National Aeronautics and Space Administration

2019 EXPLORE SCIENCE

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EXPLORE SCIENCE

"Action without vision is only passing time, vision without action is merely day dreaming, but vision with action can change the world."

– Nelson Mandela

At NASA's Science Mission Directorate, our vision propels us to be purposeful and blur the lines between the present and future. From the first 60 years of NASA Science and into the future, our goal is to reach beyond what we know by investigating nature—the Earth, the Moon, the Sun, other worlds of our solar system, the countless stars and galaxies, and the universe—where we can learn more.

Staying true to our roots, we are using the lessons history has taught us through past lunar exploration to expand future commercial and international partnerships, as well as create new innovative approaches for attaining human and science exploration goals. We also use lunar exploration to light our way and unlock the secrets of Mars. NASA science research does more than just satisfy human curiosity to explore the universe around us, it also improves and saves the lives of people around the world every day. As we appreciate the power and wonder of nature, we also inspire future generations of scientists, engineers, and curious minds to seek answers to questions we haven't yet even thought to ask.

The selected images in the calendar are nature's art. Each is a moment in space and time that represents the efforts of many individuals committed to the scientific pursuit of knowledge and advancement of humankind. As Nelson Mandela stated, a vision with action can truly change the world. It is my honor to lead this visionary effort.

Thomas H. Zurbuchen

Associate Administrator
NASA Science Mission Directorate

Phytoplankton Bloom in the Western North Atlantic Ocean. Swirls of phytoplankton outline turbulent surface currents in the western North Atlantic Ocean. Phytoplankton are microscopic, plant-like organisms that live in both salty and fresh water. In the right conditions, phytoplankton growth explodes, a condition known as a *bloom* that can be seen in satellite images. This scene was captured on April 18, 2018, by the Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi-National Polar-orbiting Partnership (Suomi-NPP) satellite. VIIRS data are used to measure cloud and aerosol properties, ocean color, sea and land surface temperature, ice motion and temperature, fires, and Earth's albedo. **Image and text credit:** NASA

https://oceancolor.gsfc.nasa.gov/gallery/562

Born in January 1954, Michael H. Freilich is a recognized oceanographic researcher, microwave remote sensing expert, and science administrator who has directed NASA's Earth Science Division since November 2006. He led NASA and the U.S. Earth Science communities in the successful response to the inaugural 2007 Earth Science and Applications Decadal Survey; revitalized NASA's on-orbit fleet of Earth observing research satellites; created and established the Venture Class competitive flight; introduced observing system innovations and partnerships including the use of SmallSats and CubeSats as science tools; and expanded NASA's roles in international and interagency collaboration. Prior to coming to NASA HQ, Freilich held positions as Professor and Associate Dean at Oregon State University (1992–2006), and as a Member of the Technical Staff at the Jet Propulsion Laboratory (1983–1991). He was Principal Investigator and Project Scientist for NASA's orbital NSCAT, QuikSCAT, and SeaWinds/ADEOS-2 scatterometer missions, and has served in many national and international science leadership positions. Photo credit: U.S. Mission Photo/Eric Bridiers

