Orbital’s Commercial Orbital Transportation Service program.³³

17 March

NASA announced that it had awarded a contract for the completion of a 210-day independent study of the design concept of the Constellations Program’s lunar-landing craft. NASA awarded the contract, totaling approximately US\$1.5 million, to five different companies: Andrews Space of Seattle, Boeing Defense, Space and Security in Houston, Lockheed Martin Space Systems in Denver, Northrop Grumman in El Segundo, California, and Odyssey Space Research of Houston. Each company would receive a maximum payment of US\$350,000 to assess the *Altair* lunar lander’s current design, recommend safety improvements, and propose partnerships between government and industry.³⁴

³¹ U.S. Congress, House of Representatives, Committee on Science and Technology, Subcommittee on Space and Aeronautics, “Witnesses: FY09 NASA Science Budget Makes Best of Limited Resources,” press release, 13 March 2008, <http://science.house.gov/PressRoom/Item.aspx?ID=89#> (accessed 19 January 2011); U.S. Congress, House of Representatives, Committee on Science and Technology, Subcommittee on Space and Aeronautics, “NASA’s Science Programs: Fiscal Year 2009 Budget Request and Issues,” 110th Cong., 2nd sess., 13 March 2008, <http://www.gpo.gov/fdsys/pkg/CHRG-110hhrg41067/pdf/CHRG-110hhrg41067.pdf> (accessed 19 January 2011).

³² *Spacewarn Bulletin*, no. 653, 1 April 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx653.html> (accessed 13 January 2011); Agence France-Presse, “Russian Rocket Fails To Take US Satellite into Planned Orbit,” 14 March 2008.

³³ Joe Holley, “G. David Low, 52; Cerebral Astronaut Flew on 3 Shuttles,” *Washington Post*, 20 March 2008.

³⁴ NASA, “NASA Awards Contracts for Design Study of Lunar Landing Craft,” news release C08-014, 17 March 2008, http://www.nasa.gov/home/hqnews/2008/mar/HQ_C08014_Altair_BAA_Selection.html (accessed 13 January 2011).

21 March

A team of researchers led by Ralph D. Lorenz of Johns Hopkins University's APL announced in the journal *Science* that NASA's Cassini spacecraft had discovered evidence of an underground ocean composed of water and ammonia on Saturn's moon Titan. During 19 flybys made between October 2005 and May 2007, Cassini's SAR had gathered images of the moon's surface that showed that distinct features on Titan's surface, such as lakes, canyons, and mountains, had shifted location over time by as much as 19 miles (31 kilometers). The scientists believed that this shifting had occurred because winds in Titan's heavy atmosphere had moved the moon's thin surface crust, which was separated from the moon's core by an ocean, measuring 60–120 miles (97–193 kilometers) deep. Scientists had previously discovered evidence of underground oceans on other moons in Earth's solar system. However, the researchers were particularly interested to discover the presence of liquid water on Titan, because that moon has many of the same organic compounds as Earth.³⁵

Researchers led by Mikki M. Osterloo of the University of Hawaii announced in the journal *Science* that their team had found evidence of salt deposits on the surface of Mars. The scientists explained that the existence of salt deposits would provide evidence that Mars had once had an abundant supply of near-surface water, which could have sustained life. NASA's Mars Odyssey Thermal Emission Imaging System, a camera capable of producing images in visible light and infrared wavelengths, had made the discovery. The images showed spectral features consistent with chloride minerals, located at approximately 200 sites in the southern hemisphere. The salt deposits ranged in size from 0.5 square miles (1.3 square kilometers) to 25 times that size, with a thickness ranging from 3 to 10 feet (0.9 to 3 meters). Scientists believed that the mineral sites, which were approximately 3.5 to 3.9 billion years old, had formed when groundwater seeped to the surface and evaporated, leaving behind salty deposits.³⁶

26 March

Endeavour landed at NASA's KSC at 20:39 (EDT), completing STS-123. The Shuttle had lifted off from NASA's KSC on 11 March 2008 at 02:28 (EDT) with seven astronauts on board, including Takao Doi, from Japan, and Americans, Dominic L. Pudwill Gorie, Gregory H. Johnson, Robert L. Behnken, Michael J. Foreman, Richard M. Linnehan, and Garrett E. Reisman. Reisman had remained aboard the ISS, replacing ESA astronaut Léopold Eyharts, who had returned with the *Endeavour* crew. The 16-day mission was the longest Shuttle trip ever made to the ISS. STS-123 also broke a record for the number of spacewalks in a single mission. During five spacewalks, the astronauts had installed the first section of the Japanese Aerospace Exploration Agency's (JAXA's) Kibo science experiment laboratory; installed CSA's robotic

³⁵ NASA, "Cassini Spacecraft Finds Ocean May Exist Beneath Titan's Crust," news release 08-085, 20 March 2008, http://www.nasa.gov/home/hqnews/2008/mar/HQ_08085_cassini_ocean.html (accessed 2 February 2011); Charles Q. Choi, "Evidence for Ocean Found at Saturn's Moon Titan," *Space.com*, 20 March 2008, <http://www.space.com/5151-evidence-ocean-saturn-moon-titan.html> (accessed 3 February 2011); Ralph D. Lorenz et al., "Titan's Rotation Reveals an Internal Ocean and Changing Zonal Winds," *Science* 319, no. 5870 (21 March 2008): 1649–1651.

³⁶ NASA, "NASA Mission Finds New Clues To Guide the Search for Life on Mars," news release 08-084, 20 March 2008, http://www.nasa.gov/home/hqnews/2008/mar/HQ_08084_Mars_Deposits.html (accessed 13 January 2011); David Mosher, "Newly Found Martian Salt Deposits Suggest Ancient Life," *Space.com*, 20 March 2008, <http://www.space.com/5150-newly-martian-salt-deposits-suggest-ancient-life.html> (accessed 13 January 2011); M. M. Osterloo et al., "Chloride-Bearing Materials in the Southern Highlands of Mars," *Science* 319, no. 5870 (21 March 2008): 1651–1654.

arm, known as Dextre; handed over a Shuttle inspection boom; examined a jammed solar-wing joint; and tested thermal tiles.³⁷

NASA announced the resignation of S. Alan Stern as Associate Administrator for NASA's SMD. During his career with NASA, Stern had served as Principal Investigator for the New Horizons Mission to Pluto and as a member of the NASA Advisory Council. NASA Administrator Michael D. Griffin announced that Edward J. Weiler would replace Stern as interim Associate Administrator for NASA's SMD. Before accepting this position, Weiler had served as Director of NASA's Goddard Space Flight Center (GSFC).³⁸

NASA scientists released data that the Cassini spacecraft had collected on 12 March 2008, when it swooped through a geyser of water vapor erupting from the surface of Saturn's moon Enceladus. The data revealed that the water vapor contained acetylene, carbon dioxide, carbon monoxide, formaldehyde, methane, and propane. The organic material composing Enceladus closely resembled that of a comet, a discovery that surprised scientists and raised questions regarding the formation and origin of Saturn's moons. Cassini had also generated new heat maps, which showed significantly warmer temperatures on Enceladus than anticipated, particularly along the moon's "tiger stripes"—the deep fissures at its south pole. Temperatures along the fissures had registered at -135°F (-93°C), which was 63°F (17°C) warmer than previously recorded temperatures in that area and 200°F (93°C) warmer than the temperatures of other areas of the moon. Temperatures this warm raised the possibility that Enceladus could have subterranean liquid water.³⁹

APRIL 2008

2 April

At the Royal Astronomical Society's National Astronomy Meeting, a team of researchers led by Peter T. Gallagher of Trinity College, Dublin, announced that they had produced new, corrected estimates of the speed at which solar tsunamis move. Solar tsunamis, first photographed by NASA's Solar and Heliospheric Observatory (SOHO) spacecraft in the 1990's, are huge pressure waves that roll through the Sun's gaseous atmosphere. Although the scientific community had previously estimated the speed of solar tsunamis based upon the SOHO photographs, these estimates had not correlated with the waves' estimated intensity—an intensity equivalent to the release, in a fraction of a second, of 2 billion times the world's annual energy consumption. To correct the estimates, Gallagher's team had analyzed photographs that NASA's Solar Terrestrial

³⁷ NASA, "NASA's Shuttle Endeavour Begins Mission to the Space Station," new release 08-077, 11 March 2008, http://www.nasa.gov/home/hqnews/2008/mar/HQ_08077_Endavour_launch.html (accessed 13 January 2011); NASA, "NASA's Shuttle Crew Returns Home After Successful Mission," news release 08-090, 26 March 2008, http://www.nasa.gov/home/hqnews/2008/mar/HQ_08089_Endavor_Lands.html (accessed 13 January 2008); Liz Austin Peterson, "Shuttle Aims for Wednesday Night Landing," Associated Press, 26 March 2008.

³⁸ NASA, "NASA Administrator Announces Science Mission Directorate Leadership Changes," news release 08-088, 26 March 2008, http://www.nasa.gov/home/hqnews/2008/mar/HQ_08088_SMD_AA_change.html (accessed 13 January 2001).

³⁹ NASA, "Cassini Tastes Organic Material at Saturn's Geyser Moon," news release 08-089, 26 March 2008, http://www.nasa.gov/home/hqnews/2008/mar/HQ_08089_Cassini_Enceladus_Flyby.html (accessed 13 January 2011); Dave Mosher, "Seeds of Life Found Near Saturn," *Space.com*, 26 March 2008, <http://www.space.com/5179-seeds-life-saturn.html> (accessed 1 February 2011).

Relations Observatory (STEREO) spacecraft had captured on 19 May 2007. Because STEREO had captured more images per day than SOHO had, the researchers had been able to calculate the speed of solar tsunamis at over 1 million kilometers per hour (over 621,371.19 miles per hour), much faster than scientists had previously thought. Additionally, the researchers had used STEREO's Extreme Ultraviolet Imager instruments to show that the solar tsunamis had moved through dense layers of the atmosphere just as quickly as through less dense layers. Solar tsunamis are associated with the appearance of coronal mass ejections (CMEs), which are massive explosions of gas and magnetic fields near the Sun's atmosphere. Astronomers believed that monitoring solar tsunamis could help to predict CMEs.⁴⁰

The House Science, Space, and Technology Subcommittee on Research and Science Education held a hearing to address international science and technology cooperation. NASA Assistant Administrator for External Relations Michael F. O'Brien testified on the scope of international collaboration in NASA's programming, as well as the benefits to the United States of ongoing international scientific cooperation. O'Brien stated that, since its inception in 1958, NASA had entered more than 3,000 cooperative agreements with over 100 nations or international organizations. He said that NASA was currently a party to approximately 300 active international agreements, and that over half of NASA's missions currently in orbit involved international participation. O'Brien also discussed the benefits of scientific cooperation with other nations, including the availability to the global scientific community of research data, the advancement of specific NASA mission objectives, and the promotion of U.S. foreign policy interests.⁴¹

3 April

The House Science, Space, and Technology Subcommittee on Space and Aeronautics conducted a review of the status of NASA's space exploration initiative. The Subcommittee focused on the effect that the FY 2009 budget request would have on the ability of NASA's Exploration Systems Mission Directorate (ESMD) to implement the George W. Bush administration's 2004 Vision for Space Exploration (VSE). Among other things, the VSE had mandated that NASA return to the Moon by 2020. The ESMD's Constellation Program was developing vehicles, such as the *Orion* CEV and the Ares-I crew launch vehicle (CLV), to implement the VSE. NASA had proposed that the FY 2009 budget request include US\$3.5 billion in funding for the ESMD. During the hearing, Subcommittee Chair Mark E. Udall (D-CO) expressed concern that space exploration projects were underfunded and might become a drain on NASA's resources. Furthermore, Cristina T. Chaplain of the Government Accountability Office (GAO) testified that, because of the complexity of the Constellation Program, GAO was concerned about the reliability of cost estimates for the programs. However, Richard J. Gilbrech, Associate

⁴⁰ Andrea Thompson, "Solar Tsunamis Move at Astronomical Speeds," *Space.com*, 1 April 2008, <http://www.space.com/5198-solar-tsunamis-move-astronomical-speeds.html> (accessed 3 March 2011).

⁴¹ U.S. Congress, House of Representatives, Committee on Science, Space, and Technology, Subcommittee on Research and Science Education, "Witnesses: International Science Collaboration Mutually Beneficial," press release, 2 April 2008, <http://gop.science.house.gov/Pressroom/Item.aspx?ID=91> (accessed 17 February 2011); U.S. Congress, House of Representatives, Committee on Science, Space, and Technology, Subcommittee on Research and Science Education, "International Science and Technology Cooperation," 110th Cong., 2nd sess., 2 April 2008, <http://www.gpo.gov/fdsys/pkg/CHRG-110hrg41470/pdf/CHRG-110hrg41470.pdf> (accessed 4 March 2011).

Administrator of the ESMD, asked Congress to support the FY 2009 budget request, asserting that it would provide NASA with a stable source of funding.⁴²

The Senate Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies received testimony from NASA Administrator Michael D. Griffin regarding the FY 2009 budget request. Griffin supplied the Subcommittee with a detailed explanation of the request, which would provide NASA with US\$17.6 billion in funding. Griffin stated that he believed that this budget would maintain an adequate fiscal balance between NASA's aeronautics research missions, Earth and space science missions, and space exploration missions. However, Senator Barbara A. Mikulski (D-MD) expressed disappointment over the funding request. Calling the budget "stagnant," she expressed her concerns regarding requested cuts in funding for aeronautics research; the lack of funding to reimburse NASA for the cost of returning the Space Shuttle to operation after the *Columbia* disaster; and the inadequate funding for the period between the 2010 retirement of the Space Shuttle and the expected 2015 launch of the *Orion* and Ares vehicles.⁴³

ESA's ATV Jules Verne successfully docked with the ISS in a 4-hour process completed at 14:52 (GMT). Previously, only Russia had successfully achieved an automated docking in space. To align the ATV with the docking cone on the Zvezda module, the cargo ship used global positioning system (GPS) technology and videometers that pointed toward laser retroreflectors on the ISS. Docking occurred while both of the spacecraft were orbiting at an altitude of 340 kilometers (211.27 miles) above Earth, at approximately 28,000 kilometers per hour (17,398.39 miles per hour). ESA officials supervised the docking from an ESA control center in France, with assistance from the Russian ISS control center near Moscow and from NASA's JSC. The ISS partners planned for the ATV Jules Verne to remain docked at the ISS for approximately four months, during which time the ATV would serve as an additional module. The mission's goals were to ferry 7.5 tons (6,803.89 kilograms) of supplies to the crew of the ISS and to use the ATV's propulsion system to lift the orbit of the ISS.⁴⁴

8 April

A Russian *Soyuz* TMA-12 passenger-transport craft launched from Baikonur Cosmodrome in Kazakhstan at 12:17 (UT), marking the beginning of the ISS's Expedition 17 mission. The *Soyuz*

⁴² U.S. Congress, House of Representatives, Committee on Science, Space, and Technology, Subcommittee on Space and Aeronautics, "Subcommittee Examines Status of NASA's Human Exploration Initiative," press release, 3 April 2008, <http://gop.science.house.gov/PressRoom/Item.aspx?ID=94> (accessed 19 January 2011); U.S. Congress, House of Representatives, Committee on Science, Space, and Technology, Subcommittee on Space and Aeronautics, "Subcommittee Examines Progress and Plans of NASA's Exploration Initiative," press release, 3 April 2008, <http://sciencedems.house.gov/press/PRArticle.aspx?NewsID=2142> (accessed 15 March 2011); U.S. Congress, House of Representatives, Committee on Science, Space, and Technology, Subcommittee on Space and Aeronautics, "NASA's Exploration Initiative: Status and Issues," 110th Cong., 2nd sess., 3 April 2008, <http://www.gpo.gov/fdsys/pkg/CHRG-110hrg41471/pdf/CHRG-110hrg41471.pdf> (accessed 4 March 2011).

⁴³ U.S. Congress, Senate, Committee on Appropriations, Subcommittee on Commerce, Justice, Science, and Related Agencies, "Commerce, Justice, Science, and Related Agencies Appropriations for Fiscal Year 2009," 110th Cong., 2nd sess., 3 April 2008, http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_senate_hearings&docid=f:41242.pdf (accessed 15 March 2011).

⁴⁴ ESA, "Europe's Automated Ship Docks to the ISS," press release no. 20-2008, 3 April 2008, http://www.esa.int/esaCP/SEMORO5QGEF_index_0.html (accessed 17 February 2011); Warren E. Leary, "Robot Ship Successfully Docks with Space Station," *New York Times*, 4 April 2008.

carried Russian cosmonauts, Sergei A. Volkov and Oleg D. Kononenko, and South Korean astronaut So-yeon Yi. Yi, the first South Korean to enter space, would stay on the ISS for only 10 days, conducting experiments. She would then return to Earth with the departing Expedition 16 crew members, aboard a *Soyuz* TMA-11 that had been docked at the ISS since October 2007. Kononenko was Expedition 17's Flight Engineer, and Volkov was the mission's Commander. Volkov was the son of cosmonaut Alexander A. Volkov, making this launch the first occasion of a second-generation cosmonaut or astronaut traveling to space. The third member of the expedition, American astronaut Garrett E. Reisman, was already aboard the ISS. Over the course of six months, the crew of Expedition 17 planned to install the large Japanese Kibo laboratory, supervise the undocking of ESA's Jules Verne ATV, and complete at least one spacewalk.⁴⁵

10 April

NASA announced the appointment of Michael R. Luther as NASA's Deputy Associate Administrator for Programs in the Science Mission. Luther had begun his career with NASA in 1981 at NASA's LaRC. In 1987 he had moved to NASA Headquarters in Washington, DC, where he had served as Program Manager of the Upper Atmosphere Research Satellite and as Earth Science Flight Program Director. Luther had received NASA's Outstanding Leadership Medal in 2005. As Deputy Associate Administrator for Programs, Luther would supervise the administration, including formulation and development, of the 36 missions of NASA's SMD. Additionally, he would manage the implementation of 54 operation missions. NASA's SMD was responsible for conducting research and for operating scientific programs to explore the solar system and universe, to observe the Earth, and to study space weather.⁴⁶

15 April

NASA announced that it had awarded a sole-source contract to Hamilton Sundstrand Space Systems International of Windsor Locks, Connecticut, to provide a water-production system aboard the ISS. Under the terms of the contract, Hamilton Sundstrand would provide equipment that would use excess carbon dioxide and hydrogen on the ISS to produce water and methane, using a chemical process called a Sabatier reaction. The ISS's waste-water system would treat the water produced in this process, so that the astronauts could use it for drinking, washing, preparing food, generating oxygen, and cooling electronic equipment. NASA planned to send the equipment to the ISS aboard mission STS-130, scheduled for launch in 2009. Officials hoped that the water-production system would pave the way for other new technologies that NASA could use in future missions traveling too far from the Earth for routine resupply. The contract represented a change in NASA's business arrangements. Instead of purchasing the hardware for water production, NASA had contracted only for the production of services. The contractor had agreed to be responsible for all system development and performance. The contract, which would extend through 30 September 2014, could reach a value of as much as US\$65 million.⁴⁷

⁴⁵ *Spacewarn Bulletin*, no. 654, 1 May 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx654.html> (accessed 17 February 2011); Clara Moskowitz, "New Station Crew, Korean Astronaut Rocket Into Space," *Space.com*, 8 April 2008, <http://www.space.com/5217-station-crew-korean-astronaut-rocket-space.html> (accessed 3 March 2011).

⁴⁶ NASA, "NASA Earth Scientist To Head Programs Office in Science Directorate," news release 08-096, 10 April 2008, http://www.nasa.gov/home/hqnews/2008/apr/HQ_08096_Luther_Named_SMD_DAA.html (accessed 17 February 2011).

⁴⁷ NASA, "NASA Awards Space Station Water Contract to Hamilton Sundstrand," news release C08-020, 15 April 2008, http://www.nasa.gov/home/hqnews/2008/apr/HQ_C08020_ISS_Water_Contract.html (accessed 17 February 2011).

18 April

The Socialist Republic of Vietnam launched its first communications satellite aboard an Ariane-5 ECA rocket at 22:17 (UT) from Kourou spaceport in French Guiana. Lockheed Martin Commercial Space Systems had built the 2,600-kilogram (5,732-pound) VINASAT-1 satellite for Vietnam's Post and Telecommunications Group. The Vietnamese intended for VINASAT 1 to come to rest at 132°E longitude, above the border between Indonesia and Papua New Guinea. From that position, the satellite would deliver communications to remote Vietnamese communities. Previously, Vietnam had leased satellite capacity from other countries, but with the launch of VINASAT 1, some Vietnamese officials hoped that they would be able to sell their own satellite's extra capacity to their neighbors. The Ariane-5 ECA rocket also carried into orbit the Brazilian satellite Star One C2.⁴⁸

19 April

The Russian *Soyuz* TMA-11 landed in Kazakhstan at 04:30 (EDT), after a ballistic reentry that deposited the spacecraft approximately 295 miles (474.76 kilometers) from its intended landing location. NASA officials explained that, in a ballistic reentry, a spacecraft reenters Earth's atmosphere at an angle steeper than normal, subjecting the astronauts to higher gravitational forces. Russian officials pledged to investigate the cause of the rough landing. The crew members on board—Peggy A. Whitson, Yuri I. Malenchenko, and So-yeon Yi—did not report any injuries from the incident. The three crew members were returning to Earth after completing Expedition 16 to the ISS. Yi, South Korea's first astronaut, had been aboard the ISS for 10 days, conducting experiments. Whitson, an American astronaut, had served as the first female commander of the ISS. During this mission, she had set the record for the most cumulative time an American had spent in space. Malenchenko, a Russian cosmonaut, had been Flight Engineer for Expedition 16. During the busy mission, lasting six months, crew members had conducted a wide variety of scientific experiments. During seven spacewalks, they had attached new modules to the ISS, repaired damages to the station, and received three visits from the Shuttle and one visit from ESA's unpiloted cargo ship Jules Verne.⁴⁹

22 April

NASA announced that it had awarded a contract to General Dynamics Advanced Information Systems to build the Landsat Data Continuity Mission (LDCM) spacecraft. The award was one of NASA's Rapid II indefinite delivery/indefinite quantity contracts, covering core spacecraft systems with nonstandard services. LDCM was part of the Landsat Program, a joint mission of NASA and the U.S. Geological Survey, which had been collecting multispectral imagery of Earth's surface since 1972. In addition to providing the LDCM, NASA was responsible for providing the instruments, the launch vehicle, and missions operations for the ground systems. The delivery order, valued at US\$116,306,179, obligated General Dynamics to design and to fabricate the LDCM spacecraft bus; to integrate the government-furnished instruments; to

⁴⁸ *Spacewarn Bulletin*, no. 654; *BBC News*, "Dedicated Satellite for Vietnam," 19 April 2008.

