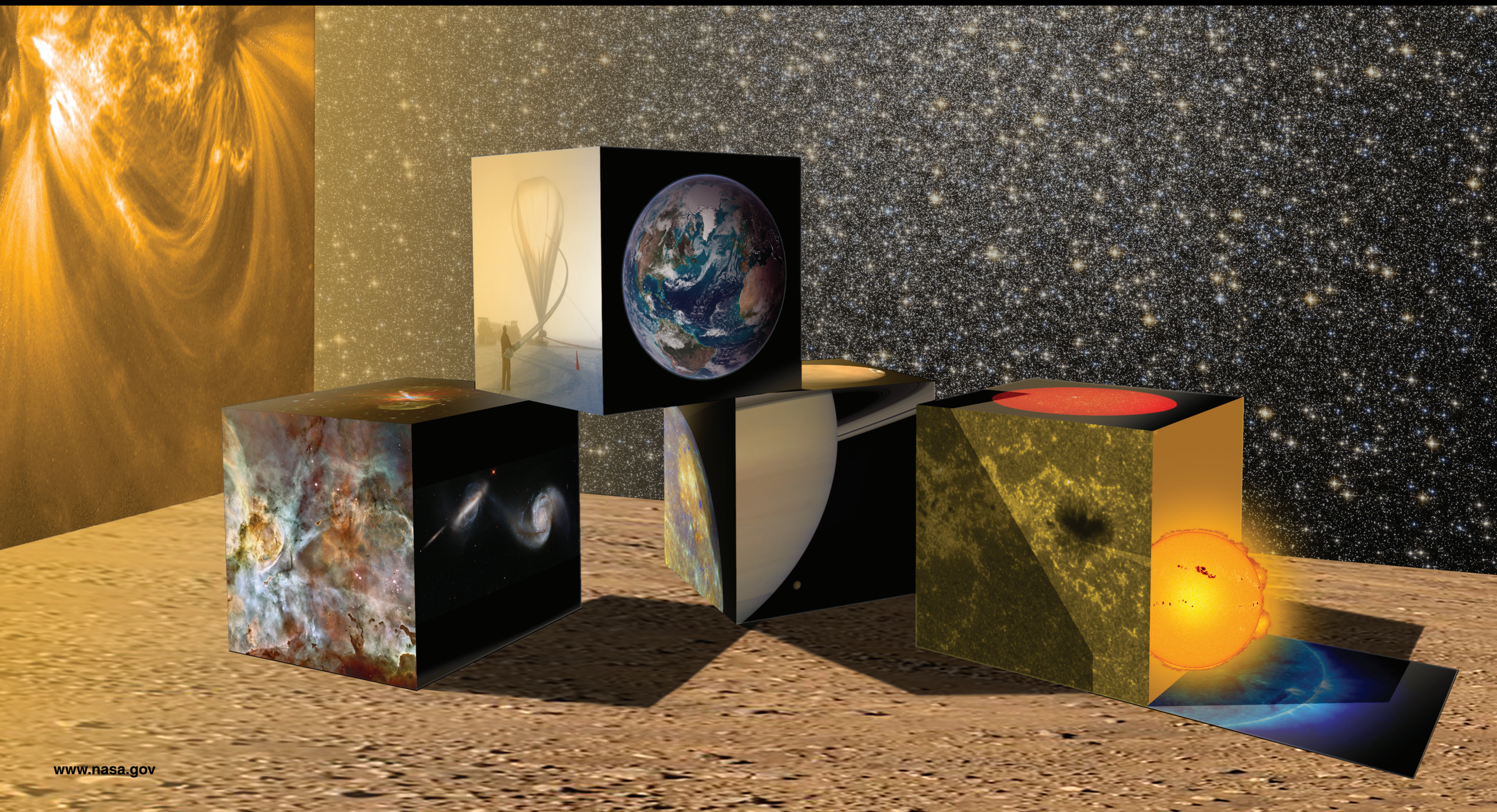
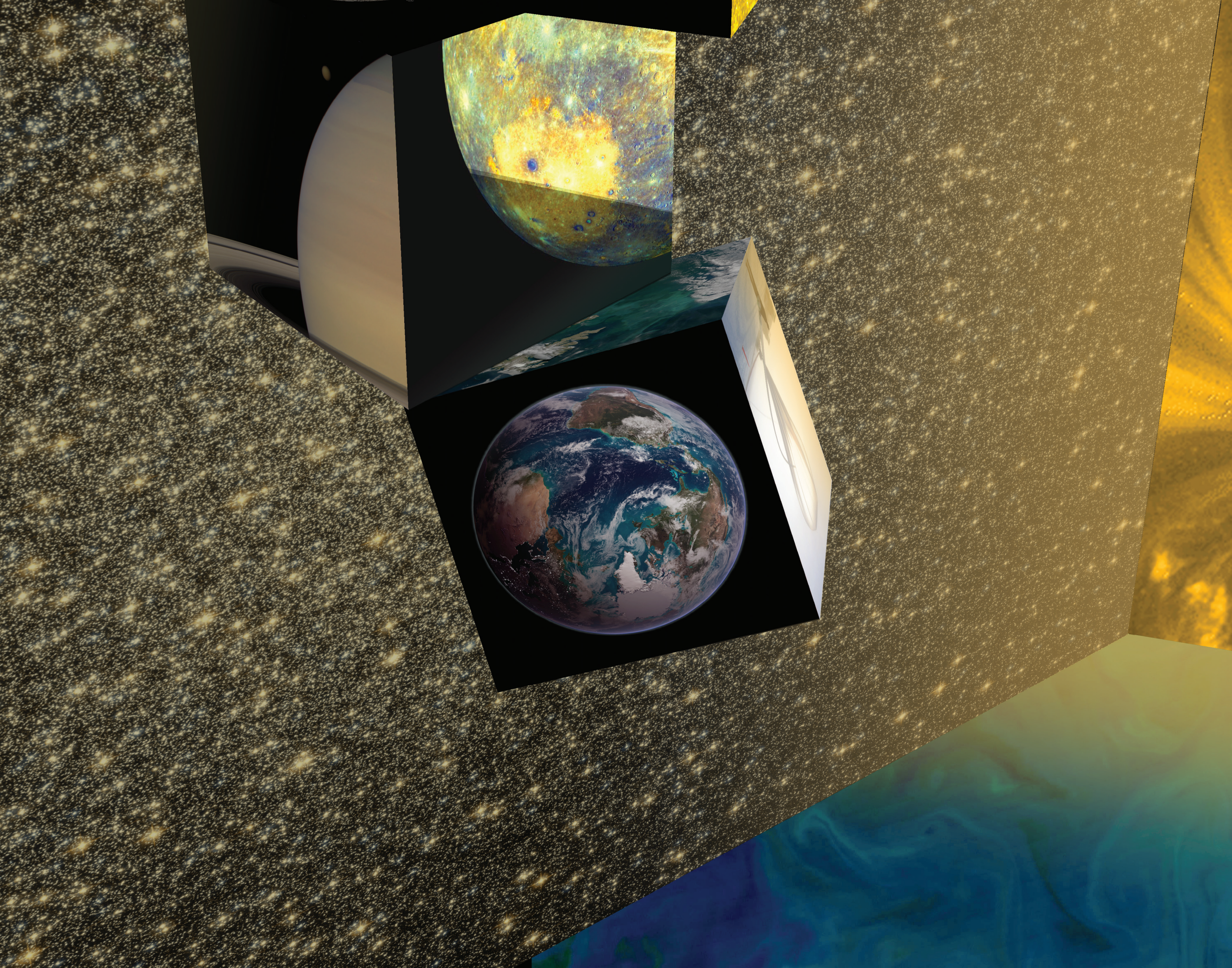
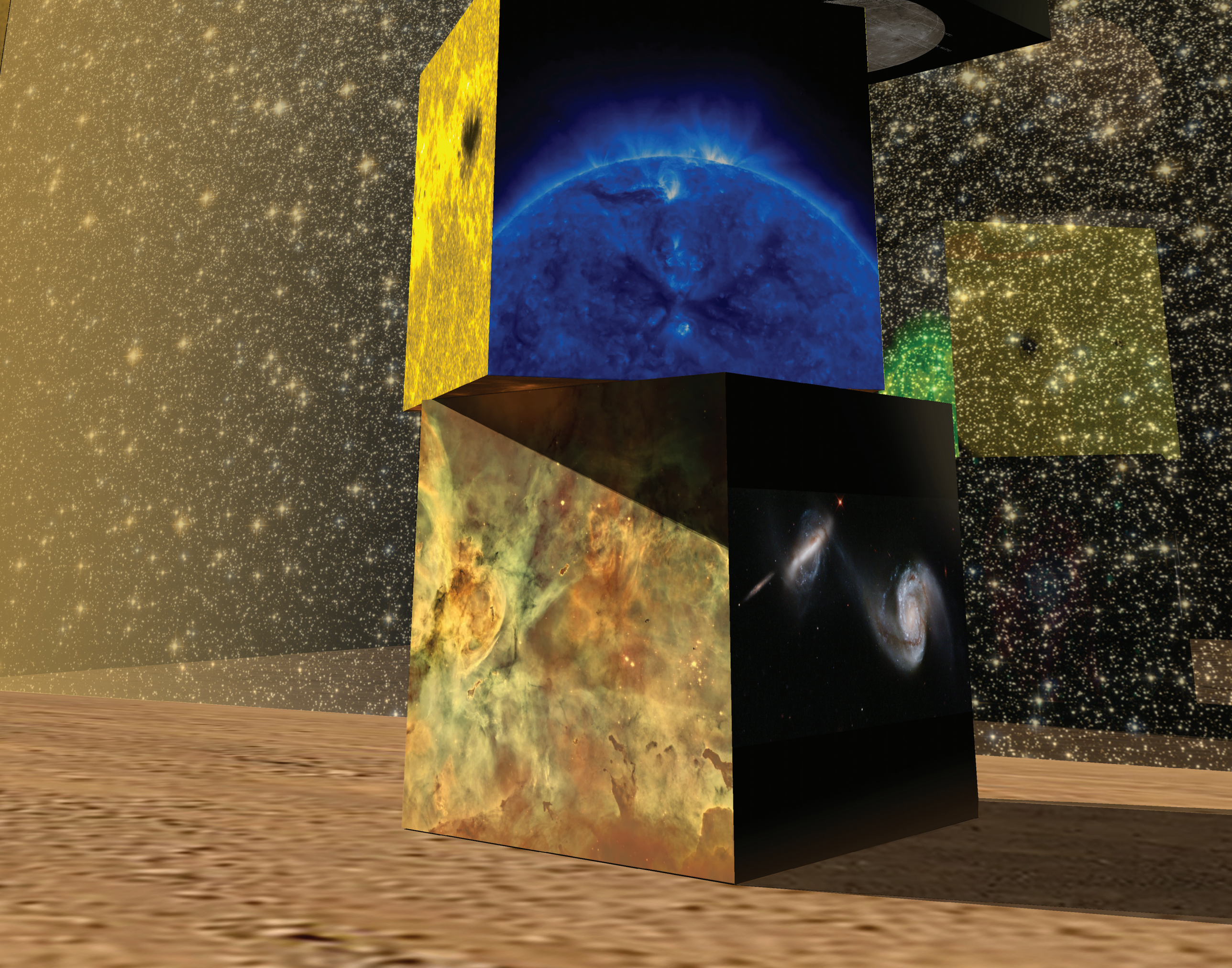
National Aeronautics and Space Administration