December 2018

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30	31					

February 2019

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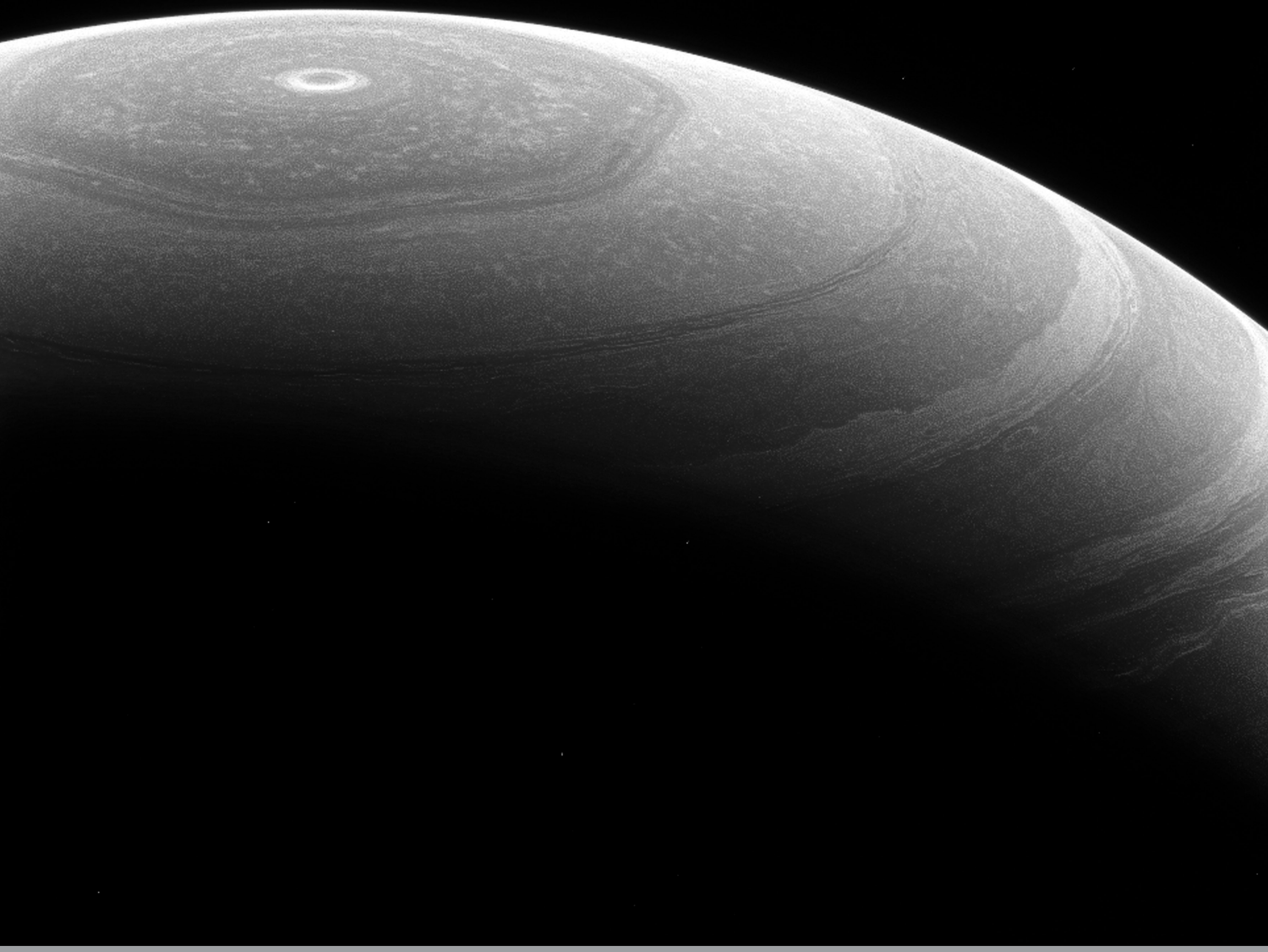
24	25	26	27	28		

JANUARY 2019

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1 New Year's Day	2	3	4	5
New Moon 6	7	8	9	10	11	12
13	First Quarter 14	15	16	17	18	19
20	Full Moon 21 Birthday of Martin Luther King, Jr. (observed date)	22	23	24	25	26
Last Quarter 27	28	29	30	31		



Circles and Hexagons. Saturn's cloud belts generally move around the planet in a circular path, but one feature is slightly different. The planet's wandering, hexagon-shaped polar jet stream breaks the mold—a reminder that surprises lurk everywhere in the solar system.

This atmospheric feature was first observed by the Voyager mission in the early 1980s and was dubbed "the hexagon." Cassini's visual and infrared mapping spectrometer was first to spy the hexagon during the mission, since it could see the feature's outline while the pole was still immersed in wintry darkness. The hexagon became visible to Cassini's imaging cameras as sunlight returned to the planet's northern hemisphere.