⁴⁹ *Spacewarn Bulletin*, no. 654; Tariq Malik, "Space Station Astronauts Land Off-Target, But Safely," *Space.com*, 19 April 2008, <http://www.space.com/5262-space-station-astronauts-land-target-safely.html> (accessed 3 March 2011); NASA, "Expedition 16 Soyuz Lands Safely in Kazakhstan," news release 08-105, 19 April 2008, http://www.nasa.gov/home/hqnews/2008/apr/HQ_08105_Exp_16_lands.html (accessed 17 February 2011).

produce a spacecraft/observatory simulator; and to provide satellite-level testing, on-orbit satellite checkout, and continuing on-orbit engineering support.⁵⁰

NASA announced that it had selected Space Exploration Technologies (SpaceX) for a contract with the Launch Services Program at NASA's KSC. The indefinite delivery/indefinite quantity contract stipulated that NASA would be able to place orders for the launch services of the Falcon-1 and Falcon-9 launch vehicles through 30 June 2010, and that ordered launches could take place through December 2012. SpaceX would have to be able to launch payloads of 551 pounds (249.93 kilograms) or more into a circular orbit of 124 miles (199.56 kilometers) at an orbital inclination of 28.5°. Since 1999, NASA had awarded launch services contracts two times per year to multiple launch services providers. NASA allowed the companies awarded contracts to compete for missions in support of NASA's Science Directorate, Space Operations Directorate, and Exploration Directorate. The contract's potential value was between US\$20,000 and US\$1 billion, depending upon the number of launches NASA actually ordered.⁵¹

24 April

The House Science, Space, and Technology Subcommittee on Space and Aeronautics received testimony on the status of the ISS, including the progress of its construction and the manner in which the ISS partners should use, operate, and manage it. NASA's FY 2009 budget would provide US\$2.06 billion to the ISS program, an increase of US\$247 million over NASA's 2008 funding of the program. William H. Gerstenmaier, NASA's Associate Administrator for Space Operations, praised the ISS for its role in promoting U.S. leadership in space operations, as well as for the many training and research opportunities that it would provide. However, Cristina T. Chaplain, Director of GAO's Acquisition and Sourcing Management, testified that GAO continued to question NASA's ability to complete assembly of the ISS before the retirement of the Space Shuttle in 2010 and NASA's capacity to provide logistics and maintenance to the ISS after 2010. Chaplain had previously stated GAO's concerns in her July 2007 testimony before the Subcommittee. Subcommittee Chair Mark E. Udall (D-CO) called for farsighted budgeting measures that would adequately fund ISS resupply missions after the Shuttle's retirement.⁵²

26 April

ESA launched its Galileo In-Orbit Validation Element (GIOVE-B), the second of its Galileo global navigation system satellites, at 22:16 (UT). The 500-kilogram (1,102.31-pound) satellite lifted off aboard a Russian Soyuz-Fregat from the Baikonur Cosmodrome in Kazakhstan. GIOVE-B, like its predecessor GIOVE-A, was a test craft for a fleet which would eventually

⁵⁰ NASA, "NASA Selects Contractor for Landsat Continuity Mission Spacecraft," news release C08-021, 22 April 2008, http://www.nasa.gov/home/hqnews/2008/apr/HQ_C08021_Landsat_Data.html (accessed 17 February 2008).

⁵¹ NASA, "NASA Awards Launch Services Contract to SpaceX," news release C08-023, 22 April 2008, http://www.nasa.gov/home/hqnews/2008/apr/HQ_C08023_KSC_launch_services.html (accessed 17 February 2001).

⁵² U.S. Congress, House of Representatives, Committee on Science, Space, and Technology, "Construction of ISS Progressing, Subcommittee Explores Research Capabilities," press release, 24 April 2008, <http://gop.science.house.gov/PressRoom/Item.aspx?ID=97> (accessed 19 January 2011); U.S. Congress, House of Representatives, Committee on Science, Space, and Technology, Subcommittee on Space and Aeronautics, "NASA's International Space Station Program: Status and Issues," 110th Cong., 2nd sess., 24 April 2008, <http://www.gpo.gov/fdsys/pkg/CHRG-110hhr41799/pdf/CHRG-110hhr41799.pdf> (accessed 18 March 2011); U.S. Congress, House of Representatives, Committee on Science, Space, and Technology, "Subcommittee Examines the Status of the International Space Station," press release, 24 April 2008, <http://sciencedems.house.gov/press/PRArticle.aspx?NewsID=2167> (accessed 15 March 2011).

total 30 satellites. Once completed, ESA officials intended for the Galileo program to be interoperable with the American GPS and the Russian Global Navigation Satellite System (GLONASS). Because navigation systems rely on precise timing, GIOVE-B carried two redundant rubidium atomic clocks, which would serve as back up to the Passive Hydrogen Maser (PHM). The PHM was the most accurate clock that had ever been placed in orbit, with a stability of better than 1 nanosecond per day. GIOVE-B also carried a radiation-monitoring payload and a laser retroreflector for high-accuracy laser ranging. Astrium GmbH had built the satellite, with the assistance of Thales Alenia Space.⁵³

MAY 2008

1 May

The House Science and Technology Subcommittee on Space and Aeronautics held a hearing on NASA's aeronautics R&D programs. Jaiwon Shin, NASA's Associate Administrator of the Aeronautics Research Mission, was among the witnesses. The Subcommittee examined whether NASA's aeronautics R&D programs were satisfactorily meeting the United States' needs, especially regarding the impact of aviation on the environment, the development of aeronautics safety, and the development of the Next Generation Air Transportation System (NextGen). NextGen, a joint program of NASA, the White House Office of Science and Technology Policy (OSTP), and the Departments of Commerce, Defense, Homeland Security, and Transportation, proposed to overhaul the nation's air transportation system. NextGen required an increase in applied R&D. However, to comply with the NASA Authorization Act of 2005, NASA had shifted its focus from applied R&D to fundamental research. Additionally, Congress had reduced NASA's FY 2009 budget for the Aeronautics Research Program from FY 2008 levels by US\$62.5 million. At the hearing, Subcommittee Chair Mark E. Udall (D-CO) expressed concern that NASA would not be able to maintain the relevancy of its aeronautics R&D in the face of decreased funding.⁵⁴

2 May

Johns Hopkins University's Applied Physics Laboratory (APL) announced that NASA had selected APL to construct the Solar Probe, a spacecraft that would fly within 4.3 million miles (6.92 million kilometers) of the Sun. NASA had pledged to contribute US\$13.8 million in 2008 for development of the spacecraft. NASA and APL expected that the total mission cost would reach US\$750 million. APL intended to design a 9-foot-long (2.74-meter-long), 992-pound (449.96-kilogram) probe, which would use a 6-inch-thick (15.24-centimeter-thick) carbon-

⁵³ *Spacewarn Bulletin*, no. 654, 1 May 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx654.html> (accessed 17 February 2011); ESA, "ESA's Most Advanced Navigation Satellite Launched Tonight," press release no. 25-2008, 27 April 2008, http://www.esa.int/esaCP/SEM9GD2QGFF_index_0.html (accessed 17 February 2011); *BBC News*, "Europe Launches Sat-Nav Tester," 26 April 2008.

⁵⁴ U.S. Congress, House of Representatives, Committee on Science, Space, and Technology, Subcommittee on Space and Aeronautics, "Subcommittee Examines NASA's Aeronautics R&D Program," press release, 1 May 2008, <http://sciencedems.house.gov/press/PRArticle.aspx?NewsID=2175> (accessed 16 June 2010); U.S. Congress, House of Representatives, Committee on Science, Space, and Technology, Subcommittee on Space and Aeronautics, "NASA Aeronautics Program Faces Challenges To Meet Air Travel Demands," press release, 1 May 2008, <http://gop.science.house.gov/Pressroom/Item.aspx?ID=100#> (accessed 16 March 2001); U.S. Congress, House of Representatives, Committee on Science, Space, and Technology, Subcommittee on Space and Aeronautics, "NASA's Aeronautics R&D Program: Status and Issues," 110th Cong., 2nd sess., 1 May 2008, <http://www.gpo.gov/fdsys/pkg/CHRG-110hrg41902/pdf/CHRG-110hrg41902.pdf> (accessed 16 March 2011).

carbon foam shield to withstand temperatures near the Sun—temperatures reaching as high as 2,552°F (1,400°C). The Solar Probe’s instruments would measure the solar corona’s dust, magnetic field, and high-energy protons and electrons. Scientists hoped that these measurements would help explain why temperatures in the Sun’s outer atmosphere are higher than at its surface, and why solar wind accelerates as it moves away from the Sun. NASA intended to launch the Solar Probe in 2015 on a mission expected to last for seven years.⁵⁵

7 May

NASA announced that Edward J. Weiler would continue in the position of Associate Administrator for the SMD. He had held the position of Interim Associate Administrator for the SMD since 26 March 2008. Joining NASA in 1978, Weiler had served as Chief of the Ultraviolet/Visible and Gravitational Astrophysics Division, Chief Scientist for the Hubble Space Telescope (HST), Director of the Astronomical Search for Origins Program, Associate Administrator for the Space Science Enterprise, and Director of NASA’s GSFC. As Associate Administrator for NASA’s SMD, Weiler would be responsible for managing research and exploration programs on a number of topics, including Earth studies, space weather, the solar system, and the universe. Additionally, he would oversee the SMD’s grant-based research programs and spacecraft projects.⁵⁶

For the first time since its 27 April 2008 launch, ESA’s satellite GIOVE-B transmitted navigation signals. GIOVE-B, a test craft for the Galileo global navigation system, successfully transmitted the common GPS-Galileo signal in a specific optimized waveform known as multiplexed binary offset carrier (MBOC), thus demonstrating that the GPS and Galileo systems could operate compatibly. Compared to GPS, Galileo would provide deeper penetration for indoor navigation and a greater level of accuracy in environments where multipath and interference occur. ESA officials would analyze the quality of the signal to ensure that it conformed to the system’s design specification, that it did not interfere with services on adjacent frequency bands, and that the environment did not affect the signal.⁵⁷

8 May

NASA’s KSC announced that it had awarded a contract for the construction of the Ares-I mobile launcher to Hensel Phelps of Orlando, Florida. The Ares-I rocket, as part of the Constellation Program, would transport the *Orion* CEV (crew exploration vehicle), with its crew and cargo, into low Earth orbit. The contractor had agreed to construct a mobile launcher that would transport the Ares I to the launchpad and to provide ground support for the launches. The mobile launcher would comprise a main support structure, which would include a base, a tower, and ground-support systems for the facility. Handel Phelps would supply all of the equipment, labor, and materials for the project; separate contracts would provide for ground-support equipment.

⁵⁵ Frank D. Roylance, “APL To Build Craft That Will Touch the Sun,” *Baltimore Sun*, 3 May 2008; Brian Berger, “Ambitious NASA Probe To Fly Through Sun’s Fringe,” *Space.com*, <http://www.space.com/5370-ambitious-nasa-probe-fly-sun-fringe.html> (accessed 16 March 2011).

⁵⁶ NASA, “Weiler Assumes Official Role as NASA Science Chief,” news release 08-114, 7 May 2008, http://www.nasa.gov/home/hqnews/2008/may/HQ_08114_Weiler_Science_AA.html (accessed 16 March 2011).

⁵⁷ ESA, “GIOVE-B Transmitting Its First Signals,” press release no. 26-2008, 7 May 2008, http://www.esa.int/esaCP/Pr_26_2008_p_EN.html (accessed 29 March 2011).

The firm fixed-price contract, which included an option for an additional Ares-I mobile launcher, could be worth up to US\$263,735,000, if NASA exercised all the options.⁵⁸

14 May

An uncrewed Russian cargo ship, known as Progress-M 64 or Progress 29, launched at 20:23 (UT) aboard a Soyuz-U rocket from the Baikonur Cosmodrome in Kazakhstan. It carried 3.1 tonnes (3,100 kilograms or 6,834.33 pounds) of supplies to the crew of the ISS, including 568 pounds (257.64 kilograms) of food; 282 pounds (127.91 kilograms) of hygiene products; 277 pounds (125.65 kilograms) of medicine; 770 pounds (349.27 kilograms) of propellant; over 100 pounds (45.36 kilograms) of oxygen and air; and 925 pounds (419.57 kilograms) of water. Also traveling to the ISS aboard the cargo craft were 90 snails that would be part of a scientific experiment studying the effects of weightlessness on live organisms. The ISS crew expected Progress to dock automatically with the ISS on 17 May 2008.⁵⁹

15 May

A team of researchers, led by Roger J. Phillips of the Southwest Research Institute in Boulder, Colorado, announced in the online version of the journal *Science* that NASA's Mars Reconnaissance Orbiter (MRO) had gathered evidence indicating that Mars's lithosphere is colder and thicker than scientists had previously thought. Using the Shallow Radar (SHARAD) on the MRO, the researchers had produced the most precise pictures to date of the Martian crust and upper mantle below the polar ice cap. The ice cap on Mars is 1.2 miles (1.93 kilometers) deep and 310,000 square miles (802,896.31 square kilometers) wide. On Earth, the force of a similar weight would cause the lithosphere to sag, but the Martian lithosphere remains level and even. The crust's rigidity implies that the planet's interior is colder than scientists had previously thought, indicating that any aquifers of liquid water that may exist on Mars would lie deeper below the surface, closer to the planet's warm core. The radar pictures also showed that the crust is composed of layers of icy dust, interspersed with layers of almost pure ice. The researchers believed that vacillations in Mars's orbit had caused the planet's climate to change, resulting in these layers. ASI, the Italian space agency, had produced the SHARAD. NASA's JPL managed MRO for NASA's SMD.⁶⁰

21 May

The X Prize Foundation announced that four new teams had registered for the Google Lunar X Prize competition, bringing the total number of registered teams to 14. The Google Lunar X Prize race would grant US\$20 million to the first team to build a privately funded spacecraft that would land on the Moon, move 500 meters, and transmit data, images, and video back to Earth. The deadline for receiving the full purse had been set for 31 December 2012; after that date, the

⁵⁸ NASA, "NASA Awards Contract for Ares I Mobile Launcher," news release C08-025, 8 May 2008, http://www.nasa.gov/home/hqnews/2008/may/HQ_C08025_Ares_MLP_contract.html (accessed 16 March 2011).

⁵⁹ *Spacewarn Bulletin*, no. 655, 1 June 2008, <http://nssdc.gsfc.nasa.gov/spacwarn/spx655.html> (accessed 16 March 2011); Tariq Malik, "Russian Cargo Ship Launches Toward Space Station," *Space.com*, 15 May 2008, <http://www.space.com/5344-russian-cargo-ship-launches-space-station.html> (accessed 16 March 2011).

⁶⁰ NASA, "NASA Satellite Finds Interior of Mars Is Colder," news release 08-128, 15 May 2008, http://www.nasa.gov/home/hqnews/2008/may/HQ_08128_MRO_Mars_Temp.html (accessed 16 March 2011); Charles Q. Choi, "Brrr! Mars Colder Than Expected," *Space.com*, 16 May 2008, <http://www.space.com/5347-brrr-mars-colder-expected.html> (accessed 16 March 2011); see also Roger J. Phillips, "Mars North Polar Deposits: Stratigraphy, Age, and Geodynamical," *Science* 320, no. 5880 (30 May 2008): 1182–1185.

X Prize Foundation would reduce the value of the grand prize. The X Prize Foundation had also offered a second prize and bonus prizes. One of the new teams that had joined the competition was a mystery team. The contest rules permitted a team to keep its identity a secret until 20 July 2009. Also joining the race were the contest's first Asian team, Team Advaeros of Malaysia, led by Hanidy Yusof; the Juxtopia Urban Robotics Brilliant Application National (JURBAN) team, led by Jayfus T. Doswell and composed of both professional and student engineers; and Team STELLAR, led by Richard D. Dell and based in North Carolina.⁶¹

22 May

A team of astronomers led by Alicia M. Soderberg announced in the journal *Nature* that they had made the first observations of a supernova in the process of exploding. Before this discovery, astronomers had only observed supernovas by means of their visible light, which had traveled at least a month before reaching Earth. However, by serendipity, Soderberg had viewed the supernova SN 2008D from the beginning of its explosion. She had been observing the star's galaxy using NASA's Swift X-ray Telescope, when she caught the initial explosion of SN 2008D, only visible in the x-ray wavelength. Soderberg had alerted the astronomy community of the event. Scientists had trained several telescopes, including NASA's HST and NASA's Chandra X-ray Observatory, on SN 2008D. They had watched the star as it exploded over the following days. Scientists hoped that studying the initial x-ray burst of SN 2008D would teach them how to recognize and observe other supernovas in the future.⁶²

23 May

A team of researchers announced in the journal *Science* that they had found on Mars soil deposits composed of more than 90 percent silica. NASA's Spirit rover had found the deposits in the Columbia Hills in Mars's Gusev Crater. Initially, scientists had used Spirit's Miniature Thermal Emission Spectrometer (Mini-TES) and Alpha Particle X-Ray Spectrometer to identify a pure silica deposit in the groove that Spirit's broken front wheel had made as it dragged through the dirt. Subsequently, they had found other silica deposits nearby. On Earth, pure silica forms from the interaction of hot water and rock. Therefore, the scientists believed that these deposits might indicate that Mars had possessed hydrothermal vents in its ancient past. Because hydrothermal vents support microbial life on Earth, scientists believed that similar vents on Mars might also have hosted life.⁶³

25 May

Ernst Stuhlinger, one of the original members of Werner von Braun's rocket team, died at his home in Huntsville, Alabama, at the age of 94. The U.S. government had brought the team to the United States after World War II. Stuhlinger, Associate Director of Science on von Braun's team, was an expert in spacecraft guidance and navigation instruments. Stuhlinger had also made

⁶¹ *Space.com*, "Four New Teams Join Moon Rover Race," 22 May 2008, <http://www.space.com/5383-teams-join-moon-rover-race.html> (accessed 29 March 2011).

⁶² Dennis Overbye, "Scientists See Supernova in Action," *New York Times*, 22 May 2008; Andrea Thompson, "Supernova Birth Observed for First Time," *Space.com*, 22 May 2008, <http://www.space.com/5371-supernova-birth-observed-time.html> (accessed 16 March 2011); see also A. M. Soderberg et al., "An Extremely Luminous X-Ray Outburst at the Birth of a Supernova," *Nature* 453, no. 7194 (22 May 2008): 469–474.

⁶³ Andrea Thompson, "Hydrothermal Vents on Mars Could Have Supported Life," *Space.com*, 23 May 2008, <http://www.space.com/5374-hydrothermal-vents-mars-supported-life.html> (accessed 16 March 2011); see also S. W. Squyres et al., "Detection of Silica-Rich Deposits on Mars," *Science* 320, no. 5879 (23 May 2008): 1063–1067.

important contributions in the field of propulsion. He had developed an innovative second-stage firing device for Explorer 1 in his garage, becoming renowned for having pressed the button that triggered that device at exactly the right moment during the satellite's 1958 launch. Before his retirement in 1975, Stuhlinger had served as Director of Science at NASA's MSFC. He was author of the 1964 book, *Ion Propulsion for Space Flight* and co-author of the 1993 biography *Werner von Braun: Crusader for Space*.⁶⁴

NASA's Phoenix spacecraft made a successful landing in the Martian northern polar region, beginning a three-month mission to burrow into the soil of Mars in search of water ice and carbon-based compounds. Phoenix had launched on 4 August 2007 and had completed a 422-million-mile (679.14-kilometer) journey to reach Mars. Phoenix was the sixth spacecraft to land safely on Mars and the first craft since the 1976 Viking 2 to land without airbags. The spacecraft, built by Lockheed Martin Space Systems, was 7 feet (2.13 meters) tall and weighed 904 pounds (410.05 kilograms). It contained seven scientific instruments, including cameras, small chemistry labs, an 8-foot-long (2.44-meter-long) robotic arm, and a weather station. The Phoenix mission, which cost US\$457 million, would be the first to collect water samples on another planet. The University of Arizona was leading the mission, in partnership with NASA's JPL and Lockheed Martin in Denver. International contributors to the mission included CSA; the University of Copenhagen and the University of Aarhus, both in Denmark; the Max Planck Institute in Germany; the University of Neuchatel in Switzerland; and the Finnish Meteorological Institute.⁶⁵

31 May

Space Shuttle *Discovery* launched from NASA's KSC at 21:02 (UT), commencing Mission STS-124 to the ISS. During liftoff, observers noticed pieces of insulating foam falling from *Discovery*'s external fuel tank; however, NASA officials stated that they were not worried about the foam, since it had fallen after the time when it could have damaged the spacecraft. Seven crew members were aboard the Space Shuttle, including American astronauts, Commander Mark E. Kelly, Pilot Kenneth T. Ham, Gregory B. Birely, Michael E. Fossum, Ronald J. Garan Jr., and Karen L. Nyberg, and Japanese astronaut Akihiko Hoshide. During the mission, the astronauts planned to repair a broken toilet on the ISS and to install on the Japanese Kibo laboratory a new, 16-tonne (16,000-kilogram or 35,273-pound) room, known as the Japanese Pressurized Module (JPM). The astronauts planned three spacewalks. In addition to installing the JPM, they intended to clean a damaged power-supply rotary joint and to perform routine maintenance. NASA planned for the mission to last for 14 days. Garrett E. Reisman, who had been aboard the ISS since March 2008, would return to Earth with the STS-124 crew, and Chamitoff would remain aboard the ISS in his place.⁶⁶

⁶⁴ John Noble Wilford, "Ernst Stuhlinger, Rocket Scientist Crucial in Space Race, Is Dead at 94," *New York Times*, 28 May 2008; Martin Weil, "Ernst Stuhlinger, 94; Space Program Pioneer," *Washington Post*, 27 May 2008.