NASA SCIENCE 2009



www.nasa.gov





January 2009

New Moon · First Quarter · Full Moon · Last Quarter

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
				1 New Year's Day	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19 Martin Luther King, Jr. Day	20 Inauguration Day	21	22	23	24
25	26	27	28	29	30	31

Aqua Captures Record Low Sea Ice Coverage in the Arctic

Satellites have been tremendously valuable in revealing the declining Arctic sea ice coverage over recent years. Ice routinely fills most of the Arctic Ocean and many of the surrounding seas and bays in wintertime but retreats to less than half its wintertime coverage in late summer. Although there is much variability from year to year in the details of the ice coverage, overall the amount of ice in each season has been decreasing since the 1970s, when satellites were first able to monitor the ice cover. The decreasing sea ice is in line with pronounced warming of the Arctic region and has been most prominent in September, at the end of summer.

The image, created from data acquired on September 14, 2007 by the Japan Aerospace Exploration Agency's Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E) on NASA's Aqua satellite, shows the Arctic ice at its lowest extent since satellite data coverage began. Notably, the ice has totally retreated from the Alaskan and European coastlines, and there is a clear ice-free Northwest Passage through Baffin Bay (west of Greenland, at the top center of the image) and the islands of the Canadian Archipelago. The ice-free Northwest Passage reflects a marked contrast to the ice-clogged conditions encountered by explorers often risking their lives to find such a passageway in the nineteenth century.

In addition to sea ice, the image also shows the Greenland ice sheet, and ice and snow coverage in the rest of the far North.

Image Credit: NASA and the Japan Aerospace Exploration Agency.

DECEMBER 2008

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FEBRUARY 2009

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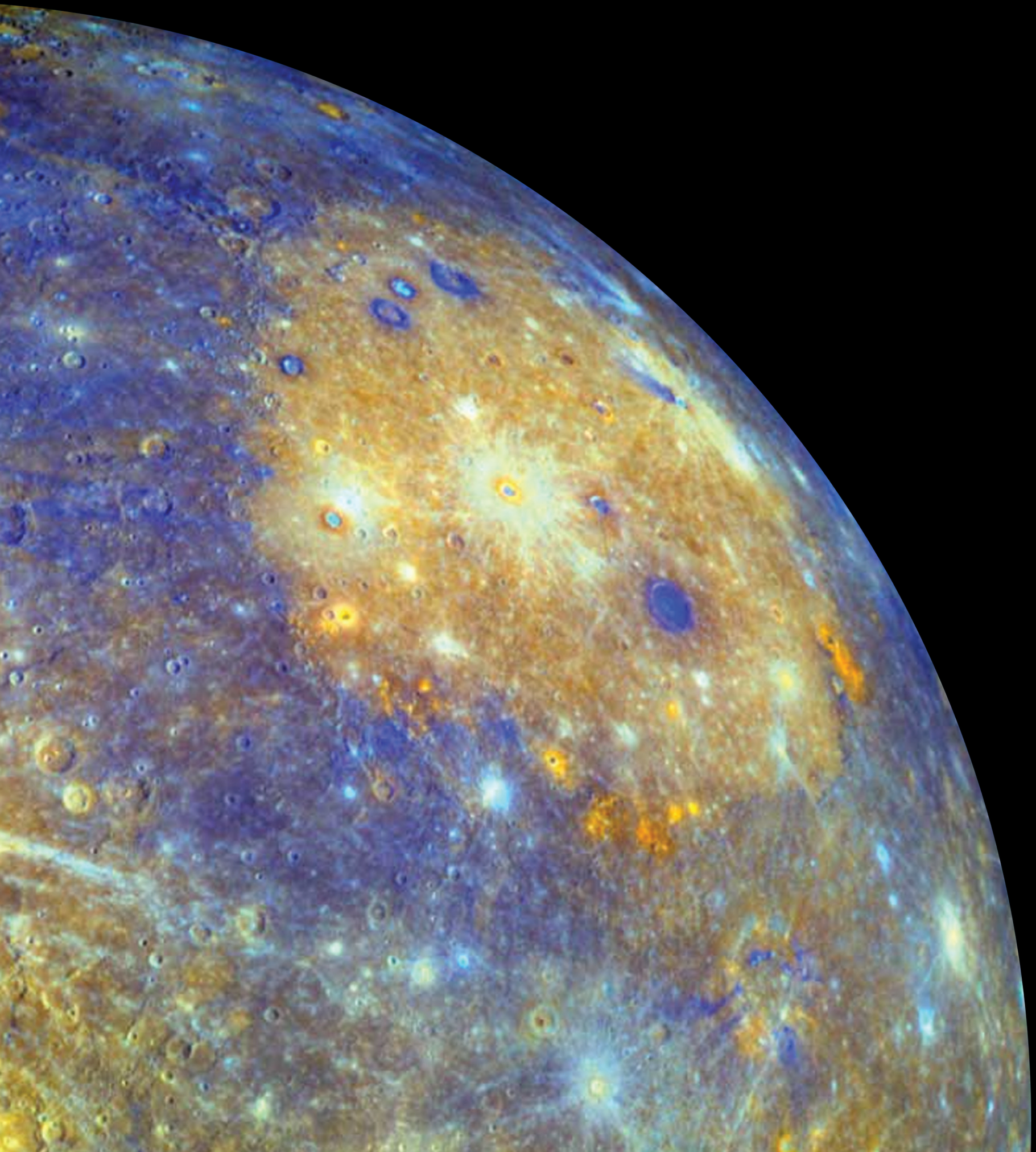


February 2009

New Moon · First Quarter · Full Moon · Last Quarter

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16 Washington's Birthday	17	18	19	20	21
22	23	24	25	26	27	28

Sending a MESSENGER to Mercury

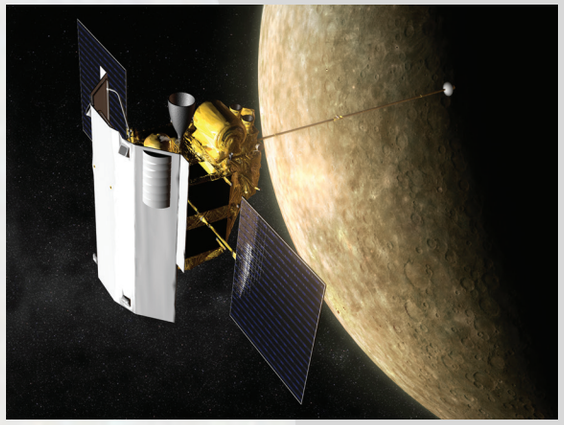
The planet Mercury is similar in appearance to Earth's moon; it is marked with craters and plains and has no atmosphere or moons. But the process that shaped Mercury's surface has puzzled scientists for decades.