This view looks toward the northern hemisphere of Saturn—in summer, when this view was acquired—from above 65 degrees north latitude. The image was taken with the Cassini spacecraft wide-angle camera on June 28, 2017, using a spectral filter which preferentially admits wavelengths of near-infrared light centered at 752 nanometers. The view was acquired at a distance of approximately 536,000 miles (862,000 kilometers) from Saturn. Image scale is 32 miles (52 kilometers) per pixel. The Cassini spacecraft ended its mission on September 15, 2017. **Image and text credit:** NASA/JPL-Caltech/Space Science Institute

https://www.nasa.gov/image-feature/jpl/pia21348/circles-and-hexagons

Elizabeth Roemer (1929–2016) was an American astronomer whose research interests centered on comets and asteroids. Roemer was a professor at the University of Arizona. She discovered the two main-belt asteroids 1930 Lucifer and 1983 Bok. In addition, she took an extensive set of photographic plates of comets over 25 years, attempting to get consistent data for the magnitudes of the comet nuclei. She identified 79 returning short period comets during her career. In 1975, she also co-discovered Themisto (Jupiter XVIII), one of the 67 moons of Jupiter. The inner main-belt asteroid 1657 Roemera, discovered by Swiss astronomer Paul Wild in 1961, was named in her honor (M.P.C. 2347). Photo credit: Smithsonian Institution Archives

January 2019

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27	28	29	30	31		

March 2019

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17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

FEBRUARY 2019

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3	New Moon 4	5	6	7	8	9
10	11	First Quarter 12	13	14	15	16
17	18 Washington's Birthday (observed date)	Full Moon 19	20	21	22	23
24	25	Last Quarter 26	27	28		

Parker Solar Probe Blasts Off To Touch the Sun. NASA's Parker Solar Probe mission launched from Cape Canaveral Air Force Station in Florida on August 12, 2018. The mission is the first to fly directly through the Sun's *corona*—the hazardous region of intense heat and solar radiation in the Sun's atmosphere that is visible during an eclipse.

Over the course of 7 years, Parker Solar Probe will make 24 orbits around the Sun, circling ever closer to the Sun with the help of gravity assists from Venus—a maneuver a bit like a handbrake turn—that whips the spacecraft around the planet, using Venus's gravity to trim the spacecraft's orbit tighter around the Sun. Even the very first flyby of the Sun in December 2018 will place Parker Solar Probe as close as 15 million miles (~24 million kilometers) from the Sun—within the corona—closer than anything made by humanity has ever gone before. **Image and text credit:** NASA/Bill Ingalls

https://www.nasa.gov/press-release/nasa-ula-launch-parker-solar-probe-on-historic-journey-to-touch-sun

Born in March 1927, Joan Feynman is an astrophysicist who worked both at NASA's Ames Research Center and at NASA's Jet Propulsion Laboratory. She discovered that coronal mass ejections could be recognized by increased amounts of helium in the solar wind. She also worked on predicting the hazards of solar wind and the origins of auroras and was the first woman to be elected as an officer of the American Geophysical Union. She credited her older brother, physicist Richard Feynman, with encouraging her interest in science by taking her to see an aurora at a young age. Photo credit: NASA

February 2019

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24	25	26	27	28		

April 2019

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21	22	23	24	25	26	27
28	29	30				

MARCH 2019

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3	4	5	New Moon 6	7	8	9
10 Daylight Saving Time Begins	11	12	13	First Quarter 14	15	16
17	18	19	20	Full Moon 21	22	23
24 31	25	26	27	Last Quarter 28	29	30

Twins with Difference. This Hubble Space Telescope image shows a spiral galaxy known as NGC 7331. First spotted by the prolific galaxy hunter William Herschel in 1784, NGC 7331 is located about 45 million light-years away in the constellation of Pegasus. NGC 7331 is similar in size, shape, and mass to the Milky Way. It also has a comparable star formation rate, hosts a similar number of stars, has a central supermassive black hole and comparable spiral arms. The primary difference between our galaxies is that NGC 7331 is an *unbarred spiral galaxy*—it lacks a "bar" of stars, gas and dust cutting through its nucleus, as we see in the Milky Way. Its central bulge also displays an unusual rotation pattern, spinning in the opposite direction to the galactic disc itself.