⁶⁵ NASA, "NASA's Phoenix Spacecraft Lands at Martian Arctic Site," news release JLP2008-081, 25 May 2008, http://www.nasa.gov/home/hqnews/2008/may/HQ_JPL2008-081_Phoenix.html (accessed 16 March 2011); John Johnson Jr., "NASA's Phoenix Spacecraft Is Ready To Get Its Hands Dirty on Mars," *Los Angeles Times*, 27 May 2008; Mark Carreau, "Soft Landing on a Rough Mars Terrain," *Houston Chronicle*, 26 May 2008.

⁶⁶ *Spacewarn Bulletin*, no. 655; NASA, "NASA's Shuttle Discovery Launches with Japanese Laboratory," news release 08-136, 31 May 2008, http://www.nasa.gov/home/hqnews/2008/may/HQ_08136_STS-124_launch_release.html (accessed 16 March 2011); John Schwartz, "Shuttle Discovery Heads Toward the Space Station," *New York Times*, 1 June 2008.

JUNE 2008

5 June

Engineers completed thermal vacuum testing of the Lunar Crater Observation and Sensing Satellite (LCROSS) at the Northrop Grumman facility in Redondo Beach, California. LCROSS was a NASA mission to search for water ice in a permanently shadowed crater in the Moon's polar region. The satellite successfully completed the tests, which simulated the temperature variations in space, from highs of 230°F (110°C) to lows of -40°F (-40°C). After completing all final checkout tests, Northrop Grumman planned to deliver LCROSS to NASA's KSC for integration on the Atlas V, as a secondary payload to Lunar Reconnaissance Orbiter (LRO). The LCROSS mission was part of the Lunar Precursor Robotic Program at NASA's MSFC.⁶⁷

11 June

NASA successfully launched its Gamma-Ray Large Area Telescope (GLAST) aboard a Delta-2 rocket from Cape Canaveral Air Force Station at 16:05 (UT). GLAST could survey the entire sky every 3 hours, searching for gamma-ray bursts (GRBs). Scientists hoped to study GRBs to further their understanding of black holes, dark matter, and the laws of physics. GLAST consisted of two elements: the Gamma-Ray Burst Monitor (GBM) and the Large Area Telescope (LAT). The GBM was able to detect gamma-ray bursts and to orient the LAT to observe them more closely. NASA, the U.S. Department of Energy, and 37 other research institutions worldwide were collaborating on the US\$690 million spacecraft.⁶⁸

The International Astronomical Union (IAU) announced at a meeting in Oslo, Norway, that it would henceforth use the term "plutoid" to classify objects similar to Pluto. Astronomers had formerly believed that Pluto was a planet, but in 2006 the IAU had determined that Pluto was more accurately classified as an "object." The 2003 discovery of an object both bigger and farther from the Sun than Pluto, in an area known as the Kuiper Belt, had precipitated the controversial decision to change Pluto's status. Astronomers had named the newly discovered object Eris. Since that discovery, astronomers had adopted a number of terms to describe Pluto and Eris, including "dwarf planet," "Kuiper Belt object," and "plutino." The IAU's choice of the word "plutoid" was meant to quell the confusion. The IAU defined "plutoids" as "celestial bodies in orbit around the Sun at a distance greater than that of Neptune that have sufficient mass for the self-gravity to overcome rigid body forces so that they assume a hydrostatic equilibrium (near-spherical) shape, and that have not cleared the neighborhood around their orbit." However, although Pluto and Eris fit this definition, the object Ceres, which is located between Mars and Jupiter, did not qualify for the status of "plutoid." The IAU stated that it expected that astronomers would discover more plutoids in the future. Since the early twentieth century, the IAU had been officially responsible for naming astronomical bodies. However, some

⁶⁷ NASA, "Moon-Bound NASA Spacecraft Passes Major Preflight Tests," news release 08-156, 24 June 2008, http://www.nasa.gov/home/hqnews/2008/jun/HQ_08156_LCROSS.html (accessed 21 April 2011).

⁶⁸ *Spacewarn Bulletin*, no. 656, 1 July 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx656.html> (accessed 24 April 2011); NASA, "NASA's GLAST Launch Successful," news release 08-141, 11 June 2008, http://www.nasa.gov/home/hqnews/2008/jun/HQ_08141_GLAST_Launch.html (accessed 21 April 2011); Dennis Overbye, "NASA Launches an Orbiting Mystery-Solver," *New York Times*, 12 June 2008.

astronomers expressed their opposition to the term “plutoid” and to the IAU’s decision-making process in selecting the name.⁶⁹

12 June

NASA announced that it had awarded a contract to the Houston-based firm Oceaneering International for the design, development, and production of a new line of spacesuits for the Constellation Program. Under the new contract, NASA would order 109 spacesuits for astronauts to use on voyages to the ISS and, later, to the Moon. The cost-plus-award-fee contract included a basic performance period and two contract options. The basic performance period of the contract included the design, manufacture, and first flight of the suit components. Valued at US\$183.8 million, the basic performance period would run from June 2008 to September 2014. Option 1, the development and testing of the components of a spacesuit for use on the Moon’s surface, had a value of US\$302 million and would run from October 2010 through September 2018. Option 2, the production of the *Orion* suit, had a value of US\$260 million and would run from October 2014 through September 2018. NASA also announced the subcontractors for the Constellation Program: Air-Lock of Milford, Connecticut; David Clark of Worcester, Massachusetts; Cimarron Software Services of Houston, Texas; Harris Corporation of Palm Bay, Florida; Honeywell International of Glendale, Arizona; Paragon Space Development of Tucson, Arizona; and United Space Alliance of Houston. Oceaneering International had competed for the contract against Explorations Systems and Technology, which was a joint venture of Hamilton Sundstrand and ILC Dover. Hamilton Sundstrand had been the primary contractor providing NASA’s spacesuits since the 1960s.⁷⁰

NASA announced that the International Mineralogical Association had confirmed the identification of a new mineral—manganese silicide—that scientists believed had originated in a comet. Keiko Nakamura-Messenger of NASA’s JSC had led the research, with contributions from scientists in Germany, Japan, and the United States. The researchers had named the mineral “Brownleeite,” in honor of University of Washington professor Donald E. Brownlee, who had originated the study of interplanetary dust particles (IDPs). Scientists examine IDPs because these tiny grains of space sand are composed of the original building blocks of the solar system. NASA had found the Brownleeite on an IDP collected in 2003 by an ER-2 high-altitude aircraft flown out of NASA’s DFRC at Edwards Air Force Base. The aircraft had collected dust from the stream of the comet 26P/Grigg-Skjellerup. NASA’s JSC had analyzed the tiny IDP, which measured only 0.0001 inches (0.000254 centimeters), using a transmission electron microscope.⁷¹

13 June

NASA and Alliant Techsystems (ATK) performed a successful test firing of the igniter on the abort motor of the *Orion* CEV. The abort motor’s function was to separate the crew capsule from the Ares-I launch vehicle, in case of an emergency on the launchpad or during the first 300,000

⁶⁹ Robert Roy Britt, “Pluto Now Called a Plutoid,” *Space.com*, 11 June 2008, <http://www.space.com/5494-pluto-called-plutoid.html> (accessed 29 April 2011).

⁷⁰ NASA, “NASA Awards Contract for Constellation Spacesuit for the Moon,” news release C08-037, 12 June 2008, http://www.nasa.gov/home/hqnews/2008/jun/HQ_C08037_Constellation_Spacesuit.html (accessed 12 June 2011); Associated Press, “Oceaneering International Awarded Contract for New Spacesuit,” 12 June 2008.

⁷¹ NASA, “NASA Finds New Type of Comet Dust Mineral,” news release 08-143, 12 June 2008, http://www.nasa.gov/home/hqnews/2008/jun/HQ_08143_comet_dust.html (accessed 21 April 2011).

feet (91,440 meters) of ascent. The igniter, a 36-inch-long (91.44-centimeter-long) piece that would light the motor's solid propellant, generated roughly 21,000 pounds (9,525.44 kilograms) of thrust during the testing, with combustion gas temperatures of more than 5,800°F (3,204°C). Engineers ascertained that the motor had performed as expected. They planned to use the test results to assess the igniter's ballistic properties and the pressure created inside its chamber. The testing took place at ATK's facility in Promontory, Utah.⁷²

The National Aeronautic Association awarded its prestigious Robert J. Collier trophy to a team of researchers that included staff from NASA's ARC and NASA's LaRC. The team, named Automatic Dependent Surveillance-Broadcast (ADS-B), had developed a system for air traffic control using GPS satellite technology. The system was able to provide air traffic controllers and pilots with highly accurate air traffic data in real-time updated displays. It also gave pilots weather, terrain, and flight-information services. The National Aeronautic Association had been awarding the Collier Trophy since 1911, to researchers with significant achievements in American aeronautics or astronautics.⁷³

14 June

Space Shuttle *Discovery* landed at NASA's KSC at 11:15 (EDT), completing Mission STS-124 to the ISS. The crew included NASA astronauts, Commander Mark E. Kelly, Kenneth T. Ham, Michael E. Fossum, Karen L. Nyberg, Ronald J. Garan Jr., and Garrett E. Reisman, and Akihiko Hoshide of JAXA. Reisman was returning to Earth after almost three months aboard the ISS. Gregory E. Chamitoff had taken his place aboard the ISS. The astronauts had transported the second room of JAXA's Kibo laboratory, the JPM, to the ISS. During the course of the 14-day mission, the crew had conducted three spacewalks. They had installed the JPM, which was approximately the size of a bus, along with its robotic arm. In addition, they had installed in its permanent position the laboratory's logistics module, which had been in a temporary location since March 2008.⁷⁴

20 June

The Ocean Surface Topography Mission/Jason-2 satellite launched from Vandenberg Air Force Base aboard a Delta-2 rocket at 07:46 (UT). The 510-kilogram (1,124.36-pound) craft was a joint mission of the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT); the French space agency (Centre National d'Études Spatiales—CNES); the National Oceanic and Atmospheric Administration (NOAA); and NASA. EUMETSAT's aim was to continue the data-collection mission that NASA and CNES had begun in 1992 with their ocean topography experiment, the TOPEX/Poseidon mission, and had continued with the 2001 launch of Jason 1. Jason 2 had five instruments—improved versions of those aboard Jason 1—that could chart the topography of the ocean's surface, the speed and direction of the ocean's current, and the amount of solar energy the ocean stores. Scientists hoped to use these measurements to track global climate change, to hone their predictions of hurricane intensity,

⁷² NASA, "NASA, ATK Conduct First Launch Abort System Igniter Test for Orion," news release 08-147, 16 June 2008, http://www.nasa.gov/home/hqnews/2008/jun/HQ_08147_Orion_igniter_test.html (accessed 21 April 2011).

⁷³ NASA, "NASA A Team Recipient of Celebrated Collier Trophy," news release 08-148, 13 June 2008, http://www.nasa.gov/home/hqnews/2008/jun/HQ_08148_Collier_Trophy.html (accessed 21 April 2011).

⁷⁴ NASA, "NASA's Shuttle Discovery Glides Home After Successful Mission," news release 08-150, 14 June 2008, http://www.nasa.gov/home/hqnews/2008/jun/HQ_08150_discovery_lands.html (accessed 21 April 2011).

and to improve their understanding of currents, eddies, and tides. The project partners had scheduled Jason 2 to fly in tandem with Jason 1 for approximately six months, while engineers calibrated Jason 2's instruments. Afterwards, the two spacecraft would travel in separate orbits, doubling the global satellite coverage.⁷⁵

23 June

The Senate Commerce, Science and Transportation Subcommittee on Space, Aeronautics, and Related Sciences held a field hearing in Florida to assess the impact on NASA's KSC workforce of the transition from the Space Shuttle Program (SSP) to the Constellation Program. Early in 2008, NASA had estimated that ending the SSP would force the elimination of 6,400 workers. However, at the hearing, NASA Administrator Michael D. Griffin testified that new hiring for the Constellation Program would offset some of those job losses. Altogether, he estimated that NASA's KSC would only lose 3,000–4,000 workers. As it shifted its workforce duties from other space centers to NASA's KSC, NASA would also create some new jobs. For instance, although the sustaining engineering for the SSP had mostly taken place at NASA's JSC and NASA's MSFC, the sustaining engineering work for the Constellation Program would occur in Florida. Additionally, NASA intended to perform final assembly and integration of the Altair landers, Ares-5 rockets, and *Orion* capsules at NASA's KSC. At the time of the hearing, NASA's KSC had a workforce of 14,500 people.⁷⁶

26 June

A team of scientists reported in the journal *Nature* that they had gathered new evidence to support the theory that Mars's Borealis Basin is a large impact crater. After NASA's Viking spacecraft had captured the first clear images of the Martian surface in the 1970s, scientists had puzzled over the dichotomy of the planet: the roughly cratered southern highlands have an altitude 2.5 to 5 miles (4.02 to 8.05 kilometers) higher than the smooth plains of the northern lowlands. One theory that scientists had advanced to explain this dichotomy was that the impact of a foreign object had created the lowlands of the Borealis Basin. However, many in the scientific community had doubted this theory because the images from the 1970s suggested that the basin did not have the typical shape of an impact crater. In the article in *Nature*, NASA's MRO and NASA's Mars Global Surveyor teams reported that they had gathered new topographical and gravitational data, showing that the basin has an elliptical shape consistent with that of impact craters. Moreover, two other studies published in the same *Nature* issue had used computer models to demonstrate that a meteor might conceivably have created the Borealis Basin. Scientists estimated that an object 1,250 miles (2,011.68 kilometers) wide, traveling at a speed of approximately 20,000 miles (32,186.88 kilometers) per hour, could have formed the crater when it crashed into Mars. If this theory proved correct, the Borealis Basin would be the largest known impact crater in the solar system.⁷⁷

⁷⁵ *Spacewarn Bulletin*, no. 656, 1 July 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx656.html> (accessed 24 April 2011); NASA, "NASA Launches Ocean Satellite To Keep a Weather, Climate Eye Open," news release 08-154, 20 June 2008, http://www.nasa.gov/home/hqnews/2008/jun/HQ_08154_OSTM-Jason-2_Launch.html (accessed 21 April 2011).

⁷⁶ Todd Halvorson, "KSC Tries To Salvage Some Jobs," *Florida Today* (Brevard, FL), 24 June 2008.

⁷⁷ NASA, "NASA Spacecraft Reveal Largest Crater in Solar System," news release 08-159, 25 June 2008, http://www.nasa.gov/home/hqnews/2008/jun/HQ_08159_Mars_crater.html (accessed 21 April 2011); Kenneth Chang, "Astronomers Explain Mars's Lopsided Shape," *New York Times*, 26 June 2008; see also Jeffrey C.

28 June

Robert C. Seamans Jr., who had served as NASA Deputy Administrator during the Apollo era, died of heart failure at age 89. Seamans had begun his career as a professor at the Massachusetts Institute of Technology (MIT) in the 1940s. In 1960 he had accepted a position with NASA as Associate Administrator, and, from 1965 to 1968, he had served as Deputy Administrator. During his tenure, NASA had worked to achieve President John F. Kennedy's goal of landing a man on the Moon, and Seamans had been instrumental to the success of that mission. In 1968 Seamans had left his position at NASA to return to MIT, although he remained a consultant to NASA's Administrator. Later that year, he had assisted in making the controversial decision to send *Apollo 8* to orbit the Moon, a move that had laid the groundwork for the lunar landing. Seamans had served as Secretary of the U.S. Air Force from 1969 to 1973. In 1974 he had been appointed Administrator of the Energy, Research and Development Administration, a predecessor agency to the Department of Energy. In 1977 Seamans had accepted a position as Dean of the School of Engineering at MIT, where he had continued to teach aeronautics classes even after his formal retirement in 1984.⁷⁸

30 June

NASA announced astronaut James F. Reilly's resignation from NASA to pursue a career in the private sector. Reilly had been an astronaut since 1994. During his first mission, in January 1998, he had flown aboard Space Shuttle *Endeavour* on Mission STS-89 to *Mir*. In 2001 he had participated in the STS-104 flight of *Atlantis* to the ISS. On that mission, he had made three spacewalks to install a joint airlock on the ISS. On his final flight, Mission STS-117 in 2007, he had again flown aboard *Atlantis* to the ISS, making two additional spacewalks to perform construction and maintenance on the ISS. During his career as an astronaut, Reilly had logged more than 853 hours in space and more than 31 hours of spacewalking.⁷⁹

NASA announced the resignation of Robert P. Hopkins as NASA's Chief of Strategic Communications. Hopkins had held positions at NASA as Senior Advisor to Deputy Administrator Shana L. Dale and as Assistant Administrator of the Office of Communications Planning. Over the course of his career, he had managed the development of a strategic communications plan that had served as the basis for NASA activities, such as planning NASA's fiftieth anniversary in 2008. Additionally, Hopkins had enacted initiatives, such as a communications portal and a toolkit for implementing the Communications Coordinating Committee, helping to facilitate communication across NASA. He had advanced NASA's outreach through development programs, such as the NASA Future Forums and the NASA Lecture Series. Upon leaving NASA, Hopkins planned to take a position in the private sector. NASA Administrator Michael D. Griffin named Christopher M. Shank as Acting Chief of Strategic Communications. Shank had joined NASA in 2005, after holding positions in the U.S. Air Force, in the NRO, and, as a staff member on the U.S. House Science and Technology

Andrews-Hanna, Mary T. Zuber, and W. Bruce Banerdt, "The Borealis Basin and the Origin of the Martian Crustal Dichotomy," *Nature* 453, no. 7199 (26 June 2008): 1212–1215.

⁷⁸ Peter Schworm, "Robert Seamans; Helped Lead NASA During Apollo Missions," *Boston Globe*, 30 June 2008.

⁷⁹ NASA, "Astronaut James Reilly Leaves NASA," news release 08-162, 30 June 2008, http://www.nasa.gov/home/hqnews/2008/jun/HQ_08163_Seamans_statement.html (accessed 21 April 2011).

Subcommittee on Space and Aeronautics. At NASA, Shank had served as Director of Strategic Investments for the Office of Program Analysis and Evaluation.⁸⁰

JULY 2008

4 July

In a series of 11 articles published in the journal *Science*, researchers reported on the data MESSENGER had gathered during its 14 January 2008 fly-by of Mercury. During the mission, the spacecraft had taken high-resolution images of Mercury's surface, sampled ions in the planet's atmosphere, taken altitude measurements, and gathered data on Mercury's atmospheric composition and surface chemistry. The MESSENGER images settled a scientific debate, which had been ongoing since the 1970s, regarding whether Mercury's smooth plains had formed from cooled lava or from melted rock resulting from the impact of a large meteor crashing into the planet's surface. The images showed a topography indicating that lava flows had formed the plains, as well as evidence of volcanoes, including a 60-mile-wide (96.56-kilometer-wide) shield volcano in the Caloris Basin. The MESSENGER data also showed that, as Mercury's dense core had cooled, the planet had contracted at least 30 percent more than researchers had previously thought. This contraction had affected Mercury's magnetic field. MESSENGER's measurements showed that Mercury's magnetic field is mostly dipolar, like that of Earth. However, Mercury's magnetic field is much weaker than Earth's. Because of the planet's weak magnetic field and close proximity to the Sun, solar winds weather Mercury's atmosphere and surface chemistry. Scientists hoped that Mercury's "space weathering" would help them measure the age of the planet's geographical features.⁸¹

10 July

Russian cosmonauts Sergei A. Volkov and Oleg D. Kononenko removed an explosive bolt from a *Soyuz* spacecraft docked at the ISS. The spacewalk was the first for both cosmonauts. Despite experiencing some initial delays at the beginning of the 6-hour spacewalk, Volkov and Kononenko were able successfully to pry off the 3-inch (7.62-centimeter) bolt and to deposit it in a blast-proof case. If the bolt had accidentally discharged during its removal, the force of the explosion could have torn open the cosmonauts' spacesuits. Russian engineers expected that the *Soyuz* mission scheduled for 23 October 2008 would return the bolt to Earth. The engineers hoped to study the bolt, to determine why similar bolts had failed or misfired during the *Soyuz* reentries of 21 October 2007 and 19 April 2008. Because of those malfunctions, the spacecraft had entered Earth's atmosphere at steeper-than-normal angles, subjecting the crews to higher gravitational forces and causing the vehicles to land as far as 300 miles (482.80 kilometers) off course.⁸²

⁸⁰ NASA, "Strategic Communications Chief Hopkins Leaving NASA," news release 08-164, 30 June 2008, http://www.nasa.gov/home/hqnews/2008/jun/HQ_08164_Hopkins_leaving_NASA.html (accessed 21 April 2011).