When the Mariner 10 spacecraft provided images of Mercury's surface in 1975, some scientists believed that the smooth plains visible were created in the same way as similar features seen during Apollo 16's 1972 mission to the Moon—by material ejected from large impacts. Others thought that Mercury's plains were the remnants of erupted lavas, but the absence of volcanic features in images prevented a consensus … until now …

Compelling new evidence from the Mercury Surface, Space Environment, Geochemistry, and Ranging (MESSENGER) spacecraft shows that volcanoes were in fact involved in the formation of Mercury's surface topography. Data coming back from MESSENGER also suggest that Mercury's magnetic field is actively produced in its core. In addition, the mission has provided the first look at the chemical composition of the planet's surface.

This image, taken during MESSENGER's January 2008 flyby of Mercury, reveals the planet's dominant tectonic landforms, called *lobate scarps*. These huge cliffs mark the tops of crustal faults that formed during the contraction of the surrounding area, and tell us how important the cooling core has been to the evolution of the surface.

Image and partial text credit: NASA, Johns Hopkins University Applied Physics Laboratory, and the Carnegie Institution of Washington.



Artist's rendition of the MESSENGER spacecraft in orbit near Mercury. Credit: NASA, Johns Hopkins University Applied Physics Laboratory, and the Carnegie Institution of Washington.

JANUARY **2009**

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MARCH **2009**

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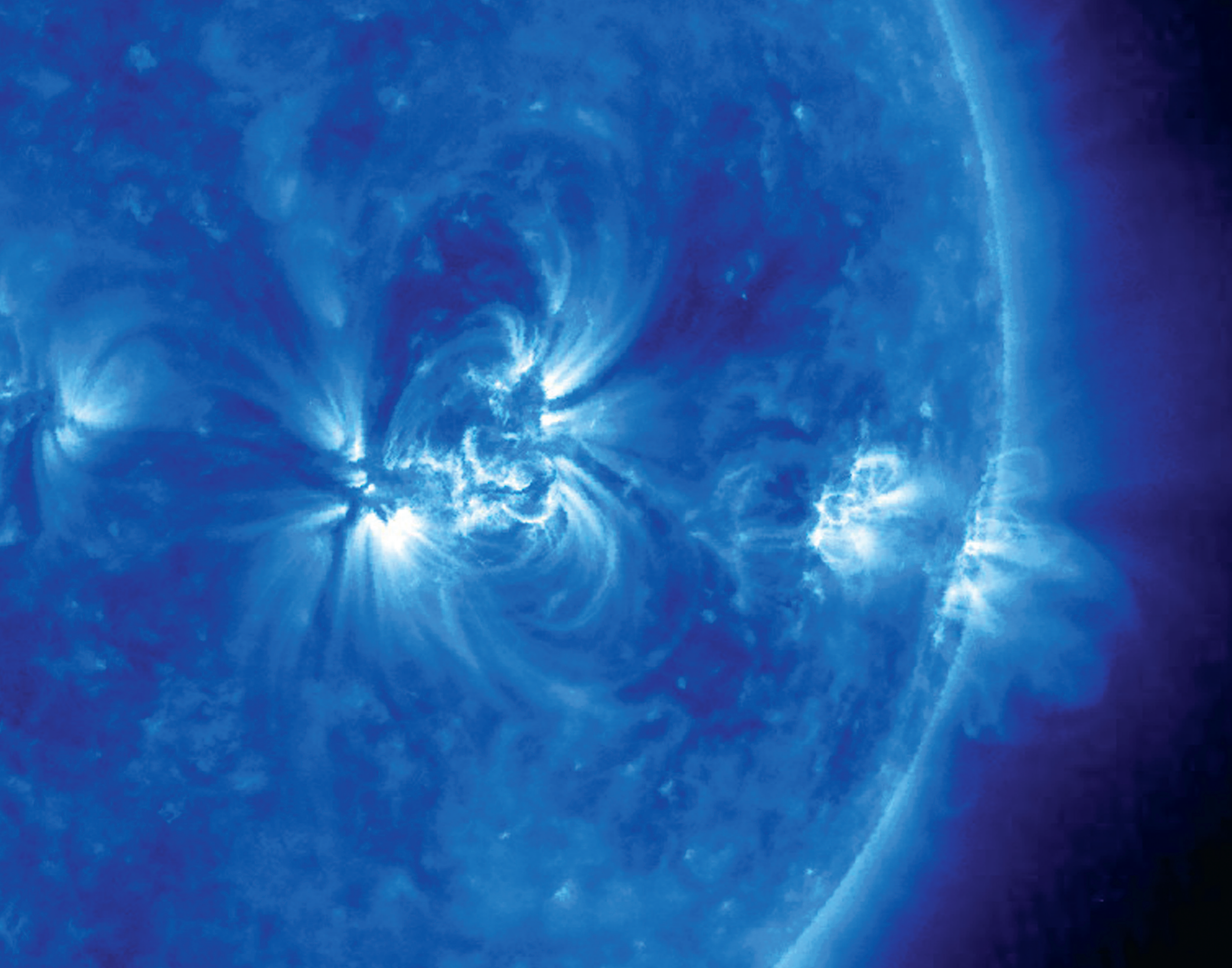

March 2009

New Moon · First Quarter · Full Moon · Last Quarter

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4	5	6	7
8 Daylight Saving Time Begins	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

STEREO Captures Stunning Solar Loops

The Solar TErrestrial RElations Observatory (STEREO) consists of two separate space-based observatories—one positioned ahead of Earth in its orbit (STEREO-A), and the other trailing behind (STEREO-B). With this new pair of viewpoints, scientists now have literally added a whole new dimension to their understanding of the Sun and solar activity. They can observe the three-dimensional structure of solar storms and monitor their progress as they blast from the Sun and move out through space. The STEREO mission is especially focused on coronal mass ejections (CMEs) that can be produced by active regions. CMEs are clouds of magnetically bound material that shoot out from the Sun into the solar system and can lead to disturbances at Earth, including severe magnetic storms in Earth's magnetosphere. They can pose a hazard to spacecraft and also to astronauts venturing outside the protection of the International Space Station.

The image above shows the Sun as it appears in extreme ultraviolet light. Viewed in that light, a string of *active regions* located near the Sun's equator become quite apparent. The Sun's strong magnetic field "bottles up" superheated gas that gives off ultraviolet energy. We see several active regions (the brighter areas on the image with the loops above them) that were lined up as they approached the edge of the Sun. STEREO-B obtained this image on June 9, 2007.

Image credit: NASA.

Artist's rendition of the pair of STEREO spacecraft. Credit: NASA and the Johns Hopkins University Applied Physics Laboratory.

FEBRUARY **2009**

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APRIL **2009**

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April 2009

New Moon · First Quarter · Full Moon · Last Quarter

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
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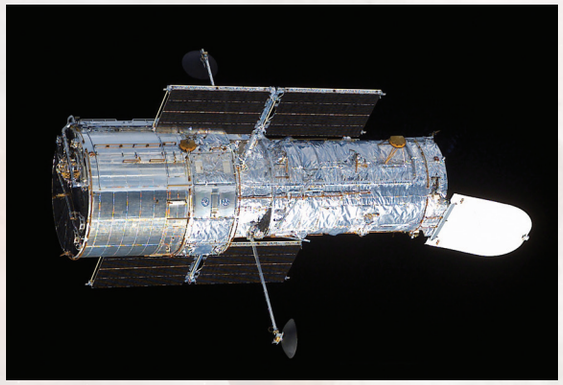
Hubble Witnesses the Birth and Death of Stars in the Carina Nebula

"A time to be born, a time to die." The writer of Ecclesiastes penned those words centuries ago and they seem an apt description of the nature of life in our Universe. The saying is true for the lives of human beings … and even for the lives of stars. The stars seem fixed in the heavens above us and from our vantage point they seem like they will be there forever, but on galactic timescales, even stars are born, grow old, and eventually die. Across the vast expanses of our Universe, some stars are being born at the same moment others are dying … and NASA's Great Observatories are giving us dramatic views of this stellar cycle of life.

The image of the nebula shown here comes from the Hubble Space Telescope and was assembled from 48 frames taken by the telescope's Advanced Camera for Surveys. It is a 50-light-year-wide view of the central region of the Carina Nebula where a maelstrom of star birth—and death—is taking place. The immense nebula contains at least a dozen brilliant stars that are estimated to be at least 50 to 100 times the mass of our Sun. The most unique and opulent inhabitant is the star Eta Carinae, at far left. Eta Carinae is in the final stages of its relatively brief and eruptive lifespan, as evidenced by two billowing lobes of gas and dust that presage its upcoming explosion as a titanic supernova. The hurricane blast of stellar winds and blistering ultraviolet radiation within the cavity is now compressing the surrounding walls of cold hydrogen. This is triggering a second stage of new star formation. Our Sun and our solar system may have been born inside such a cosmic crucible 4.6 billion years ago. In looking at the Carina Nebula, we are seeing the genesis of star making as it commonly occurs along the dense spiral arms of a galaxy.

Image and partial text credit: NASA, European Space Agency, University of California, Berkeley, and the Hubble Heritage Team (STScI/AURA).