Astronomers took this image using Hubble's Wide Field Camera 3 (WFC3), as they were observing an extraordinary exploding star—a *supernova*. Named SN2014C, it rapidly evolved from a supernova containing very little Hydrogen to one that is Hydrogen-rich—in just one year. This rarely observed metamorphosis was luminous at high energies and provides unique insight into the poorly understood final phases of massive stars. **Image and text credit:** ESA/Hubble and NASA/D. Milisavljevic (Purdue University)

https://www.spacetelescope.org/images/potw1805a

Vera F. C. Rubin (1928–2016) was an American astronomer who pioneered work on galaxy rotation rates and dark matter. Her legacy was described by *The New York Times* as "ushering in a Copernican-scale change" in cosmological theory. She was honored throughout her career for her achievements, and received the Bruce Medal, the Gold Medal of the Royal Astronomical Society, and the National Medal of Science, among others. Photo credit: NOAO/AURA/NSF

March 2019

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24	25	26	27	28	29	30
31						

May 2019

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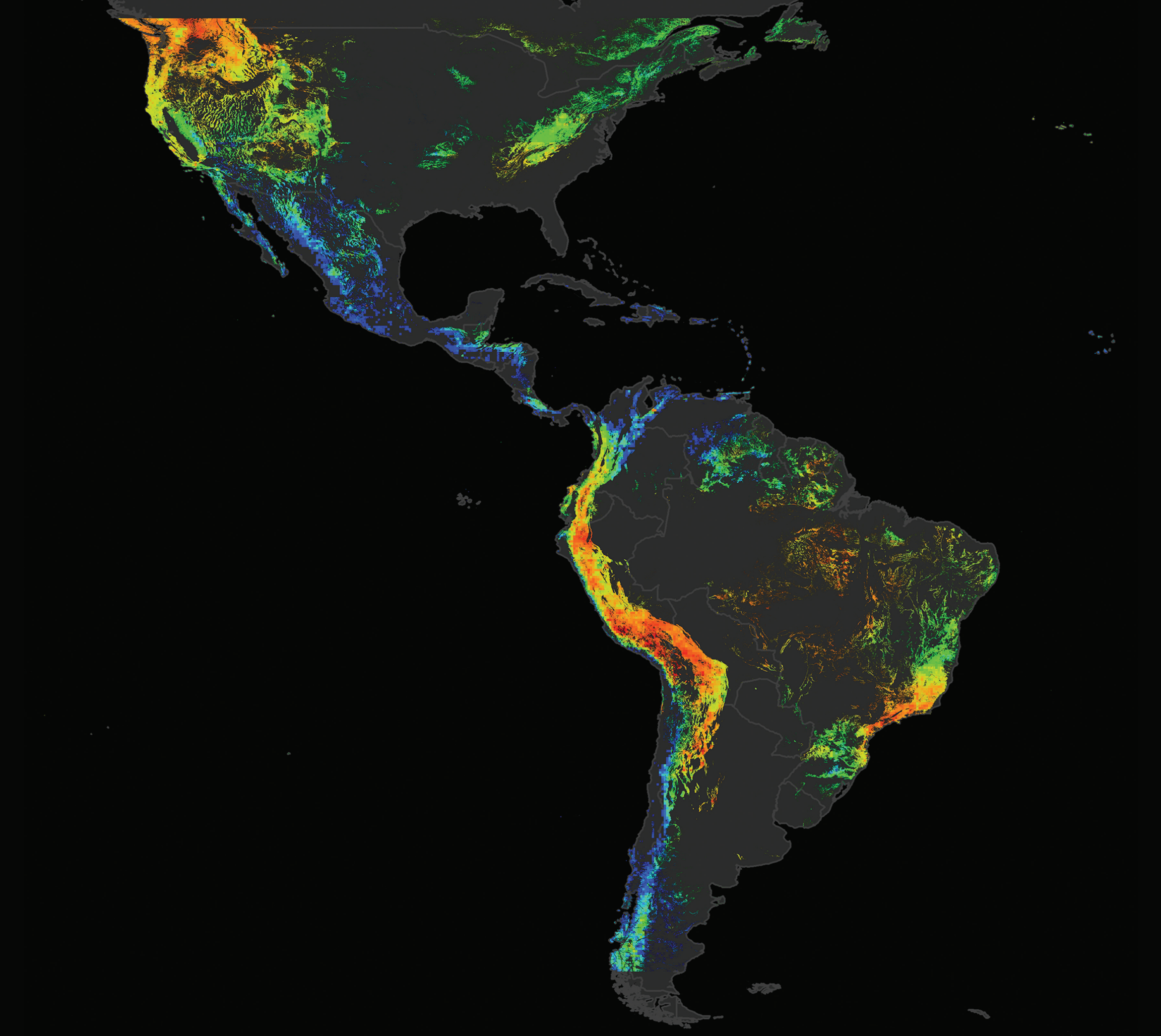
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