⁸¹ NASA, "NASA Reveals New Discoveries from Mercury," news release 08-166, 3 July 2008, http://www.nasa.gov/home/hqnews/2008/jul/HQ_08166_Messenger_Mercury.html (accessed 26 May 2001); Andrea Thompson, "Volcanoes on Mercury Solve 30-Year Mystery," *Space.com*, 3 July 2008, <http://www.space.com/5589-volcanoes-mercury-solve-30-year-mystery.html> (accessed 26 May 2011).

⁸² Mark Carreau, "Cosmonauts Remove Explosive Bolt on Daring Spacewalk," *Houston Chronicle*, 11 July 2008.

14 July

Hamilton Sundstrand, a subsidiary of United Technologies, filed a protest with GAO requesting a review of a contract award to design spacesuits for the Constellation Program. Along with its partner, ILC Dover of Frederica, Delaware, Hamilton Sundstrand sought to clarify the reasons NASA had awarded the contract to Oceaneering International of Houston, Texas, and its partner, David Clark. Hamilton Sundstrand had been the sole supplier of spacesuits to NASA from the 1960s until NASA's award of the most recent contract. The new contract specified the production of 109 extra vehicular activity (EVA) suits, including 24 lunar suits. It was valued at US\$184 million for the initial phase through September 2014, with options through 2018, which could place the total contract value at US\$562 million.⁸³

15 July

In their second spacewalk in five days, Russian cosmonauts Sergei A. Volkov and Oleg D. Kononenko left the ISS to undertake a spacewalk in which they set up a docking target and worked on two scientific experiments. The ISS partners had originally scheduled the tasks for the 10 July 2008 spacewalk, but officials had postponed those activities to allow time for the removal of an explosive bolt on a *Soyuz* spacecraft. During the walk, which lasted nearly 6 hours, Volkov and Kononenko placed a docking target on the side of the Zvezda module, in preparation for the scheduled arrival in 2009 of a new airlock, the Mini-Research Module 2 (MRM2). The astronauts then installed a physics experiment called *Vsplesk*, which would study the effects of high-energy particle streams near Earth. The cosmonauts also retrieved the payload of the Biorisk experiment, which had studied the effects of space radiation and zero gravity on microorganisms. Additionally, they made an impromptu repair of a ham-radio antenna.⁸⁴

17 July

NASA announced that Robert D. Strain had accepted the position of Center Director of NASA's GSFC, the Greenbelt, Maryland, facility that develops uncrewed scientific spacecraft and administers NASA's Earth observation, astronomy, and space physics missions. Strain had been serving as the Head of the Space Department at the Johns Hopkins University's APL in Laurel, Maryland. He had previously served as the Associate Department Head and Assistant Department Head at APL, and as an executive at Axiom Corporation, Orbital Sciences Corporation, and Fairchild Space and Defense Company. NASA expected that Strain would begin work as Center Director at NASA's GSFC on 4 August 2008.⁸⁵

Leaders from the partner agencies that work on the ISS met at ESA headquarters in Paris to discuss the configuration, development, and operation of their activities. Those present for the discussion included representatives of the space agencies of Canada, Europe, Japan, Russia, and the United States. They noted the achievements aboard the ISS since their last meeting, in January 2007, including the delivery of two new laboratories, a node, and a large robot, as well as the launching of ESA's ATV and the formation of a global ground-operation control center. In

⁸³ J. Lynn Lunsford, "Hamilton Files Protest on NASA Spacesuit Decision," *Wall Street Journal*, 16 July 2008; Stephen Singer for Associated Press, "Hamilton Sundstrand Protests NASA Contract," 16 July 2008.

⁸⁴ Jeremy Hsu, "Cosmonauts' Second Spacewalk Goes Smoothly," *Space.com*, 16 July 2008, <http://www.space.com/5630-cosmonauts-spacewalk-smoothly.html> (accessed 26 May 2011).

⁸⁵ NASA, "NASA Names Strain New Goddard Space Flight Center Director," news release 08-179, 17 July 2008, http://www.nasa.gov/home/hqnews/2008/jul/HQ_08179_Strain_GSFC_Director.html (accessed 18 May 2011).

addition, the agency heads discussed the ISS's improved capacity for engineering testing, on-orbit research, and technological development. They also examined future plans for the ISS, including the effects of the planned change to a six-person crew in 2009, the enhanced reliance on the Russian *Soyuz* and Progress vehicles for transportation to the ISS, and the long-term use of the station beyond 2015.⁸⁶

22 July

NASA announced the cowinners of its 2007 Software of the Year Award: the Data-Parallel Line Relaxation (DPRL) software and the Adaptive Modified Gerberg-Saxton Phase Retrieval program. The DPRL, developed at NASA's ARC, simulated the heat, pressures, and shear stresses that a spacecraft experiences while entering a planet's atmosphere. Because it was more accurate than a test facility, the software allowed engineers to design optimally suited protective materials for spacecraft. NASA's JPL had developed the Adaptive Modified Gerberg-Saxton Phase Retrieval program, which used algorithms to characterize possible errors in the imaging of a telescope's scientific camera and then corrected the errors, improving the camera's resolution and sensitivity. NASA had used the software in designing its James Webb Space Telescope, scheduled to launch in 2013. NASA's Software of the Year Award recognized software inventions that had significantly improved NASA's ability to explore space and had benefited science.⁸⁷

23 July

NASA and the U.S. Department of Agriculture (USDA) Agricultural Research Service signed a memorandum of understanding (MOU) that would allow USDA to conduct research on the ISS. USDA's research project would study the biological cellular mechanisms of plants. This was the second MOU that NASA had signed with another federal agency; the first was a September 2007 agreement with the National Institutes of Health. NASA planned to promote the ISS as a national laboratory and to enter into future agreements with other government agencies, private sector research organizations, and universities.⁸⁸

24 July

NASA's Lunar Science Institute, along with nine other international space agencies, signed a statement of intent to consider participating in the International Lunar Network (ILN), a cooperative effort to install mobile science stations on the Moon. The stations would replace the technology that NASA astronauts had placed on the lunar surface during the Apollo program. The signing of the statement took place in the course of a four-day NASA Lunar Science Conference at NASA's ARC. The conference had gathered approximately 500 scientists, from Canada, France, Germany, India, Italy, Japan, Korea, the United Kingdom, and the United States, to discuss the future of lunar exploration. Although scientists from the participating agencies planned to refine the ILN concept, the agencies expected to make initial decisions

⁸⁶ NASA, "Heads of Agency International Space Station Joint Statement," news release 08-178, 17 July 2008, http://www.nasa.gov/home/hqnews/2008/jul/HQ_08178_HOA_Joint_Statement.html (accessed 18 May 2011).

⁸⁷ NASA, "NASA's Ames, JPL Win NASA Software of Year Award," news release 08-182, 22 July 2008, http://www.nasa.gov/home/hqnews/2008/jul/HQ_08182_Software_of_the_Year.html (accessed 18 July 2011).

⁸⁸ NASA, "NASA, USDA Sign Space Station Research Agreement," news release 08-184, 23 July 2008, http://www.nasa.gov/home/hqnews/2008/jul/HQ_08184_USDA_mou.html (accessed 18 May 2011).

regarding communications standards and potential landing sites, and to select a set of scientifically equivalent core instruments to perform specific measurements.⁸⁹

28 July

NASA announced that the Constellation Program had awarded to 11 companies and a university contracts to conduct 180-day studies of the systems necessary for lunar outposts. NASA would use the studies' recommendations to choose packaging options, to identify basic functions for lunar habitats, and to develop innovative avionics, computer software, and energy storage ideas, as well as equipment and techniques to assist in preparing for the outpost site. NASA had awarded contracts on six study topics. Oceaneering Space Systems of Houston would study alternative packaging options, and Honeywell International of Glendale, Arizona, would study avionics. ATK Space Systems Group of Brigham City, Utah, Battelle Memorial Institute of Columbus, Ohio, and Hamilton Sundstrand of Canoga Park, California, would study energy storage. The Boeing Company of Huntington Beach, California, ILC Dover of Frederica, Delaware, and University of Maryland, College Park, would study minimum habitation functions. Astrobotic Technology of Pittsburgh and Honeybee Robotic of New York would study methods for moving regoliths. The Charles Stark Draper Laboratory of Cambridge, Massachusetts, and United Space Alliance of Houston would study software. The maximum value of each individual award was US\$250,000, and the total value of all contracts was approximately US\$2 million.⁹⁰

Virgin Galactic unveiled a unique new aircraft, the mothership for its commercial spacecraft, a very large composite plane named WhiteKnightTwo. Virgin Galactic would use WhiteKnightTwo to lift Virgin Galactic's spacecraft, SpaceShipTwo, to approximately 48,000 feet (14,630.40 meters) above Earth. From that distance, the spacecraft could carry tourists to an altitude of 65 miles (104.61 kilometers). Virgin Galactic stated that WhiteKnightTwo also had other possible uses. Virgin Galactic could use the mothership to transport passengers from one destination on Earth to another, travelling at near orbital speeds. Furthermore, since the craft could provide short bursts of microgravity conditions, people would be able to use it to train for space travel. In addition, Virgin Galactic could use WhiteKnightTwo to launch satellites and uncrewed aerial vehicles and to carry large payloads.⁹¹

30 July

NASA observed the fiftieth anniversary of the signing of the National Aeronautics and Space Act, the 1958 law that combined the staff and facilities of the National Advisory Committee for Aeronautics with those of other governmental space research facilities, thereby establishing NASA. In honor of the occasion, the House Committee on Science and Technology held a hearing to discuss NASA's accomplishments to date and to consider future challenges facing NASA. On 9 July, the U.S. House of Representatives had commemorated the creation of NASA with the passage of H. Res. 1315, honoring the men and women of NASA on its fiftieth

⁸⁹ NASA, "NASA Hosts International Meeting for Lunar Science Discussions," new release 08-190, 29 July 2008, http://www.nasa.gov/home/hqnews/2008/jul/HQ_08190_NASA_hosts_ILN.html (accessed 18 May 2011); David Perlman, "Scientists Swap Moon, Mars Exploration Plans," *San Francisco Chronicle*, 22 July 2008.

⁹⁰ NASA, "NASA Awards Contracts for Concepts of Lunar Surface Systems," news release C08-48, 28 July 2008, http://www.nasa.gov/home/hqnews/2008/jul/HQ_C0848_Lunar_surface_contract.html (accessed 18 May 2011).

⁹¹ Leonard David, "Virgin Galactic Unveils Space Liner Mothership," *Space.com*, 28 July 2008, <http://www.space.com/5665-virgin-galactic-unveils-space-liner-mothership.html> (accessed 26 May 2011).

anniversary, acknowledging NASA's discoveries and accomplishments, and pledging that the United States would maintain a position of leadership in aeronautics, space exploration, and technology.⁹²

31 July

A team of scientists led by Robert H. Brown of the University of Arizona, Tucson, announced in the journal *Nature* that NASA's Cassini spacecraft had gathered evidence that Saturn's moon Titan has at least one lake of liquid hydrocarbons. The discovery made Titan the only known celestial body, besides Earth, to have liquid on its surface. Data from previous fly-bys had shown that Titan has several features that appear to be lakes, but scientists had been unsure whether these bodies contained liquid or solid material. Then, in a December 2007 fly-by, Cassini had used its visual and infrared mapping spectrometer (VIMS) to gather data on a lake in the southern polar region named Ontario Lacus. The lake covers an area of 7,800 square miles (20,201.91 square kilometers) and is composed of a liquid ethane solution, along with methane, other hydrocarbons, and nitrogen. At the surface temperature of Titan, which is -300°F (-184.44°C), these compounds exist both as liquid and as gas. Cassini's data showed that the lake had experienced some evaporation at summer temperatures. Titan has a methane-based hydrological cycle; therefore, the scientists believed that a precipitation of liquid methane fills Ontario Lacus.⁹³

NASA announced that LRO had successfully completed its first round of environmental testing. Engineers had performed the tests, which included a spin test and a vibration test, at NASA's GSFC. The spin test ascertained the craft's center of gravity and measured its rotation. The vibration test determined the structural integrity of LRO by simulating the shaking the craft would experience during launch. Before the launch, NASA planned for LRO to undergo acoustics testing, thermal-vacuum testing, and a simulation of separation from the rocket during launch. LRO's launch window would open on 27 February 2009.⁹⁴

NASA announced that its Phoenix Mars Lander had verified the presence of water ice in the Martian soil. Phoenix, which landed on Mars on 25 May 2008, had collected a soil sample from a 2-inch-deep (5.08-centimeter-deep) trench. Phoenix Mars Lander had dug the trench in the Martian polar region. The spacecraft had experienced difficulty moving the soil into the Thermal and Evolved-Gas Analyzer (TEGA) for testing, because the freshly dug soil samples had been

⁹² U.S. Congress, House of Representatives, Committee on Science and Technology, Subcommittee on Research and Science Education, "House Passes S&T Bills Commemorating NASA's 50th Anniversary, First Woman in Space," press release, 9 July 2008, <http://gop.science.house.gov/PressRoom/Item.aspx?ID=118#> (accessed 18 May 2011); U.S. Congress, House of Representatives, Committee on Science and Technology, Subcommittee on Research and Science Education, "Committee Holds Hearing Honoring NASA's 50th Anniversary," press release, 30 July 2008, <http://gop.science.house.gov/PressRoom/Item.aspx?ID=121#> (accessed 18 May 2011); Clinton Parks, "50 Years Ago: NASA Born in Sputnik's Wake," *Space.com*, 29 July 2008, <http://www.space.com/5671-50-years-nasa-born-sputnik-wake.html> (accessed 25 May 2011).

⁹³ Jeanna Bryner, "Giant Lake Confirmed on Saturn's Moon Titan," *Space.com*, 31 July 2008, <http://www.space.com/5673-giant-lake-confirmed-saturn-moon-titan.html> (accessed 18 May 2011); NASA, "NASA Confirms Liquid Lake in Saturn Moon," new release 08-193, 30 July 2008, http://www.nasa.gov/home/hqnews/2008/jul/HQ_08_193_Titan_lake.html (accessed 18 May 2011); see also R. H. Brown et al., "The Identification of Liquid Ethane in Titan's Ontario Lacus," *Nature* 454, no. 7204 (31 July 2008): 607–610.

⁹⁴ NASA, "NASA Tests Moon Imaging Spacecraft at Goddard," news release 08-194, 31 July 2008, http://www.nasa.gov/home/hqnews/2008/jul/HQ_08194_LRO_Environment_Tests.html (accessed 18 May 2011).

stickier than scientists had expected. After allowing some of the water to evaporate from a sample measuring 3 cubic centimeters (0.18 cubic inches), scientists had used Phoenix's whirling rasp to grate the soil into the TEGA. The TEGA had analyzed the vapor that the sample released when heated to the melting point of 32°F (0°C), confirming the presence of water in the soil. The analyzer had also examined the sample while it was heating to 1,800°F (982.22°C). Although the Mars Odyssey spacecraft had first sighted ice on the planet's surface while orbiting Mars in 2002, Phoenix's test was the first chemical analysis to prove the existence of water ice on Mars. NASA announced that it planned to add 90 days to Phoenix's original mission, extending the mission through 30 September 2008.⁹⁵

AUGUST 2008

3 August

A SpaceX Falcon 1 rocket failed, at approximately 2 minutes and 20 seconds after its launch at 03:34 (UT) from the U.S. Army's Reagan Missile Test Site on Omelek Island in the Kwajalein Atoll. SpaceX executives explained that unanticipated residual thrust from the Merlin engine had caused the first stage of the rocket to collide with the second stage, as the second stage began to fire. The rocket's two stages and its payload were destroyed in the Pacific Ocean. The Falcon 1's cargo included a Department of Defense Trailblazer demonstration satellite; NASA's NanoSail-D, a solar propulsion experiment; and NASA's small automated laboratory PRESat. Additionally, the rocket carried the ashes of 208 people who had paid the company Celestis to launch their remains into space. The ashes of astronaut L. Gordon Cooper Jr. were on board. SpaceX officials stated that they would be able to prevent a similar launch failure from happening in the future by adding 1.5 seconds to the Falcon 1's separation sequence.⁹⁶

4 August

NASA announced the appointment of Thomas B. Irvine as the new Deputy Associate Administrator of the Aeronautics Research Mission Directorate, to assist Associate Administrator Jaiwon Shin in developing, managing, and planning NASA's aeronautics research. Irvine had previously held positions as Deputy Director of the Aeronautics Test Program at NASA Headquarters; Chief of the Facility Management and Planning Office at NASA's GRC; and Director of the Mission Support Office for the Directorate at NASA Headquarters. Irvine had received NASA's Exceptional Service Medal for sustained contributions to NASA's aeronautics and spaceflight missions.⁹⁷

⁹⁵ Kenneth Chang, "Test of Mars Soil Sample Confirms Presence of Ice," *New York Times*, 1 August 2008; NASA, "NASA Spacecraft Confirms Martian Water, Mission Extended," news release 08-195, 31 July 2008, http://www.nasa.gov/home/hqnews/2008/jul/HQ_08_195_Phoenix_water.html (accessed 18 May 2008); David Perlman, "NASA Craft Probes Ice on Mars," *San Francisco Chronicle*, 1 August 2008.

⁹⁶ *Spacewarn Bulletin*, no. 658, 1 September 2008, <http://nssdc.gsfc.nasa.gov/spacwarn/spx658.html> (accessed 8 July 2011); John Schwartz, "Launch of Private Rocket Fails; Three Satellites Were Onboard," *New York Times*, 4 August 2008; Tariq Malik, "SpaceX Traces Third Rocket Failure to Timing Error," *Space.com*, 7 August 2008, <http://www.space.com/5707-spacex-traces-rocket-failure-timing-error.html> (accessed 21 July 2011).

⁹⁷ NASA, "NASA Names Irvine Deputy Associate Administrator for Aeronautics," news release 08-197, 4 August 2008, http://www.nasa.gov/home/hqnews/2008/aug/HQ_08197_Aero_Deputy.html (accessed 7 July 2011).

5 August

NASA's Human Research Program announced that it would fund nine ground-based studies on the effects of space radiation on human health. The selected study proposals, chosen from a pool of 60 submissions, would investigate issues such as damage to the central nervous system and risk predictions for cancer. Researchers from California, Colorado, Georgia, Maryland, New York, and Utah would split the total value of the US\$13 million funding. The Human Research Program's mission was to provide knowledge and technologies to improve human health during space exploration and to identify possible countermeasures for known problems.⁹⁸

7 August

NASA announced that it had awarded a contract to Northrop Grumman Corporation's Integrated Systems Division of San Diego, California, for services in support of its Northrop Grumman-manufactured Global Hawk aircraft. NASA's DFRC planned to operate the two uncrewed aircraft. The indefinite-delivery, indefinite-quantity, sole-source contract, which would span from 6 August 2008 through 5 August 2013, carried a maximum value of US\$25 million. The contract would include the operation of the aircraft, their ground control station, and related systems. Additionally, the contractor would supply technical assistance, including analysis, design support, operational and manufacturing support, simulation, and software development and engineering. NASA's DFRC planned to use the high-altitude, long-endurance, long-distance aircraft in missions in support of Earth science research and the research of NASA's SMD.⁹⁹

8 August

A team of scientists led by Janice L. Bishop of the SETI (Search for Extraterrestrial Intelligence) Institute announced in the journal *Science* that they had found geological evidence that water, and possibly microorganisms, had been present in Mars's Mawrth Vallis region in the past. Using NASA's MRO's Compact Reconnaissance Imaging Spectrometer for Mars (CRISM), the scientists had studied the layers of sediment comprising the 4 billion-year-old clay deposits of that region. The top layer of clay, which contained many aluminum deposits, had probably formed in a wet environment when other minerals were leached from the soil leaving large amounts of aluminum behind. Immediately below the top layer containing aluminum-rich clay was a layer of silica opal. Clay rich in reduced iron formed a still lower layer. A large body of water interacting with a lakebed of basaltic ash or rock probably formed the lowest layer, which is composed of iron and magnesium smectites. Bishop's team noted that, on Earth, the actions of microorganisms frequently cause iron reduction in the soil. However, the team also stated that other forces could have been responsible, on Mars.¹⁰⁰

11 August

NASA's Cassini spacecraft flew by Saturn's moon Enceladus, photographing the ice jets that spew from gorges at the Enceladus's south pole and taking measurements of them. The craft

⁹⁸ NASA, "NASA Awards Space Radiobiology Research Grants," news release 08-200, 5 August 2008, http://www.nasa.gov/home/hqnews/2008/aug/HQ_08200_NRA_Space_Radiobiology.html (accessed 7 July 2011).

⁹⁹ NASA, "NASA Awards Global Hawk Support Contract to Northrop Grumman," news release C08-050, 7 August, 2008, http://www.nasa.gov/home/hqnews/2008/aug/HQ_C08-050_GLOBAL_HAWK.html (accessed 7 July 2011).