This photo of the Hubble Space Telescope, fresh from the servicing mission 3B, was taken from the Space Shuttle Columbia in March 2002. Credit: NASA.

MARCH 2009

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MAY 2009

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24/31	25	26	27	28	29	30

May 2009

New Moon · First Quarter · Full Moon · Last Quarter

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1	2
3	4	5	6	7	8	9
10 Mother's Day	11	12	13	14	15	16
17	18	19	20	21	22	23
24 31	25 Memorial Day	26	27	28	29	30

Terra Gives New Perspective for Studying Geology

NASA Earth observing satellite data is used to produce striking images of the Earth's land surface and provides a new perspective for observing and studying geology.

This image shows the Kondyor Massif located in eastern Siberia. The 6-kilometer- (3.7-mile-) wide ring of rock looks as if it was created by some sudden and violent upheaval like an asteroid's impact or a volcanic eruption, but it is actually the result of much more gradual processes. Kondyor Massif was formed by the intrusion of igneous, or volcanic, rock that gradually pushed up through overlying layers of sedimentary rock, some of them laid down more than a billion years ago.

On June 10, 2006, the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on NASA's Terra satellite observed the region and this three-dimensional view was made by draping ASTER data over topography data (also from ASTER)—called a *digital elevation model* (DEM)—to give a sense of the feature's proportions. The circular ring of rock is bare and stands out from the vegetation that surrounds the ring. In this image, even sparse vegetation appears bright green. Water collecting in the middle of the massif has formed a river that flows out of the massif, on the north side. Kondyor Massif is not just of interest for its unusual topography; it is also rich in mineral deposits. Among the highly valued minerals found at this site are gold, silver, and platinum. The area has been mined for platinum—coarse platinum-iron crystals as large as 1.5 centimeters (0.6 inches) have been found.

Image and partial text credit: NASA's Earth Observatory; NASA/Goddard Space Flight Center; Japan's Ministry of Economy, Trade and Industry; Japan's Earth Remote Sensing Data Analysis Center; Japanese Resource Observation System; and the U.S./Japan ASTER Science Team.

APRIL **2009**

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JUNE **2009**

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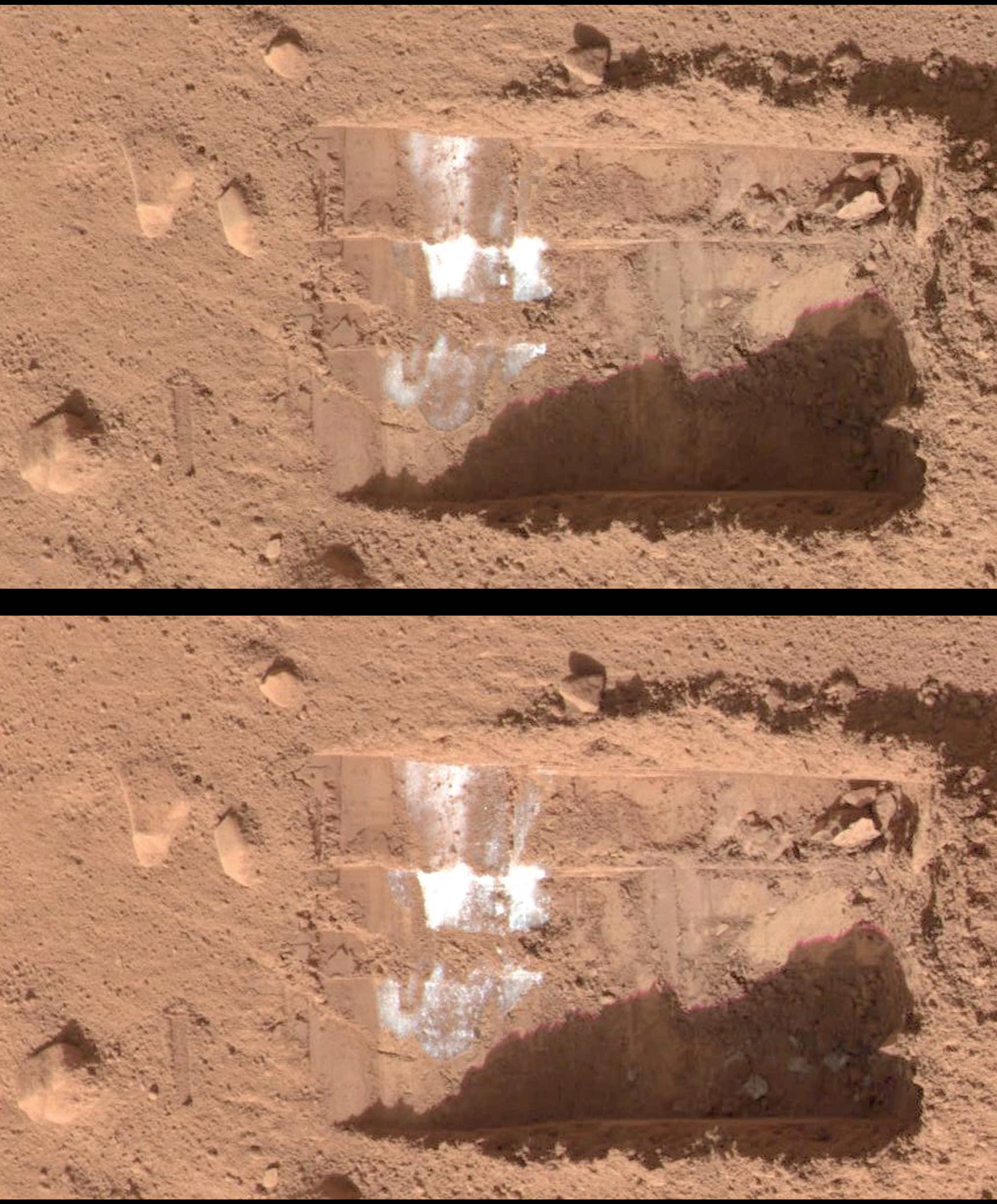


June 2009

New Moon · First Quarter · Full Moon · Last Quarter

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	1	2	3	4	5	6
7	8	9	10	11	12	13
14 Flag Day	15	16	17	18	19	20
21 Father's Day	22	23	24	25	26	27
28	29	30				

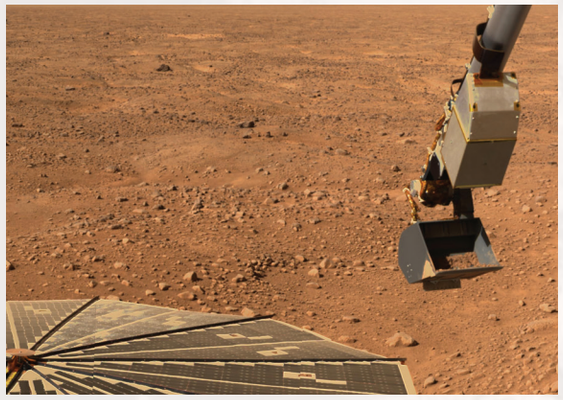
Phoenix Lander Digs Up Water on Mars

Mars is a cold, dry, desert landscape of sand and rocks; in many ways, it is quite different from Earth. And yet, the geologic processes on the two planets are surprisingly similar. On Mars, we see volcanoes, channels, and impact basins much like the ones we see on Earth. Because of these similarities, scientists study certain geologic features and processes on Earth in order to learn about analogous features on Mars. Because we don't yet have the capability to send humans to do fieldwork on Mars, we use robots. NASA has previously sent two rovers called Spirit and Opportunity to explore some of the Martian surface. Now the Mars Phoenix Lander continues to make observations.

One of the interesting topics that scientists are investigating using the Phoenix Lander is the presence of water in the Martian arctic. Previous discoveries made by the Mars Odyssey Orbiter in 2002 reveal large amounts of subsurface water ice in the northern arctic plain. Scientists specifically chose a location in the northern arctic region of Mars as the landing site for Phoenix so that they could investigate this further. Phoenix is equipped with a robotic arm that allows it to dig through the protective top soil, expose the water ice, and move the soil sample to the lander platform for scientific analysis.

Phoenix acquired the two images shown here on June 15 and 19, 2008, respectively. These images show sublimation of ice in the trench informally called "Dodo-Goldilocks" over the course of four days. In the lower left corner of the left image, a group of lumps is visible. In the right image, the lumps have disappeared, similar to the process of evaporation.

Image and partial text credit: NASA/Jet Propulsion Laboratory-Caltech, University of Arizona, and Texas A&M University.



This image shows NASA's Phoenix Mars Lander's solar panel and robotic arm with a sample in the scoop. The image was taken by the lander's Surface Stereo Imager on June 10, 2008. Credit: NASA/Jet Propulsion Laboratory-Caltech, University of Arizona, and Texas A&M University.