APRIL 2019

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3	4	New Moon 5	6
7	8	9	10	11	First Quarter 12	13
14	15	16	17	18	Full Moon 19	20
21	22	23	24	25	Last Quarter 26	27
28	29	30				



Tracking Landslide Potential in the Americas. Thanks to a new landslide model and detailed satellite measurements of precipitation made by NASA, scientists can look at landslide threats anywhere around the world in near real-time. The model, called the Landslide Hazard Assessment model for Situational Awareness (LHASA), estimates potential landslide activity triggered by rainfall.

LHASA estimates potential landslide activity by first identifying areas with heavy, persistent, and recent precipitation. Rainfall estimates are provided by a multi-satellite product developed by NASA, which provides precipitation estimates around the world every 30 minutes. In places where precipitation is unusually high, the model then uses a susceptibility map to determine if the area is prone to landslides. If the susceptibility map shows the area with heavy rainfall is vulnerable, the model produces a "nowcast" identifying the area as having a high to moderate likelihood of potential landslide activity. The model produces new nowcasts every 30 minutes at a near-global scale. This model can be used as a tool to support short-term disaster assessment and to identify long-term patterns in potential landslide activity.

This image shows the landslide nowcast results leveraging nearly two decades of Tropical Rainfall Measurement Mission (TRMM) data from 2001–2016 to identify a landslide climatology for the month of January at a 1-kilometer (~0.6-mile) grid cell. Red indicates areas where landslides are more common in the month of January. Blue indicates areas where the model shows less potential activity, and grey shows areas that are not very susceptible to slope failure. **Image and text credit:** NASA's GSFC/SVS

https://www.nasa.gov/feature/goddard/2018/new-from-nasa-tracking-landslide-hazards-new-nasa-model-finds-landslide-threats-in-near-real

Joanne Gerould Simpson (1923–2010) was the first woman in the United States to earn a Ph.D. in meteorology and became one of NASA's leading weather scientists. She first studied meteorology as a student pilot during World War II and later helped develop the *hot tower* theory critical to understanding hurricanes. In the 1960s, she developed the first computer cloud model. At NASA, Simpson made integral contributions to several historic missions, including the Tropical Rainfall Measuring Mission (TRMM). Simpson was the first woman to receive the prestigious International Meteorological Organization Prize. Image credit: Joanne Simpson and the Schlesinger Library