¹⁰⁰ Andrea Thompson, "Clays Shed Light on History of Mars Water and Possibly Life," *Space.com*, 7 August 2008, <http://www.space.com/5709-clays-shed-light-history-mars-water-possibly-life.html> (accessed 20 July 2011); see also Janice L. Bishop et al., "Phyllosilicate Diversity and Past Aqueous Activity Revealed at Mawrth Vallis, Mars," *Science* 321, no. 5890 (8 August 2008): 830–833.

passed within 30 miles (48.28 kilometers) of the moon's surface, traveling at 64,000 miles per hour (102,998.02 kilometers per hour), while snapping the highest-resolution images ever taken of the ice jets. The photographs revealed the features of the gorges known as "tiger stripes," which are approximately 980 feet (298.70 meters) deep. Tiger stripes have V-shaped sides that are strewn with large chunks of ice and dusted with a fine material, apparently composed of snow-like ice particles. Scientists were interested in studying Enceladus's ice jets because of the possibility that they might indicate the presence of liquid water beneath the moon's surface.¹⁰¹

John S. Bull, a member of NASA's original class of 19 astronauts, died at the age of 73. He had never flown in space. Bull had begun to train as an astronaut in 1966. In early 1967, NASA had chosen him as a member of the crew of LTA-8, a thermal-vacuum test of the Moon lander. However, sinus problems had prevented him from participating in the mission. In November 1967, NASA had selected Bull for the support crew of the Apollo 8 mission. However, he had resigned from the astronaut corps in July 1968 because he had a rare pulmonary disorder. Bull had obtained a Master's degree and a PhD from Stanford University, returning to NASA in 1973. He had performed flight-test research at NASA's ARC until 1986 and had then managed NASA-wide research programs in autonomous systems technology for space applications, until his retirement in 1989.¹⁰²

12 August

NASA announced that it had awarded a total of US\$97,000 in prizes at the 2008 General Aviation Technology Challenge, one of NASA's seven Centennial Challenges offering technology prize competitions for independent inventors. The General Aviation Technology Challenge took place from 4 August 2008 through 10 August 2008 at the Sonoma County Airport in Santa Rosa, California. The contest encouraged inventors to design aircraft that were easier to fly, less expensive, safer, and less of a disturbance to both the environment and the communities surrounding airports. NASA provided the prize money, and the Comparative Aircraft Flight Efficiency (CAFE) Foundation managed the contest. Frank Vance Turner's team from El Dorado Hills, California, won the largest prize, a US\$50,000 purse for the airplane with the best safety features. Turner's team also won prizes for the shortest takeoff distance and best angle of climb. In addition, the Turner team shared a prize for lowest cabin noise with John A. Dunham's team from Carson City, Nevada. Dunham's team also won the community noise prize. John Robert "Bob" Basham won a prize for the best glide ratio. NASA had offered a US\$50,000 prize for any aircraft with a fuel efficiency of less than 30 miles (48.3 kilometers) per gallon, but none of the contestant aircraft met the requirement. NASA planned to use the unawarded prize money in the 2009 competition.¹⁰³

¹⁰¹ *Space.com*, "Cassini Spots Icy Jet Sources on Saturn Moon," 15 August 2008, <http://www.space.com/5738-cassini-spots-icy-jet-sources-saturn-moon.html> (accessed 25 July 2011); Kenneth Chang, "NASA Has Its Closest Look at Geysers on Saturn Moon," *New York Times*, 16 August 2008.

¹⁰² *Collectspace.com*, "John S. Bull, Former NASA Astronaut, Dies," 14 August 2008, <http://www.collectspace.com/news/news-081408a.html> (accessed 15 July 2011).

¹⁰³ NASA, "Prizes Awarded at NASA's General Aviation Technology Challenge," news release 08-206, 12 August 2008, http://www.nasa.gov/home/hqnews/2008/aug/HQ_08206_Centennial_Challenges_Cafe_400_Winners.html (accessed 7 July 2011).

14 August

Researchers led by Vassilis Angelopoulos of the University of California–Los Angeles (UCLA), announced in the journal *Science* that their team had demonstrated that magnetic reconnection in Earth’s magnetotail produces substorms that cause the aurora borealis to brighten and to move. Magnetic reconnection is a common phenomenon in which stretched magnetic lines suddenly snap into a new shape. Angelopoulos’s team made the discovery using data from a 26 February 2008 substorm. NASA’s Time History of Events and Macroscale Interactions during Substorms mission (THERMIS) had collected the data. THERMIS tracked the beginnings of substorms, using five satellites and 20 ground observatories to make synchronized observations every four days. Scientists were interested in studying the origins of substorms because they often occur in conjunction with strong space storms, which can interfere with human activities, such as radio communication and GPS signals.¹⁰⁴

15 August

NASA announced that it had decided to take corrective action in response to a bid protest against a contract awarded to Oceaneering International. Exploration Systems & Technology, a joint venture of Hamilton Sundstrand and ILC Dover, had filed the protest with GAO, after NASA had awarded a contract to a competitor. The contract, for the design, development, evaluation, testing, and production of spacesuits for the Constellation Program, carried an initial value of US\$184 million. NASA had concluded that a compliance issue required it to terminate the contract, for the convenience of the U.S. government. Anticipating that it would have to reconsider its procurement decision, NASA had asked both companies to make limited revisions and to resubmit their proposals.¹⁰⁵

Engineers at NASA’s MSFC completed a series of tests on a main component of the J-2X engine, which powered the upper stage of the Ares-I rocket. This series of 20 tests was the second set of four planned series to test the J-2X’s workhorse gas generator, which drives the turbopumps that start the engine. The testing programs determined the gas generator’s combustion environment, durability, and performance, as well as reducing risk in the design, fabrication, and operation of flight hardware. The achieved objectives of this test series were to address stability issues in the gas chamber and to regulate ignition timing. Pratt and Whitney Rocketdyne had fabricated the gas generator.¹⁰⁶

22 August

NASA range-safety officials destroyed an ATK suborbital rocket that had swerved off course shortly after lifting off from NASA’s Wallops Flight Facility (WFF). Officials were not sure what had caused the ALV X-1 launch vehicle to fail 27 seconds after its 5:10 (EDT) launch. The

¹⁰⁴ NASA, “NASA Satellites Discover What Powers Northern Lights,” news release 08-185, 24 July 2008, http://www.nasa.gov/home/hqnews/2008/jul/HQ_08185_THEMIS.html (accessed 21 July 2011); see also Vassilis Angelopoulos et al., “Tail Reconnection Triggering Substorm Onset,” *Science* 321, no. 5891 (15 August 2008): 931–935.

¹⁰⁵ NASA, “NASA To Take Corrective Action in Spacesuit Contract Protest,” news release C08-053, 15 August 2011, http://www.nasa.gov/home/hqnews/2008/aug/HQ_08053_Spacesuit_Protest.html (accessed 7 July 2011); David Ivanovich and Mark Carreau, “NASA Nixes Oceaneering’s Suit Contract; Reopens Bidding,” *Houston Chronicle*, 18 August 2008.

¹⁰⁶ NASA, “NASA Engineers Complete Engine Test Series for Ares I Rocket,” news release 08-208, 18 August 2008, http://www.nasa.gov/home/hqnews/2008/aug/HQ_08-208_Ares_engine_test.html (accessed 7 July 2011).

rocket carried US\$11 million worth of NASA experiments, including a hypersonic flight experiment called HYBOLT (Hypersonic Boundary Layer Transition) and the Sub-Orbital Aerodynamic Re-entry Experiments (SOAREX), which would have tested new reentry design elements for spaceflight vehicles. In addition to NASA's experiments, the rocket's payload included a U.S. Naval Research Laboratory experiment to test GPS systems. NASA officials stated that they believed that the majority of the debris had fallen into the Atlantic Ocean.¹⁰⁷

26 August

NASA announced that it had renamed its GLAST telescope the Fermi Gamma-Ray Space Telescope, in honor of the early twentieth century scientist Enrico Fermi. Fermi had developed a theory to explain how cosmic particles could be accelerated to high speeds. His work formed the basis of the scientific study of gamma rays. NASA also announced that the telescope, which had launched on 11 June 2008, had successfully completed two months of instrument testing and calibration. Scientists hoped to use the Fermi Gamma-Ray Space Telescope to study gamma rays and to make new discoveries about black holes, pulsars, and the laws of physics.¹⁰⁸

28 August

NASA announced that it had signed a cooperative Space Act Agreement with the Challenger Center for Space Education of Alexandria, Virginia. The partnership would use hands-on interactive educational activities to interest students, as well as their families, teachers, and the public, in the study of engineering, mathematics, science, and technology. The Challenger Center, founded in 1986, consisted of a network of 50 Challenger Learning Centers that train teachers to use project-based learning and space exploration themes to engage skills in critical thinking, communication, decision making, and teamwork.¹⁰⁹

SEPTEMBER 2008

3 September

Officials at NASA's LaRC announced that they had completed a series of 11 tests on the Pratt & Whitney Rocketdyne SJX61-2 scramjet engine in the 8-Foot High Temperature wind tunnel. The tests had been NASA's contribution to the mission to build the X-51 WaveRider aircraft. The design of the X-51 WaveRider would enable the craft to travel at speeds near Mach 7 for approximately 5 minutes. The U.S. Air Force Research Laboratory and U.S. Defense Advanced Research Projects Agency had been the main contributors to the US\$246 million X-51 project. LaRC had tested a combined cycle, jet-fueled, air-breathing, flight-clearance engine, similar to

¹⁰⁷ NASA, "NASA and ATK Investigate Failed Launch of Hypersonic Experiments," news release 08-213, 22 August 2008, http://www.nasa.gov/home/hqnews/2008/aug/HQ_08_213_Hybolt_failure.html (accessed 7 July 2011); Carol Vaughn, "Wallops Rocket Launch Fails," *Salisbury Daily Times* (MD), 25 August 2008.

¹⁰⁸ NASA, "NASA Renames Observatory for Fermi, Reveals Entire Gamma-Ray Sky," news release 08-214, 26 August 2008, http://www.nasa.gov/home/hqnews/2008/aug/HQ_08214_NASA_renames_GLAST.html (accessed 25 July 2011).

¹⁰⁹ NASA, "NASA and Challenger Center Combining Efforts for Students," news release 08-217, 28 August 2008, http://www.nasa.gov/home/hqnews/2008/aug/HQ_08217_NASA_Challenger_Center.html (accessed 25 July 2011).

the engine that the X-51 would use. NASA engineers expected that they would complete testing by the end of September 2008.¹¹⁰

5 September

ESA's space probe Rosetta flew within 800 kilometers (497.10 miles) of asteroid 2867 Steins, travelling at speeds up to 8.6 kilometers per second (5.34 miles per second). Measuring only 4.6 kilometers (2.86 miles) in diameter, Steins is an irregularly shaped, E-type asteroid, located 360 million kilometers (223,693,629 miles) from Earth. From 4 August 2008 until 4 September 2008, Rosetta had observed Steins with its Osiris camera and two other cameras. ESA investigators had turned off the Osiris camera as the probe approached the asteroid, but 15 other instruments, including the Philae lander magnetometer, remained operational, collecting data about Steins. The instruments gathered data about Stein's orbital motion, rotation, shape, and density. Additionally, Rosetta observed the asteroid's surface, gathering information about its age, terrain, chemical and mineralogical composition, and weathering from solar wind. Rosetta had launched on 2 March 2004 for a planned 11.5-year mission that would ultimately take it to the comet 67P/Churyumov-Gerasimenko. ESA had scheduled Rosetta to continue observing Steins until 10 September 2008. Through the study of asteroids, scientists hoped to gain a better understanding of the early history of the solar system and planetary evolution.¹¹¹

ESA's first ATV, known as Jules Verne, undocked from the ISS at 23:29 (CEST). The ATV, which had launched on 9 March 2008, had carried 6 tonnes (6.6 tons or 13,227.74 pounds) of supplies to the ISS, including clothing, food, oxygen, propellants, water, and other dry cargo. The US\$1.9 billion craft had remained docked at the ISS for six months, serving as an extra room. While there, the ATV had boosted the ISS's orbit four times to counter residual atmospheric drag. Additionally, on 27 August 2008, the ATV had performed an avoidance maneuver to take the ISS out of the path of debris from an old satellite. Before Jules Verne's departure, ISS crew members had loaded it with 2.5 tonnes (2,500 kilograms or 2.76 tons) of trash. ESA had scheduled the ATV to enter a controlled destructive reentry of Earth's atmosphere on 29 September 2008.¹¹²

9 September

NASA's Office of Education announced that NASA had selected seven institutions, from among those qualified under the Historically Black Colleges and Universities and Other Minority Universities Program, to receive research grants worth a total of US\$35 million. Part of NASA's Minority University Research and Education Program, the grants would establish

¹¹⁰ Brian Berger, "NASA Helping U.S. Air Force Gear Up for 2009 X-51 Flights," *Space.com*, 8 September 2008, <http://www.space.com/5804-nasa-helping-air-force-gear-2009-51-flights.html> (accessed 27 July 2011); John Croft, "X-51A Scramjet Readied for Flight Tests," *Flight International*, 10 September 2008.

¹¹¹ ESA, "Encounter of a Different Kind: Rosetta Observes Asteroid at Close Quarters," news release 37-2008, 6 September 2008, http://www.esa.int/esaCP/Pr_37_2008_p_EN.html (accessed 26 July 2011); Peter B. de Selding, "Despite Glitch, European Spacecraft's Asteroid Flyby a Success," *Space.com*, 6 September 2008, <http://www.space.com/5809-glitch-european-spacecraft-asteroid-flyby-success.html> (accessed 27 July 2011).

¹¹² ESA, "ESA's ATV Successfully Undocks from International Space Station," news release 36-2008, 5 September 2008, http://www.esa.int/esaCP/Pr_36_2008_p_EN.html (accessed 26 July 2011); ESA, "Successful Re-entry Marks Bright Future for ATV," news release 41-2008, 29 September 2008, http://www.esa.int/esaCP/Pr_41_2008_p_EN.html (accessed 26 July 2011); Tariq Malik, "European Cargo Ship Departs Space Station," *Space.com*, 6 September 2008, <http://www.space.com/5810-european-cargo-ship-departs-space-station.html> (accessed 29 July 2011).

multidisciplinary commercial, engineering, and scientific university research centers that could contribute to NASA programs. Additionally, the grants would build partnerships between NASA and university faculty and students, increase the number of minorities with advanced degrees in NASA-related fields, and increase university aerospace research and technology development capacity. Each university would receive a maximum of US\$1 million per year, for a maximum of five years. NASA had selected the programs of the Center for Advanced Nanoscale Materials II at the University of Puerto Rico, Rio Piedras Campus, San Juan; the Center for Bio-Nanotechnology and Environmental Research, Texas Southern University, Houston; the Center for Excellence in Systems Engineering for Space Exploration Technologies, Morgan State University, Baltimore; the Center for Radiation Engineering and Science for Space Exploration, Prairie View A & M University, Prairie View, Texas; Howard University Beltsville Center for Climate System Observation, Washington, DC; NASA University Research Center SPACE Center, California State University, Los Angeles; and WaterSCAPES: Science of Coupled Aquatic Processes in Ecosystems from Space, Florida International University, Miami.¹¹³

10 September

NASA announced that it had successfully completed the preliminary design review for the Ares-I rocket, thereby clearing the components of the rocket to enter the detailed design phase. The review had examined Ares to determine whether it met NASA's standards and whether all of the rocket's disparate elements would work together. More than 1,100 reviewers from seven NASA field centers and from NASA's industry partners had contributed to the design review. Conducted at NASA's MSFC, it was the first preliminary design review of a crewed rocket that NASA had conducted since 1973. NASA officials stated that 10 percent of the issues raised during the design review lacked resolutions, including questions pertaining to the stage separation, booster noise, and the type of weather protection that the rocket would need during ascent. NASA had scheduled a final integrated review of the whole rocket for March 2011.¹¹⁴

11 September

A team of scientists led by Judith L. Racusin of Penn State University reported in the journal *Nature* their discovery that GRB 080319B had appeared extraordinarily bright because its jet had pointed almost directly at Earth. First sighted by NASA's Swift satellite on 19 March 2008, GRB 080319B had been 7.5 billion light-years away from Earth, in the constellation Bootes. After Swift had sighted it, scientists around the globe had begun observing the GRB as it brightened to a magnitude of 5.3 on the astronomical brightness scale. For approximately 40 seconds, GRB 080319B had been visible to the naked human eye. Racusin's team showed that the GRB's jet had been composed of a narrow core, 0.4° wide, moving at almost the speed of light. A slightly slower jet, approximately 20 times wider than the core, had surrounded it. The team theorized that, if other GRB jets also have bright cores, astronomers might not often see them, because GRB jets rarely point in Earth's direction, and their cores are very narrow.¹¹⁵

¹¹³ NASA, "NASA Awards Education Research Grants to Minority Universities," news release 08-226, 9 September 2008, http://www.nasa.gov/home/hqnews/2008/sep/HQ_08226_educ_Grants.html (accessed 26 July 2011).

¹¹⁴ NASA, "NASA's Ares I Rocket Passes Review To Reach Critical Milestone," news release 08-228, 10 September 2008, http://www.nasa.gov/home/hqnews/2008/sep/HQ_08228_Ares_PDR.html (accessed 26 July 2011); Tariq Malik, "NASA's New Rocket Passes Early Design Review," *Space.com*, 10 September 2011, <http://www.space.com/5831-nasa-rocket-passes-early-design-review.html> (accessed 27 July 2011).

¹¹⁵ NASA, "'Naked-Eye' Gamma-Ray Burst Was Aimed Squarely at Earth," news release 08-223, 10 September 2008, http://www.nasa.gov/home/hqnews/2008/sep/HQ_08-223_Swift_Gamma_Ray_burst.html (accessed 26 July 2011).

13 September

NASA's Swift satellite spotted the most distant GRB that scientists had ever seen. Swift's Burst Alert Telescope first sighted the exploding star at 1:47 a.m. (EDT); less than 2 minutes later, Swift's X-ray Telescope began to observe the GRB. A team of astronomers from around the globe examined light from the fading GRB in seven wavelengths, to determine its distance from Earth. The explosion's shift toward the less energetic red end of the electromagnetic spectrum—a phenomenon known as a redshift—indicated its remoteness. Named GRB 080913, the explosion had occurred 12.8 billion light-years away from Earth, in the constellation Eridanus. Occurring when the universe was less than 825 million years old, GRB 080913 was 70 million light-years farther away from Earth than the most distant previously known GRB.¹¹⁶

15 September

NASA announced that it had selected a proposal for a robotic mission to Mars, a mission that would study the planet's atmosphere, climate history, and potential habitability. Out of 20 proposals submitted, NASA had accepted the proposal of the Laboratory for Atmospheric and Space Physics at the University of Colorado at Boulder to build the US\$485 million Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft. According to the proposal, MAVEN would begin orbiting Mars in the fall of 2014. Over the course of one Earth year, the craft would use its eight instruments to gather data, including a study of the upper atmosphere 80 miles (128.75 kilometers) above the Martian surface. Scientists would also be able to use MAVEN to relay support for robotic missions on the ground on Mars. NASA would provide the University of Colorado with US\$6 million for mission planning and technology development, and Lockheed Martin would build the spacecraft. NASA's GSFC would manage the MAVEN mission. MAVEN would be the second mission conducted by the Mars Scout Program—NASA's series of small, low-cost, principal investigator-led missions to Mars.¹¹⁷

NASA announced that, for the first time, it had used commercially owned aircraft to test hardware and technologies in microgravity research flights. NASA had flown the aircraft out of Ellington Field in Houston on 9 and 10 September 2008, performing the first tests in NASA's program, Facilitated Access to the Space Environment for Technology Development and Training (FAST). Zero Gravity of Las Vegas, which had conducted the flights under a contract with NASA's GRC, had achieved microgravity conditions by flying an airplane on a parabolic trajectory. Each of the typical 2-hour flights had consisted of 50 parabolas, yielding up to 25 seconds of microgravity. NASA had originally scheduled the flights for 11 and 12 September but had suspended the tests because of the approach of Hurricane Ike. Five private companies had

2011); Andrea Thompson, "Scream of Black Hole's Birth Detected Halfway Across the Universe," *Space.com*, 10 September 2008, <http://www.space.com/5826-scream-black-hole-birth-detected-halfway-universe.html> (accessed 29 July 2011); see also J. L. Racusin et al., "Broadband Observations of the Naked-Eye γ -Ray Burst GRB 080319B," *Nature* 455, no. 7270 (11 September 2008): 183–188.

¹¹⁶ NASA, "NASA's Swift Catches Farthest-Ever Gamma-Ray Burst," news release 08-239, 19 September 2008, http://www.nasa.gov/home/hqnews/2008/sep/HQ_08239_Swift_GRB_discovery.html (26 July 2011).