MAY **2009**

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JULY **2009**

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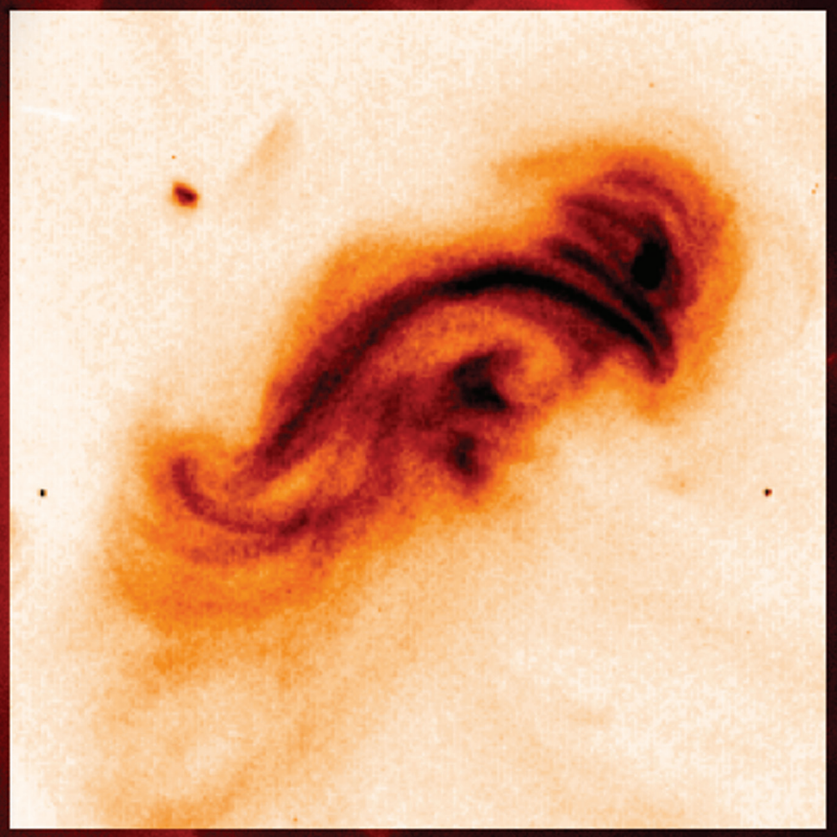


July 2009

New Moon · First Quarter · Full Moon · Last Quarter

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			1	2	3	4 Independence Day
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

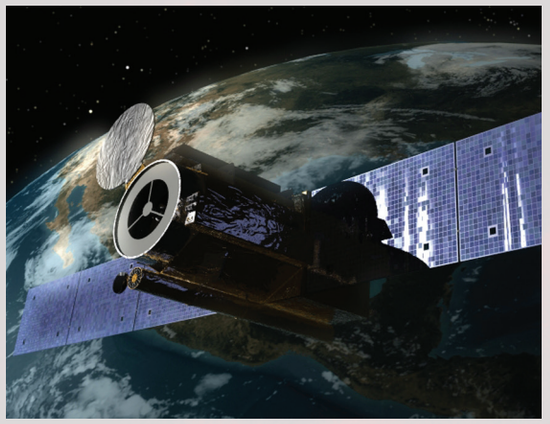
Hinode Reveals Magnetic Structures on the Sun

Occasionally, the Sun produces a sudden violent explosion of activity called a *solar flare*. They occur when magnetic fields on the Sun's surface get tangled and 'reconnect,' causing nearby plasma to become superheated and release a tremendous amount of energy across the entire electromagnetic spectrum into interplanetary space. This release of solar energy into space creates the *space weather* that occasionally impacts Earth and could disrupt its technological systems.

Sigmoids are S- or reverse S-shaped pairs of hot loops usually seen in the outer layer of the Sun, called the *corona,* around active regions. These structures are often a harbinger of solar flares or coronal eruptions.

Hinode—Japanese for sunrise—is a mission that helps scientists understand the interaction between the Sun's magnetic field at its outer layer and determine how the Sun's explosive energy propagates through the different layers of the solar atmosphere. Hinode accomplishes its mission using three instruments, one of which is a NASA-built Solar X-Ray Telescope (XRT). The XRT captured this view of a sigmoid structure on December 2, 2007. This particular sigmoid erupted about 2 hours after this image was taken.

Image credit: NASA and the Japan Aerospace Exploration Agency.



Artist's impression of the Hinode spacecraft in orbit.
Credit: NASA.

JUNE **2009**

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AUGUST **2009**

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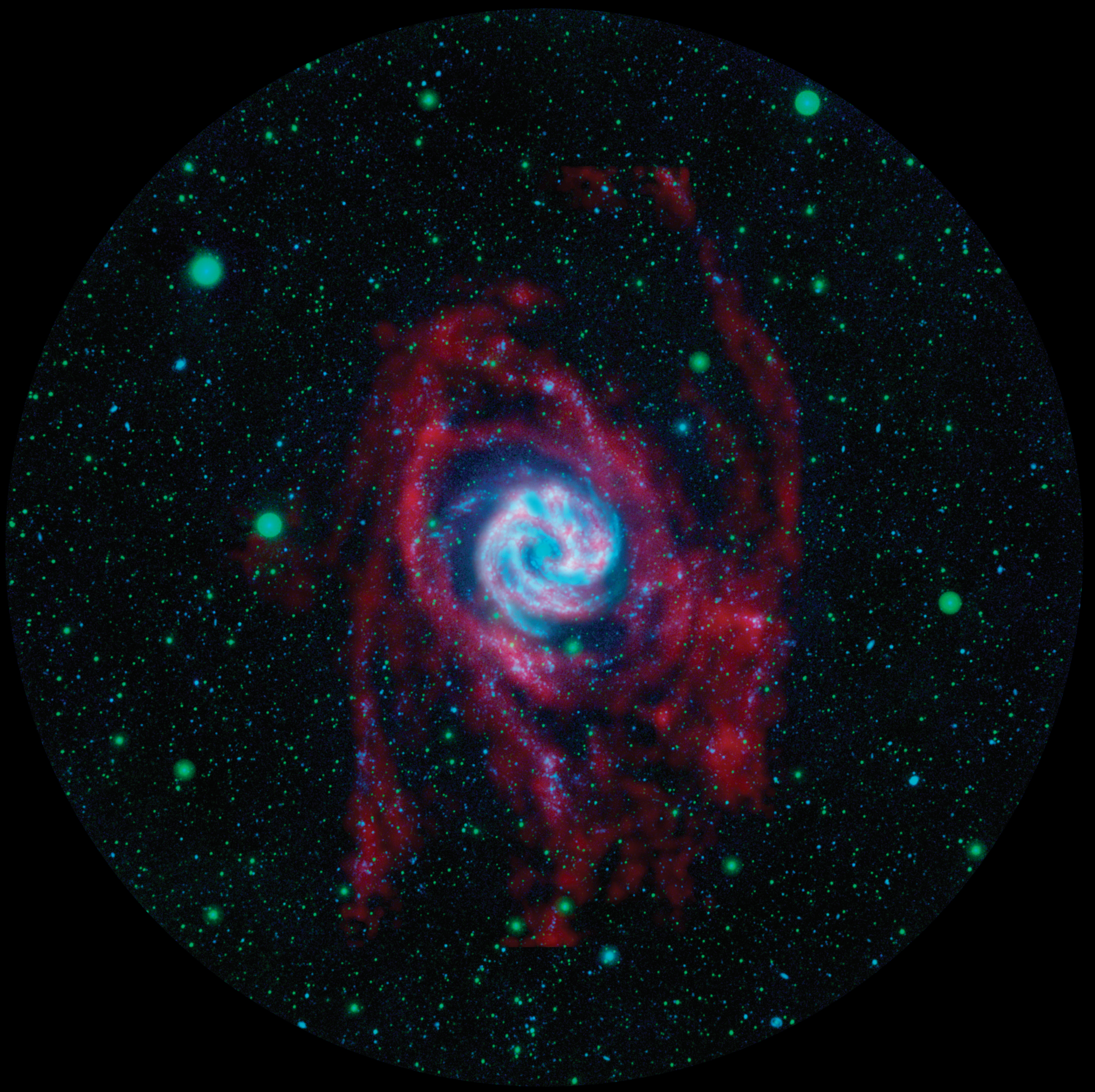

August 2009

New Moon · First Quarter · Full Moon · Last Quarter

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
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23 30	24 31	25	26	27	28	29

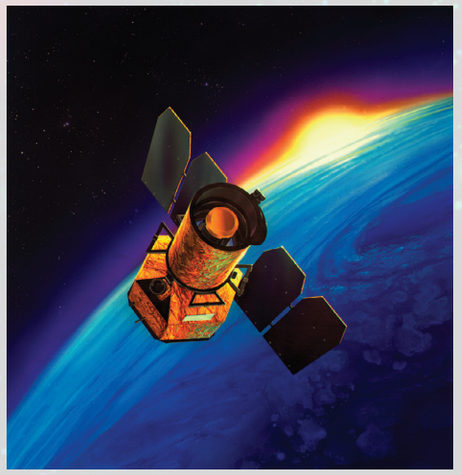
GALEX Observes Star Formation on the Galactic Frontier

NASA scientists seek to understand how stars are born. They study what makes up the space between the stars—the interstellar medium—and giant molecular clouds that are precursors to star and planet formation. Until recently it was widely believed that star formation primarily took place near the center of galaxies, the reasoning being that the outlying regions of a galaxy were relatively barren and lacking high concentrations of the ingredients needed for stars to form. However, new results show that the "galactic frontier" is not as barren and desolate as we once thought.