¹¹⁷ NASA "NASA Selects Mission To Study Mars Atmosphere," news release 08-233, 15 September 2008, http://www.nasa.gov/home/hqnews/2008/sep/HQ_08-233_MAVEN_Mars_mission.html (accessed 26 July 2011).

flown experiments on the airplanes alongside NASA's experiments, as part of NASA's Small Business Innovation Research (SBIR) program.¹¹⁸

17 September

The Russian automatic cargo carrier Progress-M 65 (Progress 30) successfully docked with the ISS at 2:43 a.m. (EDT), after a delay caused by the weather-related evacuation of NASA's JSC. The ISS partners had rescheduled the docking, originally planned for 12 September 2008, because of Hurricane Ike. When NASA evacuated the center's ISS control room in response to the hurricane's approach, flight controllers had not yet made the adjustments necessary to prevent the ISS's solar arrays sustaining damage during the cargo carrier's docking. Russia had launched Progress aboard a Soyuz rocket from Baikonur Cosmodrome in Kazakhstan on 10 September 2008 at 19:50 (UT). The carrier was transporting a total of 2.5 tons (2,267.96 kilograms) of supplies for the crew on the ISS, including 110 pounds (49.90 kilograms) of oxygen, 1,918 pounds (869.99 kilograms) of propellant, 463 pounds (210.01 kilograms) of water, and 2,866 pounds (1,300.00 kilograms) of food, clothing, equipment, and other dry cargo. News agencies also reported that Progress was carrying a new Russian Orlan spacesuit. In advance of Progress-M 65's arrival, the crew had filled the previous cargo carrier Progress 29 with trash and had undocked from the ISS on 1 September 2008.¹¹⁹

28 September

After three failed attempts, SpaceX successfully launched a Falcon-1 rocket for the first time. Falcon 1 was the first privately developed and funded rocket to achieve orbit. Liftoff occurred at 23:15 (UT) from the U.S. Army's Ronald Reagan Ballistic Defense Test Site on the Kwajalein Atoll. SpaceX had designed the 70-foot (21.34-meter), two-stage, liquid-fueled rocket to provide cost-effective access to space. The company hoped that Falcon 1 would provide an affordable research option for universities and small aerospace companies and would serve as the first installment in a family of rockets that NASA would eventually use to resupply the ISS. SpaceX officials stated that each flight of Falcon 1 cost approximately US\$8 million.¹²⁰

29 September

The People's Republic of China's *Shenzhou 7* successfully returned to Earth, landing in Mongolia at 09:38 (UT), in China's third crewed mission to space. *Shenzhou 7* had launched from Jiquan in Gansu Province on 25 September 2008 at 13:10 (UT), on a Long March-2F rocket, with astronauts Zhai Zhigang, Liu Boming, and Jing Haipeng on board. On 27 September 2008, Zhai had performed China's first spacewalk, leaving the spacecraft for 20 minutes to collect a test sample of solid lubricant that engineers had attached to the outside of the craft. The

¹¹⁸ NASA, "NASA Uses Commercial Microgravity Flight Services for First Time," news release 08-232, http://www.nasa.gov/home/hqnews/2008/sep/HQ_08232_Commercial_Zero_G.html (accessed 26 July 2011).

¹¹⁹ *Spacewarn Bulletin*, no. 659, 1 October 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx659.html> (accessed 25 July 2011); Tarik Malik, "New Cargo Ship Arrives at Space Station," *Space.com*, 17 September 2008, <http://www.space.com/5852-cargo-ship-arrives-space-station.html> (accessed 28 July 2011); Todd Halvorson, "Russian Freighter Rockets Toward Station," *Florida Today* (Brevard, FL), 11 September 2008.

¹²⁰ *Spacewarn Bulletin*, no. 659, 1 October 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx659.html> (accessed 25 July 2011); Mike Swift, "Silicon Valley Businessman Launches Rocket into Orbit," *San Jose Mercury News* (San Jose, CA), 29 September 2008; Tariq Malik, "SpaceX Successfully Launches Falcon 1 Rocket into Orbit," *Space.com*, 28 September 2008, <http://www.space.com/5905-spacex-successfully-launches-falcon-1-rocket-orbit.html> (accessed 27 July 2011).

spacewalk also tested Zhai's US\$4.4 million Chinese-made spacesuit. After the spacewalk, the astronauts had released an 88-pound (39.92-kilogram) satellite, which would take photographs and transmit them back to Earth. The mission marked China as the third nation, along with the United States and Russia, capable of independently launching crewed spaceflights and conducting spacewalks.¹²¹

30 September

NASA announced that William W. Parsons would be resigning as Director of NASA's KSC to pursue opportunities in the private sector. Parsons had begun his career with NASA in 1990. He had served in numerous positions, including Director of NASA's Stennis Space Center (SSC), Launch Site Support Manager, Manager of the Space Station Hardware Integration Office, Chief of Operations of the Propulsion Test Directorate, SSP Manager, and Deputy Director of NASA's JSC. NASA had selected former astronaut Robert D. Cabana as the new Director of NASA's KSC. Cabana, who had completed his astronaut training in 1986, had flown on four Space Shuttle missions: STS-41 in October 1990, STS-53 in December 1992, STS-65 in July 1994, and STS-88 in December 1988. Additionally, he had served as Director of NASA's SSC, Deputy Director of NASA's JSC, Chief of NASA's Astronaut Office, Manager of International Operations of the ISS Program, Director of NASA's Human Spaceflight Program in Russia, Deputy Director of the ISS Program, and Director of Flight Crew Operations.¹²²

President George W. Bush signed into law Pub. L. No. 110-329, the Consolidated Security, Disaster Assistance and Continuing Appropriations Act for 2009, which included language renewing through July 2016 NASA's waiver from the Iran-North Korea-Syria Nonproliferation Act (INKSNA). The terms of INKSNA, as enacted in 2000, barred U.S. government agencies from making "extraordinary payments" to Russia, unless the President of the United States had certified that Russia was not exporting missile and nuclear technologies to Iran. Under these terms, NASA would be unable to purchase transport on *Soyuz* spacecraft. In 2005 Congress had enacted legislation granting NASA a waiver from INKSNA through January 2012, allowing NASA to negotiate a US\$700 million contract for occasional flights to the ISS aboard the Russian *Soyuz* and Progress vehicles. However, that contract would expire in 2011, and Congress needed to renew the waiver before NASA could begin negotiating a new contract. NASA would need to purchase *Soyuz* vehicles to transport American, Canadian, European and Japanese astronauts to the ISS during the period between the retirement of the Space Shuttle Program (SSP), scheduled for 2010, and the first flights of the Constellation Program, scheduled for 2015.¹²³

GAO released a report assessing NASA's challenges in defining the scope and costs of Space Shuttle transition and retirement. The Consolidated Appropriations Act, 2008 (Pub. L. No. 110-

¹²¹ *Spacewarn Bulletin*, no. 659, 1 October 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx659.html> (accessed 25 July 2011); Clara Moskowitz, "China's Third Manned Spaceflight Returns Safely to Earth," *Space.com*, 28 September 2008, <http://www.space.com/5904-china-manned-spaceflight-returns-safely-earth.html> (accessed 27 July 2011); Christopher Bodeen, "Chinese Cheer as Astronauts Makes [sic] First Spacewalk," Associated Press, 28 September 2008.

¹²² NASA, "Cabana To Succeed Parsons as Kennedy Space Center Director," news release 08-249, 30 September 2008, http://www.nasa.gov/home/hqnews/2008/sep/HQ_08-249_Parsons_leaves.html (accessed 25 July 2011).

¹²³ Brian Berger, "Bush Signs NASA Budget, Soyuz Waiver into Law," *Space.com*, 5 October 2008, <http://www.space.com/5929-bush-signs-nasa-budget-soyuz-waiver-law.html> (accessed 16 August 2011).

161), had directed GAO to evaluate NASA's plans and progress in transitioning and retiring the SSP's equipment and facilities. From February 2008 to August 2008, GAO had examined the challenges NASA had faced in defining the scope and costs of retiring the SSP. GAO had noted whether NASA had reflected these costs in its budget requests. The report noted some specific challenges in ascertaining costs, including NASA's need to determine which SSP equipment would be retained for the Constellation Program; the cost of making artifacts from the SSP safe for public display, and how to offset many costs through the exchange or sale of property. The report determined that NASA's 2010 budget request had not accurately reflected the costs of SSP retirement, partly because NASA had not yet assessed those costs, and partly because NASA had not reflected some of the SSP's indirect costs in the SSP budget line. The report directed NASA to include in its budget requests for FY 2010, and for future years, its best estimates of total direct and indirect costs of transition and retirement of the SSP. NASA concurred with GAO's recommendation.¹²⁴

OCTOBER 2008

1 October

NASA announced that it had extended the U.S. On-Orbit Segment Acceptance and Vehicle Sustaining Engineering contract awarded to the Boeing Company through 30 September 2010. Originally granted in January 1995, the contract provided engineering support for the ISS. The contractor would complete delivery and on-orbit acceptance of the American section of the ISS, provide end-to-end subsystem management for the majority of the ISS's systems, support American hardware and software provided to international participants in the ISS program, and sustain engineering of the ISS's hardware and software. The contractor would work at NASA's JSC, KSC, and MSFC. The contract was valued at US\$350 million.¹²⁵

6 October

NASA's Aeronautic Research Mission Directorate announced that it had awarded six research contracts, with a combined value of US\$12.4 million, for the study of advanced concepts in subsonic and supersonic commercial transport. The 18-month studies would focus on the development of key technologies and advancements that would allow NASA to prepare innovative new commercial vehicles for public use sometime during 2030–2035. The studies were the first phase of a two-phase acquisition process; NASA would ask participants who successfully completed Phase 1 to submit proposals for Phase 2. The leaders of the six study teams were Boeing Company, GE Aviation, Lockheed Martin, MIT, and Northrop Grumman. Each team's contract was valued at approximately US\$2 million.¹²⁶

7 October

The X Prize Foundation of Santa Monica, California, announced that two new teams, Independence-X Aerospace and Omega Envoy, had joined the Google Lunar X Prize

¹²⁴ U.S. Government Accountability Office, "NASA: Agency Faces Challenges Defining Scope and Costs of Space Shuttle Transition and Retirement" (report no. GAO-08-1096, Washington, DC, September 2008), <http://www.gao.gov/new.items/d081096.pdf> (accessed 3 August 2011).

¹²⁵ NASA, "NASA Extend International Space Station Contract," news release C08-059, 1 October 2008, http://www.nasa.gov/home/hqnews/2008/oct/HQ_C08-059_ISS_Contract.html (accessed 16 August 2011).

¹²⁶ NASA, "NASA Awards Future Vehicle Aircraft Research Contracts," news release C08-060, 6 October 2008, http://www.nasa.gov/home/hqnews/2008/oct/HQ_C08-060_ARMD_contracts.html (accessed 8 August 2011).

competition, bringing the total number of registered teams to 14. Mohd Izmar Yamin led Independence-X Aerospace, a Malaysian team, and three University of Central Florida students—Jason Dunn, Justin Karl, and Rubin D. Nunez—led Omega Envoy. The Google Lunar X Prize competition was offering a US\$20 million grand prize to the first team to land a privately funded spacecraft on the Moon, move it 500 meters, and transmit data, images, and video back to Earth. The X Prize Foundation was also offering a US\$5 million prize to the second-place winner, as well as additional bonus prizes valued at US\$5 million. The deadline to collect the full purse was 31 December 2012.¹²⁷

12 October

A Russian *Soyuz* rocket lifted off from Baikonur Cosmodrome in Kazakhstan at 07:01 (UT), ferrying an American space tourist and two Expedition 18 crew members to the ISS. Tourist Richard A. Garriott was the son of former astronaut Owen K. Garriott, who had been a crew member of Skylab 3 in 1973. Garriott had reached a commercial agreement with the Russian federal space agency Roscosmos to spend nine days aboard the ISS and to return to Earth with the Expedition 17 crew on 23 October 2008. The Expedition 18 crew, consisting of Commander E. Michael Fincke of NASA and Russian cosmonaut Yuri V. Lonchakov, would replace two members of the Expedition 17 crew, Russian cosmonauts Sergei A. Volkov and Oleg D. Kononenko. The third crew member, Russian cosmonaut Gregory E. Chamitoff, had arrived at the ISS in June 2008 and planned to stay until November 2008. The main goal of Expedition 17 was to prepare the ISS to accommodate six crew members on long-duration missions.¹²⁸

15 October

President George W. Bush signed Pub. L. No 110-422, the National Aeronautics and Space Administration Authorization Act of 2008, which authorized an appropriation of US\$20.2 billion to NASA for FY 2009 for science, aeronautics, exploration, education, and space operations. The law required that NASA fly nine Space Shuttle missions to the ISS, two more flights than the previous manifest had required. Additionally, the law required that NASA make reasonable efforts to launch the Alpha Magnetic Spectrometer, an observatory that the crew would attach to the outside of the ISS. The law also required that NASA take all necessary steps to ensure that the ISS remained viable through at least 2020. The law authorized US\$1 billion for the Constellation Program, to advance progress on the *Orion* and Ares vehicles. To allow flexibility in scheduling future Space Shuttle missions, the law prohibited NASA from taking any actions that would prevent the Space Shuttle's use past its expected 2010 retirement.¹²⁹

¹²⁷ *Space.com*, "New Teams Join Private Race to Moon," 9 October 2008, <http://www.space.com/5957-teams-join-private-race-moon.html> (accessed 11 August 2011); Google Lunar X Prize, "Announcing Our Newest Preferred Partner, Analytical Graphics, Inc., and Two New Teams," 7 October 2008, <http://www.googlelunarxprize.org/lunar/featured-article/announcing-our-newest-preferred-partner-analytical-graphics-inc-and-two-new-t> (accessed 17 August 2011).

¹²⁸ *Spacewarn Bulletin*, no. 660, 1 November 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx660.html> (accessed 4 August 2011); NASA, "New Crew Blasts Off for International Space Station," news release 08-257, 12 October 2008, http://www.nasa.gov/home/hqnews/2008/oct/HQ_08-257_X18_Launch.html (accessed 8 August 2011).

¹²⁹ Eun Kyung Kim, "NASA Bill Boosts Budget \$2.6B, Adds Flight," *Florida Today* (Brevard, FL), 29 September 2008; Mark Matthews, "Bush Signs NASA Authorization Act," *Orlando Sentinel* (FL), 16 October 2008; Mark Carreau, "Bush Signs Act Allowing NASA More Shuttle Time, Money," *Houston Chronicle*, 17 October 2008.

16 October

Harrison “Jack” H. Schmitt, a scientist, former astronaut, and former U.S. Senator, announced that he was resigning as Chair of the NASA Advisory Council. The NASA Advisory Council, a panel of experts in various fields, advised the NASA Administrator on major policy. Since becoming Chair in November 2005, Schmitt had led the Advisory Council in submitting over 100 recommendations to the NASA Administrator. He had been the primary advocate behind a February 2007 workshop that produced 35 scientific recommendations related to NASA’s return to the Moon and had led the Advisory Council’s efforts to build relationships fostering the use of the ISS as a national laboratory. NASA named Kenneth M. Ford as the new Advisory Council Chair. Ford had served on the Exploration Committee of the Advisory Council since June 2007. He was the founder and Director of the Florida Institute for Human and Machine Cognition. Ford had developed and directed NASA’s Center of Excellence in Information Technology at NASA’s ARC. He had also served as both Director and Associate Director of NASA’s ARC. A recipient of NASA’s Outstanding Leadership Medal and the Robert S. Englemore Memorial Award, Ford had served on the U.S. Air Force Science Advisory Board and the National Science Board. He was also a fellow of the Association for the Advancement of Artificial Intelligence.¹³⁰

A team of astronomers led by Peter F. Michelson of Stanford University announced in the online version of the journal *Science* that NASA’s Fermi Gamma-ray Space Telescope had discovered a pulsar after detecting its gamma-ray beams. Pulsars, which are rapidly spinning collapsed neutron stars, emit radiation from their poles in jets that sweep past Earth. Usually, scientists detect the energy as radio waves and, occasionally, as x rays or visible light. Fermi’s sighting was the first time that scientists had seen a pulsar that only emits gamma rays. The team speculated that, although the pulsar might emit energy in other wavelengths, only the gamma-ray beam is wide enough for astronomers to detect from Earth. Part of the supernova CTA 1, the pulsar is approximately 4,600 light-years away from Earth, in the constellation Cepheus. Its gamma rays blink past Earth every 316.86 seconds. The team of astronomers believed that Fermi would find more gamma-ray pulsars, allowing scientists to learn more about their magnetic fields and about the rate at which stars explode.¹³¹

19 October

NASA’s Interstellar Boundary Explorer (IBEX) launched from the Kwajalein Atoll at 17:47 (UT) aboard a Pegasus-XL rocket. The probe was embarking on a two-year mission to create an image of the interstellar boundary region. IBEX carried two large-aperture, single-pixel “cameras” to create an image of the outer solar system. Instead of capturing light, the cameras detected energetic neutral atoms. Energetic neutral atoms are created in the outer solar system when the hot solar wind, moving at 1 million miles per hour (1,609,344 kilometers per hour), collides with the cold gases of interstellar space. The interstellar boundary region shelters Earth

¹³⁰ NASA, “Schmitt Completes NASA Advisory Council service; Ford Named Chairman,” news release 08-262, 16 October 2008, http://www.nasa.gov/home/hqnews/2008/oct/HQ_08-261_Schmitt_Leaves_NAC.html (accessed 8 August 2011).

¹³¹ NASA, “NASA’s Fermi’s Telescope Discovers First Gamma-Ray-Only Pulsar,” news release 08-259, 16 October 2008, http://www.nasa.gov/home/hqnews/2008/oct/HQ_08-259_Fermi_GRP.html (accessed 8 August 2011); Rachel Courtland, “First Pulsar Identified by Its Gamma Rays Alone,” *New Scientist*, 17 October 2008, <http://www.newscientist.com/article/dn14968> (accessed 10 August 2011); see also A. A. Abdo, “The Fermi Gamma-Ray Space Telescope Discovers the Pulsar in the Young Galactic Supernova Remnant CTA 1,” *Science* 322, no. 5905 (21 November 2008): 1218–1221.

from dangerous cosmic rays that otherwise would enter Earth's orbit and affect human health and spaceflight. NASA's GSFC was managing IBEX, which was part of the Small Explorers program.¹³²

22 October

Chandrayaan 1, India's first lunar satellite, launched at 00:52 (UT), aboard a PSLV-C11 rocket from Sriharikota, India. The 1.4-tonne (1,400-kilogram or 3,086.47-pound) spacecraft was on a two-year mission to map the lunar surface. It carried 11 scientific instruments: five instruments from India, three from ESA, two from NASA, and one from Bulgaria. NASA's instruments were the Moon Mineralogy Mapper (M3) and Mini Synthetic Aperture Radar (Mini-SAR). M3 was an imaging spectrometer that would create the first map of the Moon's entire surface at high spatial and spectral resolution. Because the map would show the mineral content of the lunar surface, scientists could use it to understand the geological origin and development of the Moon and the terrestrial planets. Additionally, lunar astronauts could use the map to locate water or other resources. Mini-SAR, an imaging radar, would map the permanently shadowed polar regions, helping scientists learn about possible locations of water ice and the nature of objects that hit the Moon. NASA's ground tracking station at the Johns Hopkins University APL would provide space-communications support to Chandrayaan 1.¹³³

23 October

A Russian *Soyuz* spacecraft landed in Kazakhstan at 10:37 p.m. (CDT), returning space tourist Richard A. Garriott and cosmonauts Sergei A. Volkov and Oleg D. Kononenko from the ISS. Garriott, who had been the sixth tourist to visit the ISS, had lifted off for the ISS with two American astronauts on 12 October 2008. Commander Volkov and Flight Engineer Kononenko had served 197 days aboard the ISS on the Expedition 17 mission, performing two spacewalks. During their mission, NASA's Space Shuttle had visited the ISS to deliver a Japanese laboratory. The Expedition 18 crew, American Commander E. Michael Fincke and Russian Flight Engineer Yuri V. Lonchakov, had replaced Volkov and Kononenko on the ISS.¹³⁴

27 October

NASA announced that Armadillo Aerospace of Rockwell, Texas, had won a US\$350,000 prize during the Northrop Grumman Lunar Lander Challenge in Las Cruces, New Mexico. Sponsored by NASA's Centennial Challenges program and managed by the X Prize Foundation, the Lunar Lander Challenge was a two-level competition to foster innovation in commercial space technology. Armadillo had won the first level with a vehicle demonstrating some of the

¹³² *Spacewarn Bulletin*, no. 660, 1 November 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx660.html> (accessed 4 August 2011); NASA, "NASA Launches IBEX Mission to Outer Solar System," news release 08-262, 19 October 2008, http://www.nasa.gov/home/hqnews/2008/oct/HQ_08262_IBEX_Launch.html (accessed 8 August 2011); Agence France-Presse, "NASA Launches Probe To Study Edge of Solar System," 20 October 2008.

¹³³ *Spacewarn Bulletin*, no. 660, 1 November 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx660.html> (accessed 4 August 2011); NASA, "NASA Returns to the Moon with Instruments on Indian Spacecraft," news release 08-263, 20 October 2008, http://www.nasa.gov/home/hqnews/2008/oct/HQ_08-263_NASA_on_Chandrayaan-1.html (accessed 8 August 2011).