A new image that combines data from NASA's Galaxy Evolution Explorer (GALEX) telescope and the National Science Foundation's Very Large Array in New Mexico shows clear evidence of new star formation some 140,000 light years from the center of the Southern Pinwheel galaxy (M83). In this image, far-ultraviolet light is blue, near-ultraviolet light is green, and radio emission at a wavelength of 21 centimeters is red. The blue and pink pinwheel in the center is the galaxy's main stellar disk, while the flapping, ribbon-like structures are its extended arms.

By combining ultraviolet measurements from GALEX with radio waves from the Very Large Array (red), scientists get a better idea of the location of gaseous hydrogen atoms—the raw ingredients of stars. When combining the radio and GALEX data, astronomers were delighted to see they matched up so well. The astronomers speculate that the young stars seen far out in M83 could have formed under conditions resembling those of the early universe, a time when space was not yet enriched with dust and heavier elements.

Image and partial text credit: NASA/Jet Propulsion Laboratory-Caltech, Very Large Array, and the Max Planck Institute for Astronomy.



Artist rendition of the Galaxy Evolution Explorer
Credit: NASA/Jet Propulsion Laboratory-Caltech.

JULY **2009**

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SEPTEMBER **2009**

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September 2009

New Moon · First Quarter · Full Moon · Last Quarter

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		1	2	3	4	5
6	7 Labor Day	8	9	10	11	12
13	14	15	16	17 Constitution Day	18	19
20	21	22	23	24	25	26
27	28	29	30			

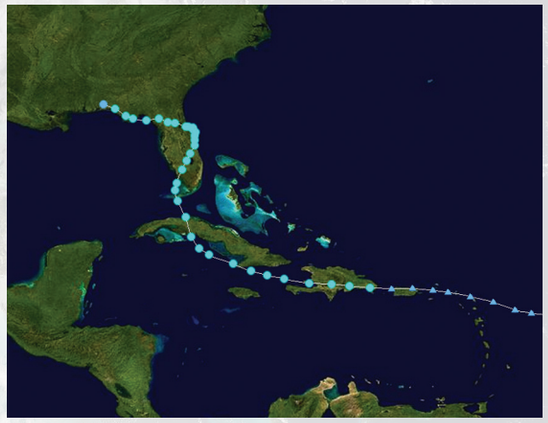
The Tropical Storm That Wouldn't Go Away

Tropical cyclones are often born far out at sea and spend most of their lives over remote areas of the ocean. There was a time not all that long ago when hurricanes and tropical storms often caught society by surprise causing untold damage and devastation to communities caught unprepared. But images and data from Earth observing satellites have helped to revolutionize our ability to track the progress of hurricanes and tropical storms. The images and data can be shared with decision makers, and provide areas that may be in the path of the storm with the advanced warning they need to give them time to plan their response to these dangerous storms.

This photo-like true color image of Tropical Storm Fay was made from data collected by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite. MODIS captured this image of the storm on August 21, 2008.

Tropical Storm Fay became the sixth named storm system of the 2008 Atlantic hurricane season after forming over the Dominican Republic on August 15. The storm system traveled the length of Hispaniola, bringing heavy rains and winds to the Dominican Republic and Haiti before traveling along Cuba's southern coast. Fay then proceeded to make landfall on an unprecedented four separate occasions in the state of Florida—Key West on August 18, Cape Romano on August 19, Flagler Beach on August 21, and Carrabelle on August 23. At the time of the storm a relatively strong mid-Atlantic ridge had developed along the central east coast of the U.S., essentially blocking any northward progression of the storm and steering Fay westward for its third and fourth Florida landfalls. The storm dumped copious amounts of rain in eastern and northern sections of Florida causing tens of millions of dollars in damage.

Image credit: NASA/GSFC MODIS Land Rapid Response Team.



Tropical Storm Fay track map. Credit: National Weather Service National Hurricane Center and NASA.

AUGUST 2009

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OCTOBER 2009

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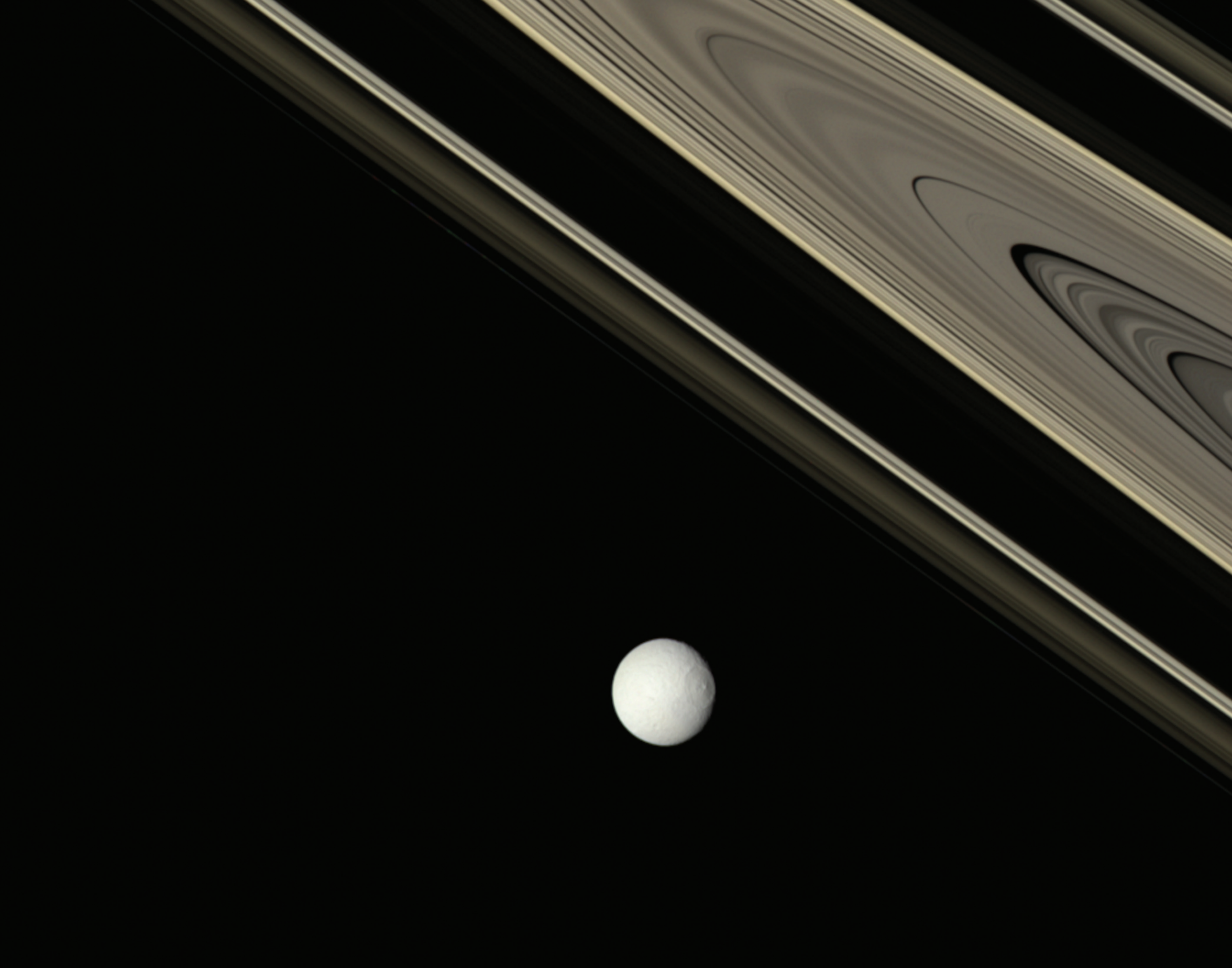

October 2009

New Moon · First Quarter · Full Moon · Last Quarter

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
				1	2	3
4	5	6	7	8	9	10
11	12 Columbus Day	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31 Halloween

Cassini Turns to the Dark Side … of Saturn

NASA's Cassini—Huygens Probe has been orbiting the planet Saturn since 2004. The images beamed back to Earth are giving scientists their most comprehensive look ever at the Solar System's second largest planet and its rings and moons. Cassini provides scientists a unique vantage point to observe processes at work today that were similar to those responsible for configuring the Solar System, for producing the habitable environment on the surface of our own planet, and even similar to those active on the early Earth. Over the last four years, Cassini has traveled over a half billion kilometers (over 300 million miles) surveying Saturn and its moons, intently watching the intricate motions of the ringed planet's clouds and eddies, and darting through the atmosphere of its largest moon, Titan.

And now Cassini turns its focus to the dark side—that is, the side not illuminated by the Sun. Shown here is a striking view of Tethys, another of Saturn's moons, set against the rings that encircle Saturn. The thinner rings are highlighted in shades of brown and gold, contrasting with the more neutral appearance of Tethys. The A ring and Cassini Division are separated by the optically thick B ring, which does not permit sunlight to penetrate and appears as the broad, dark lane between them in this view.