¹³⁴ Tariq Malik, "New Space Station Crew Takes Charge," *Space.com*, 22 October 2008, <http://www.space.com/6011-space-station-crew-takes-charge.html> (accessed 11 August 2011); NASA, "Expedition 17 Crew Returns from International Space Station," news release 08-269, 23 October 2008, http://www.nasa.gov/home/hqnews/2008/oct/HQ_08-269_Expedition_17_landing.html (accessed 8 August 2011).

technologies that a lunar lander would require to transport payloads or astronauts between lunar orbit and the lunar surface. Armadillo's vehicle had risen to a height of 50 meters (164.04 feet); traveled to a landing pad 100 meters (328.08 feet) away, while staying in the air for at least 90 seconds; landed; and later repeated the flight. Armadillo's attempt at Level Two, which was more challenging, had not succeeded, leaving US\$1.65 million in unawarded prize money that NASA would make available for future competitions. In the past, the Northrop Grumman Lunar Lander Challenge had been a key event at the X Prize Cup; however, the X Prize Foundation had dramatically scaled back X Prize Cup events in 2008, because of budgetary constraints and scheduling conflicts.¹³⁵

29 October

NASA released data that MESSENGER had gathered as it flew past Mercury on 6 October 2008. At its closest approach, at 4:40 a.m. (EDT), MESSENGER had swooped about 125 miles (201.17 kilometers) above Mercury's surface. It had taken 1,287 photographs, used the Mercury Atmospheric and Surface Composition Spectrometer to gather data on the atmosphere, and observed the planet's topography using the Mercury Laser. The spacecraft had studied 30 percent of Mercury's previously unseen surface during 30 hours of scientific observations. The flyby was the second of three Mercury flybys that NASA had planned for MESSENGER; the first flyby had occurred in January 2008, and NASA had scheduled the third for March 2011. The new observations revealed that Mercury's western hemisphere is 30 percent smoother than its eastern hemisphere. Scientists described the topography as ancient, heavily cratered, and homogenous. Photographs showed high ridges, indicating that the planet had contracted significantly during its formation, as well as large impact basins and lava flows. Measurements of Mercury's magnetic field showed that the magnetic field is very symmetric and has strong exchanges of energy with solar wind. MESSENGER also discovered the presence of magnesium in Mercury's atmosphere and showed that the spatial distributions of calcium, magnesium, and sodium in the planet's atmosphere are different. These observations would allow scientists to study the interaction between Mercury's atmosphere and its surface.¹³⁶

30 October

Regular scientific observations resumed on NASA's HST after engineers repaired a broken data-relay channel. The channel, the Side-A relay of Hubble's Science Instrument Control and Data Handling System, had failed on 27 September 2008. Without the channel, HST had not been able to transmit most of its images and scientific data to Earth. Engineers had encountered some challenges in switching to the backup Side-B channel, which HST had not used since it launched in 1990. On the second attempt, however, the engineers succeeded in reactivating the Wide Field and Planetary Camera 2 and one of the three cameras on the Advanced Camera for Surveys. They intended to activate the near-infrared camera and spectrometer in November 2008. NASA announced that it would reschedule a servicing mission to update HST and to extend its mission

¹³⁵ NASA, "NASA \$350,000 Prize Goes to Armadillo Aerospace in Lunar Challenge," new release 08-271, 27 October 2008; http://www.nasa.gov/home/hqnews/2008/oct/HQ_08-271_Armadillo_Challenge.html (accessed 8 August 2011); Jose L. Medina, "X Prize Cup Shrinks," *Las Cruces Sun News* (NM), 17 October 2008.

¹³⁶ NASA, "MESSENGER Spacecraft Reveals More Hidden Territory on Mercury," news release 08-275, 29 October 2008, http://www.nasa.gov/home/hqnews/2008/oct/HQ_08-275_Messenger_Mercury.html (accessed 8 August 2011); James Dean, "Messenger Sends New Views of Mercury," *Florida Today* (Brevard, FL), 8 October 2008; Tariq Malik, "Mercury Flyby Reveals New Oddities," *Space.com*, 29 October 2008, <http://www.space.com/6035-mercury-flyby-reveals-oddities.html> (accessed 11 August 2011).

through 2013. NASA had originally scheduled the servicing mission for 14 October 2008 but had postponed it when the data-relay channel failed. The failure had prompted NASA's decision to install a spare data-handling unit, rather than to rely on the backup system indefinitely. Because its engineers would have to test the spare data-handling unit before certifying it for flight, NASA postponed the earliest possible launch date to May 2009.¹³⁷

NASA announced that Assistant Administrator for External Relations Michael F. O'Brien had signed a joint statement of intent with Munki Lee, the Republic of Korea's (South Korea's) Ministry of Education, Science, and Technology (MEST) Director-General for Big Science. The statement of intent, signed in Seoul, was an agreement between NASA and MEST to conduct dialogues that would identify new cooperative endeavors related to aeronautics research, Earth science, human spaceflight, planetary science, and space exploration. The agencies expected that they might discuss topics for possible collaborative endeavors, such as planning exploration architecture, exchanging research analysis and data, and contributing hardware and scientific instruments to future missions. They might also consider involvement in the Global Exploration Strategy, a discussion between 14 space agencies to increase cooperation in space exploration; the International Lunar Network, an initiative to establish a robotic network on the Moon; and the International Space Exploration Coordination Group, an international effort to coordinate space exploration activities. NASA and MEST expected to prepare a report after 8 months of dialogue.¹³⁸

31 October

NASA announced that it had awarded an Integrated Mission Operations Contract to United Space Alliance of Houston, Texas, for mission and flight support of the ISS and for human space exploration activities after the retirement of the Space Shuttle. The contractor would provide development and execution of capabilities for ground-based human-spaceflight operations, including training crew and flight controllers, preparing and supporting mission planning, and executing real-time missions. The cost-plus-award-fee contract, valued at US\$206.5 million, covered the period of 1 November 2008 through 30 September 2011. An optional one-year extension, if exercised, would continue through 30 September 2012 and would bring the total value of the contract to US\$371 million.¹³⁹

NOVEMBER 2008

3 November

The Congressional Budget Office (CBO) released a report assessing the implications of possible delays in the retirement of the Space Shuttle and the commencement of Constellation Program flights. The report determined that NASA had a 20 to 60 percent probability of being able to fly the 10 scheduled Space Shuttle missions in the next two years. CBO had studied the gap in NASA's ability to launch human spaceflight after the retirement of the Space Shuttle and had

¹³⁷ *Space.com*, "Hubble Telescope Photographs a Perfect Cosmic 10," 30 October 2008, <http://www.space.com/6044-hubble-telescope-photographs-perfect-cosmic-10.html> (accessed 11 August 2011); Todd Halvorson, "Hubble Operating, Sending Images," *Florida Today* (Brevard, FL), 31 October 2008.

¹³⁸ NASA, "NASA and Korea Sign Statement of Intent for Future Cooperation," news release 08-277, 30 October 2008, http://www.nasa.gov/home/hqnews/2008/oct/HQ_08277_Korea_Agreement.html (accessed 8 August 2011).

¹³⁹ NASA, "NASA Awards Contract for Mission, Crew Operations Support," news release C08-064, 31 October 2008, http://www.nasa.gov/home/hqnews/2008/oct/HQ_C08-064_Mission_Ops.html (accessed 8 August 2011).

determined that a one-year delay in the retirement of the SSP would result in a corresponding one-year delay in initial flights of the Constellation Program. Furthermore, CBO had found that the gap could grow longer if NASA proved unable to meet the technological challenges of developing the Ares and *Orion* vehicles. Based on an analysis of 72 past NASA programs, CBO estimated that the cost growth of the Constellation Program would be approximately 50 percent and that the program would require as much as US\$7 billion more than NASA had budgeted. Therefore, if NASA did not have real growth in its budgetary allocation, the additional costs could delay the initial operating capability for Ares I and *Orion* by as much as 18 months. CBO projected that funding of the Constellation Program would increase after 2013; however, CBO also reported that NASA had determined that additional funding would not change the date that the Ares and *Orion* vehicles would reach initial operation capability.¹⁴⁰

10 November

NASA announced that officials had ceased operations on the Phoenix Mars Lander after Lander stopped communicating with mission engineers on 2 November 2008. The project team had originally scheduled Phoenix for three months of operations, launching Phoenix on 4 August 2007 and landing it on Mars on 25 May 2008. NASA had extended its mission twice until, with the seasonal decline in sunlight, Phoenix's solar arrays could no longer charge its batteries. During its mission, the US\$428 million Lander had taken more than 25,000 pictures of Mars and had observed the planet's soil and weather, looking for indications that Mars might have had an environment suitable for microbes in the past. Phoenix had documented falling snow on Mars; had found calcium carbonate, perchlorates, and salts deposits; had observed alkaline soil; and had verified the presence of two distinct types of water ice. The University of Arizona had led the Phoenix mission, and NASA's JPL had managed the project.¹⁴¹

NASA's GRC announced that it had awarded a contract for the definition, design, fabrication, assembly, integration, test, and operation of spaceflight projects to ZIN Technologies of Middleburg Heights, Ohio. The cost-plus-incentive-fee, indefinite-delivery, indefinite-quantity contract covered a base period of three years, with two optional one-year extensions. The contract's total value was US\$94.5 million. The contractor would perform ISS flight investigations, particularly in the Exploration Technology Development Program and Human Research Program. The projects would include advanced technology development and demonstrations in power, energy storage and distribution, in-space propulsion, lunar surface and in-situ resource applications, space communications, and spacecraft fire safety.¹⁴²

¹⁴⁰ Becky Iannotta, "Report: Space Shuttle Retirement Date in Jeopardy," *Space.com*, 4 November 2008, <http://www.space.com/6062-report-space-shuttle-retirement-date-jeopardy.html> (accessed 25 August 2011); U.S. Congressional Budget Office, "An Analysis of NASA's Plans for Continuing Human Spaceflight After Retiring the Space Shuttle (report, Washington, DC, November 2008), http://www.cbo.gov/ftpdocs/98xx/doc9886/11-03-NASA_Letter.pdf (accessed 25 August 2011).

¹⁴¹ NASA, "Mars Phoenix Lander Finishes Successful Work on Red Planet," news release 08-284, 10 November 2008, http://www.nasa.gov/home/hqnews/2008/nov/HQ_08-284_Phoenix_Finishes_Mission.html (accessed 22 August 2011); Kenneth Chang, "NASA Loses Contact with Mars Lander and Ends Its Mission," *New York Times*, 11 November.

¹⁴² NASA, "NASA Awards Contract for Space Flight Projects Systems Development and Operations," news release C08-065, 10 November 2008, http://www.nasa.gov/home/hqnews/2008/nov/HQ_C08065_GRC_ZIN.html (accessed 22 August 2011).

12 November

NASA announced that Richard J. Gilbrech would be resigning his position as NASA's Associate Administrator for Exploration Systems to accept a position in the private sector. During his 17 years of service with NASA, Gilbrech had held positions as Director of NASA's SSC and as Deputy Center Director of NASA's LaRC. Effective 24 November 2008, Douglas R. Cooke would replace Gilbrech. Cooke was serving as Deputy Associate Administrator for Exploration Systems. In his 35 years with NASA, Cooke had served as Manager for the Advanced Development Office at NASA's JSC, Manager of the Exploration Programs Office, and Deputy Manager of the Space Station Program. He had served as a technical advisor to the *Columbia* Accident Investigation Board, a member of the team that conducted the 90-day study on lunar and Mars exploration, and a member of the Synthesis Group, which had reported to the White House on America's space exploration initiative.¹⁴³

14 November

Indian Space Research Organisation (ISRO) announced that its lunar orbiter craft, Chandrayaan 1, had dropped a Moon Impact Probe to the lunar surface. The 64-pound (29.03-kilogram) probe, which measured 14.70 inches (37.34 centimeters) by 14.7 inches (37.34 centimeters) by 18.5 inches (46.99 centimeters), landed on the Moon at 10:01 (EST). The probe's mission was to test soft-landing technologies and to observe the lunar surface. It carried a mass spectrometer to study the lunar atmosphere, a radar altimeter to measure the probe's altitude, and a video imaging system to photograph the descent. Chandrayaan 1, a US\$80 million mission, had launched on 22 October 2008, joining China, Europe, Japan, Russia, and the United States as the only nations that had sent missions to the Moon.¹⁴⁴

15 November

Space Shuttle *Endeavour* launched at 00:55 (UT) from NASA's KSC with a crew of seven astronauts and a cargo of 32,000 pounds (14,514.96 kilograms) of supplies. The crew reported seeing debris falling during the seconds after liftoff; however, they saw no evidence of damage to the Space Shuttle. The main goal of Mission STS-126 was to make improvements to the ISS that would expand its housing capacity from a crew of three to a crew of six. The astronauts planned to install additional sleeping quarters, equipment for generating oxygen, a resistance exercise device, an additional toilet, and a system for purifying fluids—including urine—into drinking water. Additionally, officials had scheduled four spacewalks, primarily to clean and lubricate the two Solar Alpha Rotary Joints, which allow the ISS's solar arrays to track the Sun. The STS-126 crew, commanded by Christopher J. Ferguson, included Pilot Eric A. Boe, and Mission Specialists Stephen G. Bowen, Robert S. Kimbrough, Sandra H. Magnus, Donald R. Pettit, and Heidemarie M. Stefanyshyn-Piper.¹⁴⁵

¹⁴³ NASA, "NASA Announces Exploration Systems Directorate Leadership Changes," news release 08-286, 12 November 2008, http://www.nasa.gov/home/hqnews/2008/nov/HQ_08-286_ESMD_leadership.html (accessed 12 November 2011).

¹⁴⁴ *Space.com*, "India Slams Probe into the Moon," 14 November 2008, <http://www.space.com/6113-india-slams-probe-moon.html> (accessed 25 August 2011); Associated Press, "India's First Lunar Probe Lands on the Moon," 15 November 2008.

¹⁴⁵ *Spacewarn Bulletin*, no. 661, 1 December 2008, <http://nssdc.gsfc.nasa.gov/spacewarn/spx661.html> (accessed 22 August 2011); NASA, "NASA's Shuttle Endeavour Launches on Home Improvement Mission," news release 08-294, http://www.nasa.gov/home/hqnews/2008/nov/HQ_08-294_STS126_launch.html (accessed 22 August 2011); John Schwartz, "Shuttle Departs with Gear for Space Station," *New York Times*, 15 November 2008.

18 November

NASA announced that engineers from NASA's JPL, working as part of an agency-wide team, had successfully tested the first deep space communications network modeled on the Internet. NASA, in partnership with Vinton G. Cerf, a Vice President at Google, had designed the software, called Disruption-Tolerant Networking (DTN). Unlike the Internet's Transmission Control Protocol/Internet Protocol (TCP/IP) communication suite, DTN did not assume end-to-to-end connection, enabling it to withstand delays and disconnections in space. Instead of discarding information that could not reach its destination, each of DTN's network nodes could store information until it could safely communicate with the next node. Engineers had begun testing DTN in October 2008, transmitting dozens of space images. As a Mars data-relay orbiter, they had used NASA's Epoxi spacecraft, which was approximately 20 million miles (32,186,880 kilometers) from Earth.¹⁴⁶

19 November

NASA announced that it had signed a memorandum of understanding (MOU) with the U.S. Department of Energy (DOE) for the implementation of the Joint Dark Energy Mission (JDEM). JDEM would measure the universe's expansion with high precision, making it the first space-based observatory to study the nature of dark energy, specifically. Scientists hoped that understanding the properties of dark energy, which makes up approximately 70 percent of the total mass energy of the universe, would help them learn more about how galaxies form and gain their mass. NASA and DOE signed the MOU in accordance with recommendations of a 2007 study issued by the jointly funded Beyond Einstein Program Assessment Committee. The Committee had recommended that NASA should develop and launch JDEM first, out of the five proposed missions in NASA's Beyond Einstein Program.¹⁴⁷

20 November

NASA and ATK successfully test-fired a launch-abort motor for the *Orion* CEV at ATK's facility in Promontory, Utah. The 5.50-second test was the first of its kind since the beginning of the Apollo Program and the first test ever of a motor with reverse-flow propulsion technology at such a scale. NASA had designed the launch-abort motor for use in case of an emergency on the launchpad or in the first 300,000 feet (91,440 meters) of ascent. If necessary, the motor could lift the crew module off the Ares-I rocket, using 500,000 pounds (226,796.19 kilograms) of thrust. The motor, which was more than 17 feet (5.18 meters) tall and 3 feet (0.91 meters) in diameter, featured a composite case and an exhaust turn-flow technology instead of a tower, a configuration that improved the motor's weight and performance.¹⁴⁸

NASA marked the 10-year anniversary of the ISS, which the space agencies of Canada, Europe, Japan, Russia, and the United States had established with the 20 November 1998 launch of the Russian-built Zarya module. The Unity connector module had joined the ISS in December 1998.

¹⁴⁶ NASA, "NASA Successfully Tests First Deep Space Internet," news release 08-298, 18 November 2008, http://www.nasa.gov/home/hqnews/2008/nov/HQ_08-298_Deep_space_internet.html (accessed 22 August 2011).

¹⁴⁷ NASA, "NASA and DOE Collaborate on Dark Energy Research," news release 08-300, 19 November 2008, http://www.nasa.gov/home/hqnews/2008/nov/HQ_08300_NASA_DOE.html (accessed 22 August 2008).

¹⁴⁸ NASA, "NASA, ATK Successfully Test First Orion Launch Abort Motor," news release 08-306, 20 November 2008, http://www.nasa.gov/home/hqnews/2008/nov/HQ_08-306_OrionLASmotor_Success.html (accessed 22 August 2011).

Ten years later, after 29 additional construction flights, the ISS was three-quarters of the way complete, with a weight of more than 627,000 pounds (284,402.42 kilograms) and an interior volume of more than 25,000 cubic feet (707.92 cubic meters)—roughly the size of a five-bedroom house. One hundred sixty-seven people from 14 countries had visited the ISS and its 19 research facilities, which scientists had used to study astronaut health and basic science in space.¹⁴⁹

NASA announced the appointment of Arthur E. Goldman as Director of NASA's SSC. Goldman replaced Robert D. Cabana, who had accepted a position as Director of NASA's KSC in October 2008. Goldman had begun his service with NASA in 1990 as a Project Engineer for the Space Shuttle Systems Integration Office at NASA's MSFC, becoming Supervisor of that program in 1992. In 1994 he had transferred to the Space Shuttle Main Engine Project, working first as Manufacturing Engineer, then as Technical Assistant, and finally as Business Manager. Goldman had served as Deputy Director of NASA's SSC since 2006. He had received many professional awards, including NASA's Exceptional Achievement Medal and the Commendation of the Director of MSFC.¹⁵⁰

21 November

A team of scientists led by John W. Holt of the University of Texas at Austin announced in the journal *Science* that they had discovered large buried glaciers of water ice in the Hellas Basin on Mars. Using the Shallow Radar instrument on NASA's MRO, the team had made radar soundings of the gently sloping geographical features known as aprons. Scientists had long puzzled over these features. The radio waves had passed through the aprons without a significant loss of strength, indicating that the area contains a thick layer of ice, covered by a thin layer of rocky debris. The velocity of the radio waves was consistent with the composition of water ice. The researchers believed that these glaciers are the largest deposits of ice on Mars outside the polar caps. Besides providing a possible source of water for human explorers, the glacial ice may have scientific value: on Earth, buried glacial ice has preserved a record of ancient organisms and a history of the planet's climate.¹⁵¹

26 November

ISS crew member Yuri V. Lonchakov manually docked the Russian Progress-M-01M (Progress-31) cargo vehicle after the vehicle's automatic docking system experienced some last-minute problems, such as a loss of frequency information and an unusual toggling of the tracking displays. The vehicle had launched at 7:38 a.m. (EST) aboard a Soyuz-U rocket from Baikonur Cosmodrome in Kazakhstan. Shortly after reaching orbit, it had failed to deploy an antenna for the Kurs automatic docking system. Eventually, engineers had been able to extend the antenna;

¹⁴⁹ NASA, "Nations Around the World Mark 10th Anniversary of International Space Station," news release 08-296, 17 November 2008, http://www.nasa.gov/home/hqnews/2008/nov/HQ_08-296_ISS_10th_Anniversary.html (accessed 22 August 2011); Marcia Dunn, "Happy Birthday: Space Station Celebrates 10 Years," Associated Press, 20 November 2008.

¹⁵⁰ NASA, "Goldman Names Director at Stennis Space Center," news release 08-303, 20 November 2008, http://www.nasa.gov/home/hqnews/2008/nov/HQ_08-303_Goldman_SSC.html (accessed 22 August 2011).

¹⁵¹ NASA, "NASA Spacecraft Detects Buried Glaciers on Mars," news release 08-304, 20 November 2008, http://www.nasa.gov/home/hqnews/2008/nov/HQ_08-304_MRO_BuriedGlaciers.html (accessed 22 August 2011); see also John W. Holt et al., "Radar Sounding Evidence for Buried Glaciers in the Southern Mid-Latitudes of Mars," *Science* 322, no. 5905 (21 November 2008): 1235–1238.

however, they had feared that a manual docking might prove necessary. Progress-M-01M transported to the ISS approximately 5,342 pounds (2,423.09 kilograms) of cargo, including 1,808 pounds (820.10 kilograms) of propellant, 463 pounds (210.01 kilograms) of water, and 2,963 pounds (1,343.99 kilograms) of equipment, experiments, and other dry supplies. Russia had also used the Progress's flight to test new computer and avionics technologies.¹⁵²

Iran's state-run media announced that the country had successfully launched a rocket called Kavoshgar 2 into space. A follow-up to the 4 February 2008 launch of the first Kavoshgar rocket, Kavoshgar 2 had reportedly performed its functions, landing 40 minutes later. Iranian media stated that the rocket had consisted of three parts, including a space laboratory. Kavoshgar 2's mission had been to conduct space experiments on the atmosphere, to test its payload's retrieval system, and to facilitate academic coordination among scientists.¹⁵³

28 November

A team of researchers led by Paul G. Kalas of the University of California at Berkeley announced in the journal *Science* that they had used NASA's HST to take the first visible-light photograph of a planet outside our solar system. The planet, known as Fomalhaut b, circles the star Fomalhaut in the constellation Piscis Australis, 25 light-years from Earth. Planets are difficult to detect in visible light because their stars often outshine them. Therefore, astronomers usually discover planets indirectly, through the effects that they have on their stars as they pass by them. However, scientists had long suspected that a planet might exist in the ring of dust debris surrounding Fomalhaut. In 2004 they had used the coronagraph in the High Resolution Camera on Hubble's Advanced Camera for Surveys to photograph the debris ring. A second set of photographs, taken in 2006, had revealed that a dot of light visible in the photographs is an orbiting planet. Researchers estimated that Fomalhaut b is 100 million years old, has a mass equivalent to three Jupiter masses, and circles its star in an 872-year-long orbit.¹⁵⁴

30 November

Space Shuttle *Endeavour* landed at Edwards Air Force Base in California at 1:25 p.m. (PST), returning seven astronauts from a 16-day mission to the ISS. While aboard the ISS, crew members had unloaded over 7 tons (6.35 tonnes or 6,350.29 kilograms) of cargo from *Endeavour*; set up a refrigerator, exercise machine, two sleep stations, and a rack for science experiments; and activated a recycling system to turn astronauts' urine and perspiration into potable water. The crew of *Endeavour* brought back samples so that NASA scientists could test the water before NASA approved the system for use. Astronauts Heidemarie M. Stefanyshyn-Piper, Stephen G. Bowen, and Robert S. Kimbrough had conducted four spacewalks to repair the

¹⁵² *Spacewarn Bulletin*, no. 661, 1 December 2008, <http://nssdc.gsfc.nasa.gov/spacwarn/spx661.html> (accessed 22 August 2011); Tariq Malik, "Russian Cargo Ship on Course for Space Station," *Space.com*, 26 November 2008, <http://www.space.com/6168-russian-cargo-ship-space-station.html> (accessed 25 August 2011); Steve Gutterman, "Problems Force Manual Docking at Space Station," Associated Press, 30 November 2008, http://www.msnbc.msn.com/id/27983288/ns/technology_and_science-space/t/problems-force-manual-docking-space-station/ (accessed 25 August 2011).