The image shown here was obtained on October 29, 2007, and combines red, green, and blue spectral filters on Cassini's narrow-angle camera to create a "natural" color view. The spacecraft is positioned approximately 2.1 million kilometers (1.3 million miles) from Tethys and at a Sun-Tethys-spacecraft, or phase, angle of 21°. Image scale is 12 kilometers (8 miles) per pixel.

Image and partial text credit: NASA/Jet Propulsion Laboratory and the Space Science Institute.

This image of Tethys was taken in visible green light with the Cassini spacecraft narrow-angle camera on May 10, 2008, from a distance of approximately 183,000 kilometers (114,000 miles). Credit: NASA/Jet Propulsion Laboratory and the Space Science Institute.

SEPTEMBER **2009**

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27	28	29	30			

NOVEMBER **2009**

S	M	T	W	T	F	S
1	2	3	4	5	6	7
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15	16	17	18	19	20	21
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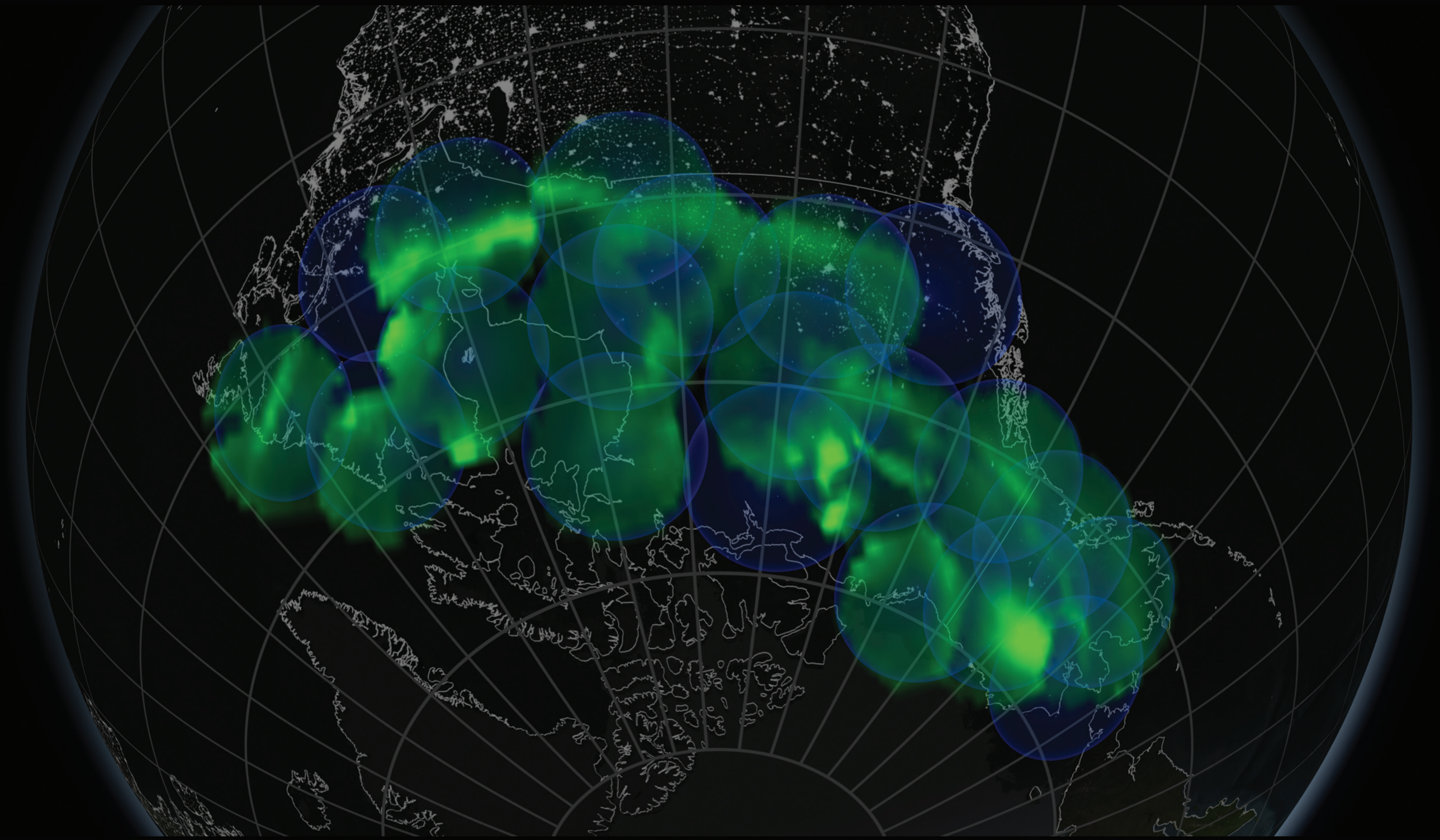


November 2009

New Moon · First Quarter · Full Moon · Last Quarter

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1 Daylight Saving Time Ends	2	3 Election Day	4	5	6	7
8	9	10	11 Veterans Day	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26 Thanksgiving Day	27	28
29	30					

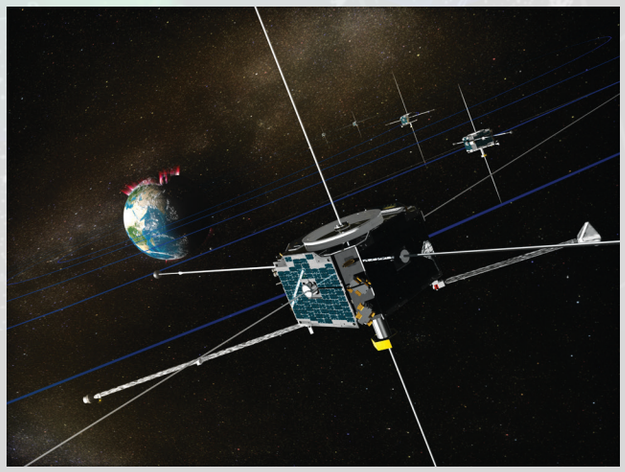
THEMIS Probes the Power Behind the Northern Lights

For many generations, people living in far Northern latitudes have looked to the skies and seen the spellbinding lights of *aurora borealis*. There were many myths to explain their existence, but we now know that the Sun is the "father" of the Northern Lights. When the stream of hot plasma known as the *solar wind* interacts with the edge of the Earth's magnetic field, charged particles sometimes energize gases in the ionosphere and produce the telltale reds, greens, blues, and violets of the Northern lights.

NASA's Time History of Events and Macroscale Interactions during Substorms (THEMIS) is a constellation of five small identical probes orbiting Earth to study auroras and determine what causes Earth's magnetosphere to occasionally unleash a huge amount of stored solar wind energy all at once—called a *substorm*—that causes the Northern Lights to become brighter and more active. The space-based observations are complemented by a system of 20 ground-based observing systems each equipped with an all-sky camera that is capable of imaging the overhead aurora from horizon to horizon and together providing an almost complete view from east Canada to west Alaska.

On March 9, 2008 a moderate geomagnetic storm created a brilliant and dynamic aurora that covered an unusually large portion of North America. This image comes from THEMIS and shows the aurora at the peak of activity when arcs were observed as far south as the northern-most states in the contiguous U.S., and bright structures extended almost to the highest observed latitudes in Canada.

Image Credit: NASA.



Artist's concept of the THEMIS spacecrafts as they might appear in orbit. Credit: NASA.

OCTOBER **2009**

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DECEMBER **2009**

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6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

December 2009

New Moon · First Quarter · Full Moon · Last Quarter

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25 Christmas Day	26
27	28	29	30	31		

Chandra Views a "Hole in the Heart" of the Centaurus-A Galaxy

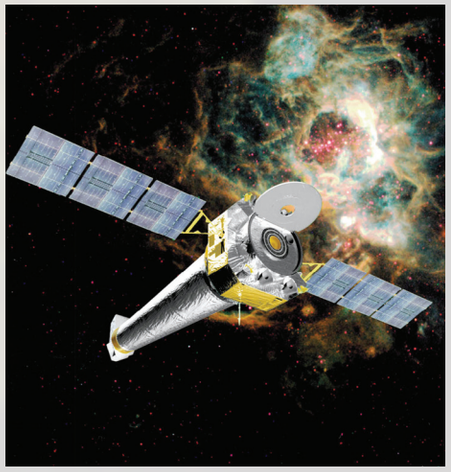
This dramatic new image from NASA's Chandra X-ray Observatory shows the nearby galaxy Centaurus A, and provides one of the best views to date of the effects of an active supermassive black hole. Opposing jets of high-energy particles can be seen extending to the outer reaches of the galaxy, and numerous smaller black holes in binary star systems are also visible. A prominent X-ray jet extending for 13,000 light years points to the upper left in the image, with a shorter "counterjet" aimed in the opposite direction. Astronomers think that such jets are important vehicles for transporting energy from the black hole to the much larger dimensions of a galaxy, and affecting the rate at which stars form there.

The inner part of the X-ray jet close to the black hole is dominated by these knots of X-ray emission, which probably come from shock waves—akin to sonic booms—caused by the jet. Farther from the black hole there is more diffuse X-ray emission in the jet. The cause of particle acceleration in this part of the jet is unknown.