¹⁵³ Agence France-Presse, "Iran Says It Has Sent Another Rocket into Space," 26 November 2008.

¹⁵⁴ NASA, "Hubble Directly Observes a Planet Orbiting Another Star," news release 08-289, 13 November 2008, http://www.nasa.gov/home/hqnews/2008/nov/HQ_08-289_Hubble_planet.html (accessed 22 August 2011); David Overbye, "Now in Sight: Far-Off Planets," *New York Times*, 14 November 2008; see also Paul Kalas et al., "Optical Images of an Exosolar Planet 25 Light-Years from Earth," *Science* 322, no. 5906 (21 November 2008): 1345–1348.

two Solar Alpha Rotary Joints that allow the ISS's solar arrays to follow the Sun. Although an astronaut had lost an untethered tool belt during the first spacewalk, the repairs appeared to have been successful. Astronaut Gregory E. Chamitoff, who had been aboard the ISS for over five months, had returned to Earth on board *Endeavour*. Sandra H. Magnus had replaced Chamitoff on the ISS. She expected to stay until February 2009.¹⁵⁵

DECEMBER 2008

2 December

NASA announced that it had signed a modification to the ISS contract with the Russian federal space agency Roscosmos for crew transportation services. NASA would use the US\$141 million, firm-fixed-price extension to meet the United States' obligations to its international partners for transportation to and from the ISS. The contract's extension would cover two *Soyuz* flights, to carry cargo to and from the ISS and to remove trash. The contract allowed for Roscosmos to launch to the ISS 50 kilograms (110.23 pounds) of cargo per person; to return to Earth 17 kilograms (37.48 pounds) of cargo per person; and to dispose of 30 kilograms (66.14 pounds) of trash per person. Additionally, the contract extension covered broad support for a long-duration mission for three ISS crew members, including crew rescue and training and preparation for launch and landing. The crew members would launch aboard two *Soyuz* rockets in the fall of 2011 and would land on Earth in the spring of 2012.¹⁵⁶

3 December

NASA Deputy Administrator Shana L. Dale announced that she would resign her position, effective 17 January 2009. Dale's career had included service for the University of Texas; the House Committee on Science, Space and Technology; the House Committee on Public Works and Transportation; the White House Office of Science and Technology Policy; and for various law firms. Since November 2005, she had served as NASA's Deputy Administrator. Dale stated that she planned to use her time off to evaluate the options for her next career phase and to spend time with her family.¹⁵⁷

4 December

NASA announced that astronaut Carl E. Walz would leave his position to take a job in the private sector. NASA had selected Walz as an astronaut in January 1990. He had flown on four Space Shuttle missions, spending a cumulative 231 days in space. Walz had flown on STS-51 in September 1993. During that mission, he had undertaken a 7-hour spacewalk. On July 1994, he had flown on STS-65; and, in September 1996, on STS-79. In December 2001, he had flown to the ISS on Expedition 4. During that expedition, he had taken two spacewalks. Walz had also

¹⁵⁵ NASA, "NASA's Shuttle Endeavour Glides Home After Successful Mission," news release 08-315, 30 November 2008, http://www.nasa.gov/home/hqnews/2008/nov/HQ_08-315_Endavour_lands.html (accessed 22 August 2011); Robert Z. Pearlman, "Space Shuttle Endeavour Lands Safely in California," *Space.com*, 30 November 2008, <http://www.space.com/6180-space-shuttle-endeavour-lands-safely-california.html> (accessed 22 August 2011); James Dean, "Endeavour Voyage Ends in California," *Florida Today* (Brevard, FL), 1 December 2008.

¹⁵⁶ NASA, "NASA Extends Contract with Russian Federal Space Agency," news release C08-068, 2 December 2008, http://www.nasa.gov/home/hqnews/2008/dec/HQ_08-317_Dale_resigns.html (accessed 22 August 2011).

¹⁵⁷ NASA, "NASA Deputy Administrator Dale To Resign on January 17," news release 08-317, 3 December 2008, http://www.nasa.gov/home/hqnews/2008/dec/HQ_08-317_Dale_resigns.html (accessed 22 August 2011).

served in a variety of technical and managerial positions in the NASA Astronaut Office. At the time of his resignation, he had been serving as Director for the Advanced Capabilities Division in the Exploration Systems Mission Directorate at NASA Headquarters.¹⁵⁸

8 December

Franklin R. Chang-Díaz, President and CEO of Ad Astra Rocket Company, and NASA Associate Administrator for Space Operations William H. Gerstenmaier signed a Space Act Agreement to test the new Variable Specific Impulse Magnetoplasma Rocket (VASIMR) engine. NASA had originally studied the VASIMR engine, and Ad Astra was developing the engine for commercial use. The engine would heat plasma to very high temperatures, for maximum fuel efficiency, generating 4 newtons of thrust, with a specific impulse of approximately 6,000 seconds. Congress had designed the Space Act Agreement as a series of “gates,” allowing NASA and Ad Astra to assess the progress of VASIMR’s development. Ad Astra would develop the engine, which could cost as much as US\$150 million, and would place it on the ISS for performance testing in space. This agreement was the first that NASA had signed for a payload on the ISS’s exterior. Officials hoped that the VASIMR project represented an expansion of the role of the ISS as a national laboratory.¹⁵⁹

16 December

Boeing Company announced that it had filed a protest with GAO over a contract that NASA and NOAA had awarded to Lockheed Martin Space Systems on 2 December 2008. The contract for NOAA’s Geostationary Operational Environmental Satellites (GOES-R) Program had covered the design, development, and delivery of two satellites, as well as pre-launch, launch, and post-launch support for the satellites. The base contract carried a total value of US\$1.09 billion, with two options, each providing for one additional satellite. NASA and NOAA would use the data from the satellites’ Earth-viewing, solar-viewing, and space-viewing instruments for weather forecasting and for environmental, solar, and space science. Boeing had been the contractor for the previous series of GOES-R satellites.¹⁶⁰

Hamilton Sundstrand and Oceaneering International announced that they had resolved a contract dispute and planned the joint development of spacesuits for NASA’s Constellation Program. NASA had awarded the US\$183.8 million contract for the Constellation Space Suit System to Oceaneering International in June 2008. Hamilton Sundstrand had filed a protest with GAO. In August 2008, NASA had decided to overturn the contract because of a compliance issue. NASA had later reopened the contract, and the two companies had agreed to pursue it together.¹⁶¹

¹⁵⁸ NASA, “Veteran Astronaut Carl Walz Leaves NASA,” news release 08-318, 4 December 2008, http://www.nasa.gov/home/hqnews/2008/dec/HQ_08-318_Walz_Leaves.html (accessed 22 August 2011).

¹⁵⁹ NASA, “NASA Administrator Hails Agreement with Ad Astra,” news release 08-332, 17 December 2008, http://www.nasa.gov/home/hqnews/2008/dec/HQ_08-332_VASIMR_engine.html (accessed 22 August 2011); Frank Moring Jr., “NASA Inks Agreement To Test Engine on ISS,” *Aviation Week*, 17 December 2008.

¹⁶⁰ NASA, “NASA Selects NOAA Goes-R Series Spacecraft Contractor,” news release C08-067, 2 December 2008, http://www.nasa.gov/home/hqnews/2008/dec/HQ_C08067_GOES.html (accessed 22 August 2011); James Gunsalus, “Boeing Protests \$1.09 Billion Satellite Award Won by Lockheed,” *Bloomberg News*, 16 December 2008.

¹⁶¹ Susanna Ray, “Hamilton Sundstrand Joins with Oceaneering for NASA Spacesuit,” *Bloomberg News*, 16 December 2008.

The X Prize Foundation announced that two new teams had entered the Google Lunar X Prize. Euroluna was a European team primarily made up of members from Denmark, Italy, and Switzerland. Led by Palle Hastrup, the team planned to launch a small rover, which would have no redundant systems, so that it could maintain a low weight. Markus Bindhammer led the team Selene, based in China. The team planned to launch its Selena-1 lander in its Lunar Rocket Car-1 (LuRoCa-1) rover. Fourteen other teams had signed up for the competition, which featured a US\$20 million grand prize, a US\$5 million second prize, and US\$5 million in bonus prizes. The grand prize would go to the team that could land a spacecraft on the Moon, move it 500 meters (1,640.42 feet), and transmit images back to Earth.¹⁶²

17 December

The “Mystery Team”—the fifth team to register for the Google Lunar X Prize the team that chose not to reveal its identity—announced its name at a press conference at NASA’s ARC: Next Giant Leap. Michael Joyce led Next Giant Leap, an American team comprising members from Aurora Flight Sciences, which specializes in aerial vehicles and space hardware; Busek, which would supply the propulsion system; Draper Laboratory, which would supply the landing technology; and MicroSat Systems, which would be the lead systems integrator. The Department of Aeronautics and Astronautics at MIT was an academic partner.¹⁶³

18 December

At the American Geophysical Union’s Fall Meeting, a team of scientists led by Bethany L. Ehlmann of Brown University announced that they had found carbonate minerals in Martian bedrock. The team had used the Compact Reconnaissance Imaging Spectrometer (CRISM) on NASA’s MRO to observe carbonate exposures in the Isidis basin, particularly along the trough system known as Nili Fossae. Carbonates form when carbon dioxide and water interact with calcium, iron, or magnesium in volcanic rocks. Because carbonates dissolve quickly in acid, their presence indicated that Mars had once possessed neutral or alkaline water. A nonacidic environment would have favored ancient life forms. Previous researchers had found carbonates in Martian soil or dust, but the presence of carbonates in bedrock indicated that they might have formed over extended periods during Mars’s early history. The journal *Science* planned to publish the study’s findings in its 19 December 2008 edition.¹⁶⁴

22 December

NASA announced that LRO had successfully completed thermal-vacuum testing at NASA’s GSFC. The testing, which had lasted for approximately two months, simulated the airless conditions and extreme temperature variations that the orbiter would encounter in space. The test was the conclusion of a series of environmental tests of LRO; previous tests had included acoustics testing, electromagnetic compatibility testing, spin testing, and vibration testing. LRO would orbit the Moon for at least one year, using its seven instruments to collect data that

¹⁶² Tariq Malik, “New Teams Join \$30 Million Moon Rover Contest,” *Space.com*, 16 December 2008, <http://www.space.com/6232-teams-join-30-million-moon-rover-contest.html> (accessed 25 August 2011).

¹⁶³ *Space.com*, “Mystery Lunar X Prize Team Revealed,” 17 December 2008, <http://www.space.com/6234-mystery-lunar-prize-team-revealed.html> (accessed 26 August 2011).

¹⁶⁴ NASA, “Scientists Find ‘Missing’ Mineral and Clues to Mars Mysteries,” news release 08-331, 18 December 2008, http://www.nasa.gov/home/hqnews/2008/dec/HQ_08-331_Mars_minerals.html; see also Bethany L. Ehlmann et al., “Orbital Identification of Carbonate-Bearing Rocks on Mars,” *Science* 322, no. 5909 (19 December 2008): 1828–1832.

scientists could use to choose safe lunar-landing sites, to determine locations for future lunar outposts, and to diminish the risk of radiation for astronauts.¹⁶⁵

ISS crew members E. Michael Fincke and Yuri V. Lonchakov spent 6 hours on a spacewalk outside the ISS. They installed a device, known as a Langmuir probe, to monitor the electrical field around the ISS. Russian engineers believed that electrical interference might have damaged the explosive bolts on two *Soyuz* spacecraft, causing the craft to experience rough flight reentries in October 2007 and April 2008. Fincke and Lonchakov also installed a Russian experiment called Impuls, retrieved the Russian microbe experiment Biorisk, and took photographs of the Russian segment of the ISS. The spacewalkers attempted to install the European biological experiment EXPOSE-R, but the experiment would not activate to relay telemetry. Russian flight controllers eventually ordered Fincke and Lonchakov to remove the experiment and to return it to the ISS. The spacewalk was the first for Lonchakov and the fifth for Fincke.¹⁶⁶

23 December

NASA announced that it had awarded two contracts for commercial cargo-resupply services, one to Orbital Sciences of Dulles, Virginia, and one to SpaceX of Hawthorne, California. The fixed-price, indefinite-delivery, indefinite-quantity contracts each covered the delivery to the ISS of a minimum of 20 tonnes (20,000 kilograms or 44,092.45 pounds) of up-mass, cargo-resupply services, in addition to the delivery of nonstandard services in support of the cargo resupply. The eight flights that NASA ordered from Orbital Sciences had a value of approximately US\$1.9 billion. SpaceX's contract covered 12 flights and had a value of approximately US\$1.6 billion. The maximum potential value of each contract was approximately US\$3.1 billion; NASA estimated that, based on known requirements, the combined value of both contracts was US\$3.5 billion. The contracts, which would begin on 1 January 2009 and would remain effective through 31 December 2016, represented the first agreements that NASA had signed with commercial firms for the independent development of rockets that would travel to the ISS.¹⁶⁷

30 December

The Spacecraft Crew Survival Integrated Investigation Team, a multidisciplinary team based at NASA's JSC, issued an in-depth study of the safety equipment and safety procedures that the crew of *Columbia* had used during the *Columbia* disaster. The study, the first comprehensive report on crew survival in a spaceflight accident, detailed five lethal events that had occurred during the breakup of *Columbia*. The team determined that, even with better cabin equipment, hypersonic-entry conditions would have prevented crew survival. The report issued 30 recommendations to improve crew safety and vehicle design, covering topics such as crew training, individual safety equipment, procedures, restraints, spacecraft design, and future

¹⁶⁵ NASA, "Next NASA Moon Mission Completes Major Milestone," news release 08-335, 22 December 2008, http://www.nasa.gov/home/hqnews/2008/dec/HQ_08-335_LRO_Thermal_Complete.html (accessed 22 August 2011).

¹⁶⁶ Mark Carreau, "Space Station Astronauts Finish 6-Hour Spacewalk," *Houston Chronicle*, 23 December 2008; Tariq Malik, "Spacewalkers Add New Experiments to Space Station," Space.com, 23 December 2008, <http://www.space.com/6254-spacewalkers-add-experiments-space-station.html> (accessed 26 August 2011).

¹⁶⁷ NASA, "NASA Awards Space Station Commercial Resupply Services Contracts," news release C08-069, 23 December 2008, http://www.nasa.gov/home/hqnews/2008/dec/HQ_C08-069_ISS_Resupply.html (accessed 22 December 2011); Andy Pasztor, "NASA Takes a Leap in Outsourcing," *Wall Street Journal*, 24 December 2011).

accident investigations. NASA had already implemented some of the recommendations, and NASA officials were assessing others.¹⁶⁸

¹⁶⁸ NASA, “NASA Report Reviews Crew Safety Measures During *Columbia* Accident, Recommends Improvements,” news release M08-269, 30 December 2008, http://www.nasa.gov/home/hqnews/2008/dec/HQ_M08269_Crew_Safety.html (accessed 22 August 2011); John Schwartz, “Report on *Columbia* Details How Astronauts Died,” *New York Times*, 31 December 2008; see also NASA, “*Columbia* Crew Survival Investigation Report” (report no. NASA/SP-2008-565, Lyndon B. Johnson Space Center, Houston, Texas, December 2008), <http://history.nasa.gov/columbia/columbiacrewsurvival.pdf> (accessed 1 September 2011).

APPENDIX A: TABLE OF ABBREVIATIONS

ADS-B	Automatic Dependent Surveillance-Broadcast
APL	Applied Physics Laboratory
ARC	Ames Research Center
ARCA	Aeronautics and Cosmonautics Romanian Association
ASI	Agenzia Spaziale Italiana
ATK	Alliant Techsystems
ATV	Automated Transfer Vehicle
CAFE	Comparative Aircraft Flight Efficiency
CBO	Congressional Budget Office
CDT	Central Daylight Time
CEST	Central European Summer Time
CEV	crew exploration vehicle
CLV	crew launch vehicle
CNES	Centre National d'Études Spatiales
COTS	Commercial Orbital Transportation Services Project
CRISM	Compact Reconnaissance Imaging Spectrometer
CSA	Canadian Space Agency
CME	coronal mass ejection
DFRC	Dryden Flight Research Center
DOE	Department of Energy
DPRL	Data-Parallel Line Relaxation
DTN	Disruption-Tolerant Networking
EDT	Eastern Daylight Time
ESA	European Space Agency
EST	Eastern Standard Time
ESMD	Exploration Systems Mission Directorate
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EVA	extra vehicular activity
FAST	Facilitated Access to the Space Environment for Technology Development and Training
FY	fiscal year
GAO	Government Accountability Office
GBM	Gamma-Ray Burst Monitor
GIOVE	Galileo In-Orbit Validation Element
GISS	Goddard Institute for Space Studies
GLAST	Gamma-Ray Large Area Telescope
GLONASS	Global Navigation Satellite System
GMT	Greenwich Mean Time

APPENDIX A: TABLE OF ABBREVIATIONS

GOES	Geostationary Operational Environmental Satellites
GPS	global positioning satellite or global positioning system
GRB	gamma-ray burst
GRC	Glenn Research Center
GSFC	Goddard Space Flight Center
GSSR	Goldstone Solar System Radar
HST	Hubble Space Telescope
HYBOLT	Hypersonic Boundary Layer Transition
IAU	International Astronomical Union
IBEX	Interstellar Boundary Explorer
IDP	interplanetary dust particle
ILN	International Lunar Network
INKSNA	Iran-North Korea-Syria Nonproliferation Act
ISI	Israel Space Industries
ISRO	Indian Space Research Organisation
ISS	International Space Station
JAXA	Japanese Aerospace Exploration Agency
JDEM	Joint Dark Energy Mission
JPL	Jet Propulsion Laboratory
JPM	Japanese Pressurized Module
JSC	Johnson Space Center
JURBAN	Juxtapia Urban Robotics Brilliant Application National
KAIST	Korea Advanced Institute of Science and Technology
KSC	Kennedy Space Center
LaRC	Langley Research Center
LAT	Large Area Telescope
LCROSS	Lunar Crater Observation and Sensing Satellite
LDCM	Landsat Data Continuity Mission
LRO	Lunar Reconnaissance Orbiter
LuRoCa	Lunar Rocket Car
M3	Moon Mineralogy Mapper
MAVEN	Mars Atmosphere and Volatile Evolution
MBOC	multiplexed binary offset carrier
MESSENGER	Mercury Surface, Space Environment, Geochemistry, and Ranging
MEST	Ministry of Education, Science and Technology
Mini-SAR	Mini Synthetic Aperture Radar
Mini-TES	Miniature Thermal Emission Spectrometer

APPENDIX A: TABLE OF ABBREVIATIONS

MIT	Massachusetts Institute of Technology
MOU	memorandum of understanding
MRM2	Mini-Research Module 2
MRO	Mars Reconnaissance Orbiter
MSFC	Marshall Space Flight Center
MST	Moscow Standard Time
NextGen	Next Generation Air Transportation System
NOAA	National Oceanic and Atmospheric Administration
NRO	National Reconnaissance Office
OSTP	Office of Science and Technology Policy
PHM	Passive Hydrogen Maser
R&D	research and development
SAR	Synthetic Aperture Radar
SBIR	Small Business Innovation Research
SETI	Search for Extraterrestrial Intelligence
SGT	Stinger Ghaffarian Technologies
SHARAD	Shallow Radar
SMD	Science Mission Directorate
STEM	scanning transmission electron microscope
SOFIA	Stratospheric Observatory for Infrared Astronomy
SOHO	Solar and Heliospheric Observatory
SpaceX	Space Exploration Technologies
SSC	Stennis Space Center
SSP	Space Shuttle Program
STEREO	Solar Terrestrial Relations Observatory
TCP/IP	Transmission Control Protocol/Internet Protocol
TEGA	Thermal and Evolved-Gas Analyzer
THERMIS	Time History of Events and Macroscale Interactions during Substorms
TOPEX	Topography Experiment
USDA	U.S. Department of Agriculture
UT	Universal Time
VASIMR	Variable Specific Impulse Magnetoplasma Rocket
VIMS	visual and infrared mapping spectrometer
VSE	Vision for Space Exploration

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