Hundreds of point-like sources are also seen in the Chandra image. Many of these are X-ray binaries that contain a stellar black hole and a companion star in orbit around one another. Determining the population and properties of these black holes should help scientists better understand the evolution of massive stars and the formation of black holes.

In this image, low-energy X-rays are colored red, intermediate-energy X-rays are green, and the highest-energy X-rays detected by Chandra are blue. The dark green and blue bands running almost perpendicular to the jet are dust lanes that absorb X-rays. This dust lane was created when Centaurus A merged with another galaxy perhaps 100 million years ago.

Image credit and partial text credit: NASA, Chandra X-ray Center, and the Smithsonian Astrophysical Observatory.



Artist's illustration of the Chandra X-ray Observatory. Credit: NASA Marshall Space Flight Center.

NOVEMBER 2009

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JANUARY 2010

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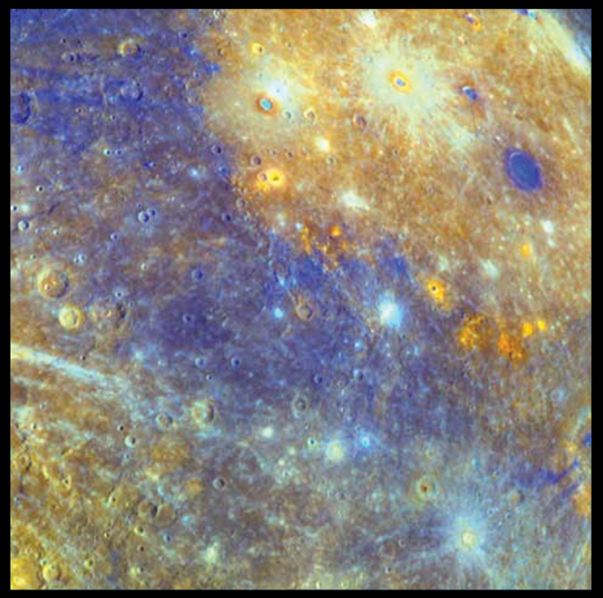

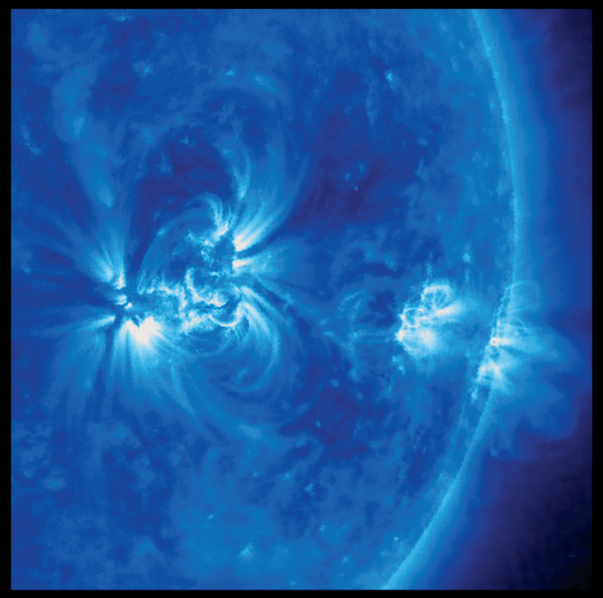

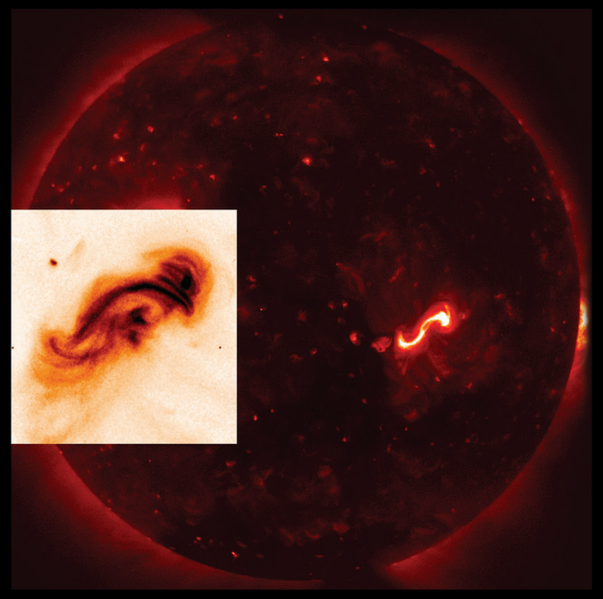

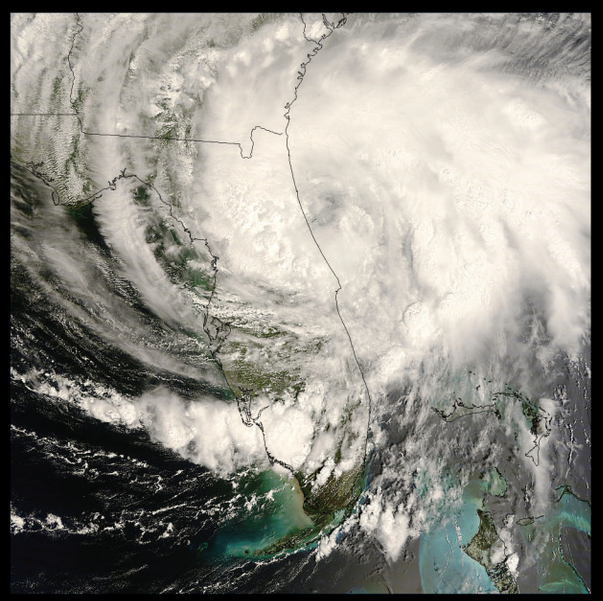

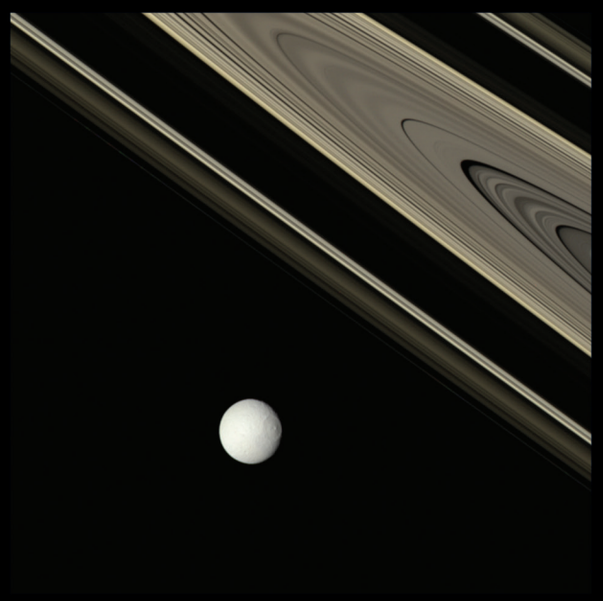

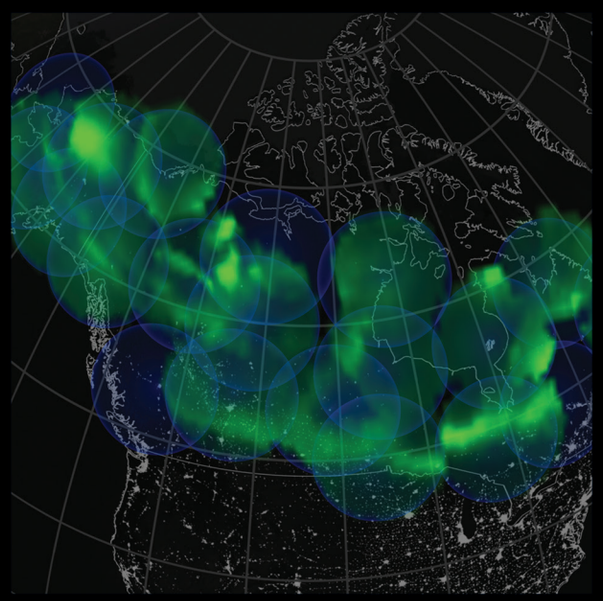

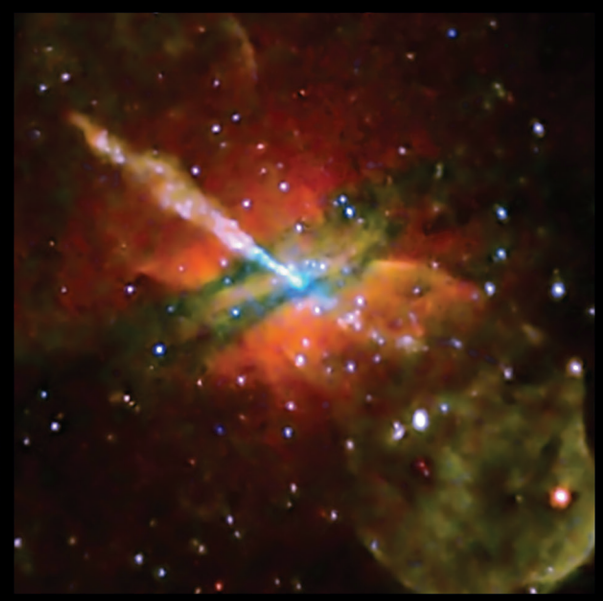

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