April 2019

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June 2019

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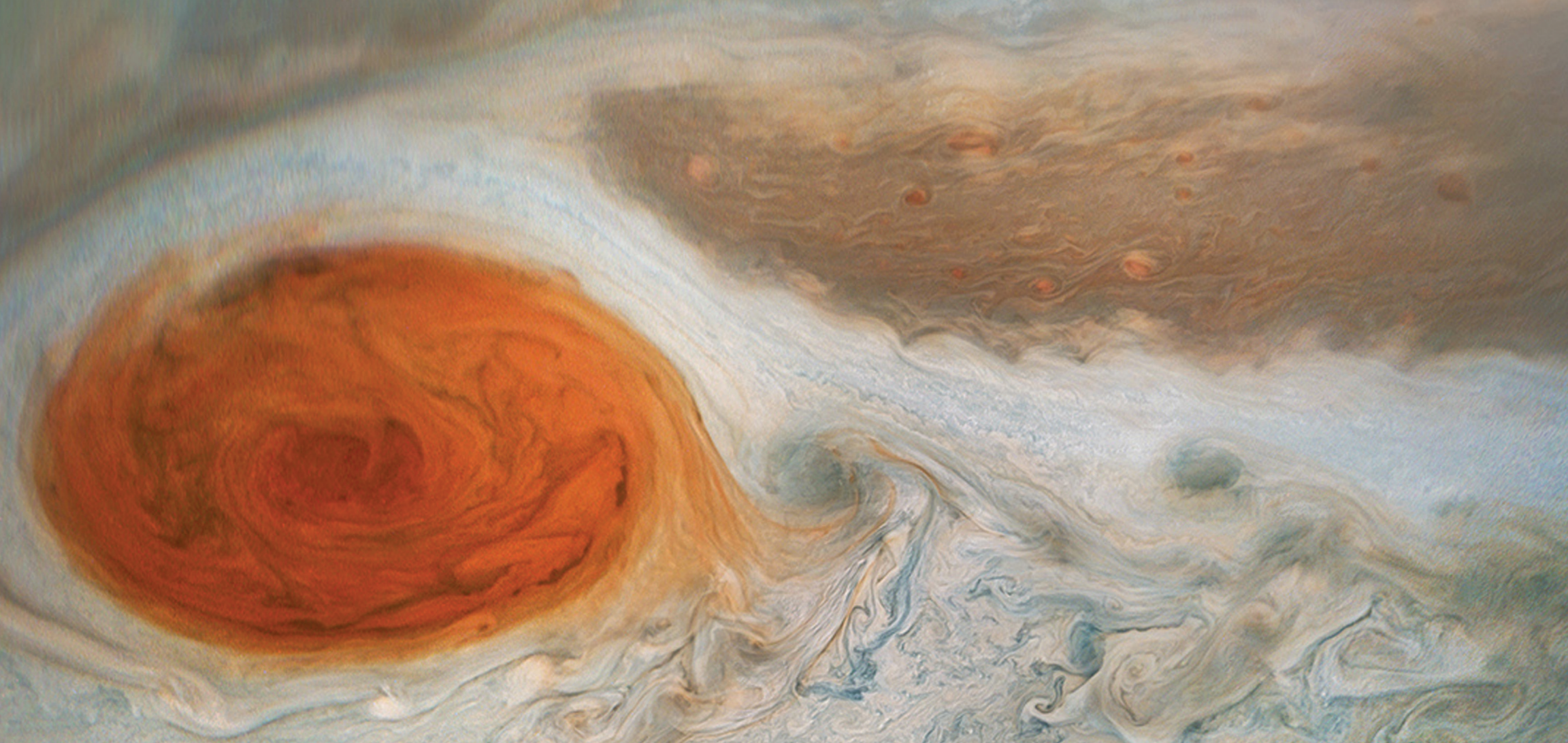
23	24	25	26	27	28	29
30						

MAY 2019

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2	3	New Moon 4
5	6	7	8	9	10	11
First Quarter 12 Mother's Day	13	14	15	16	17	Full Moon 18
19	20	21	22	23	24	25
Last Quarter 26	27 Memorial Day	28	29	30	31	



Jupiter's Great Red Spot, Spotted. This image of Jupiter's iconic Great Red Spot and surrounding turbulent zones was captured by NASA's Juno spacecraft. The color-enhanced image is a combination of three separate images taken on April 1, 2018—within 15 minutes of each other—as Juno performed its twelfth close flyby of Jupiter. At the time the images were taken, the spacecraft was 15,379 miles (24,749 kilometers) to 30,633 miles (49,299 kilometers) from the tops of the clouds of the planet at a southern latitude spanning 43.2 to 62.1 degrees. Citizen scientists Gerald Eichstädt and Seán Doran processed this image using data from the JunoCam imager. **Image and text credit:** NASA/JPL-Caltech/SwRI/MSSS/Gerald Eichstädt/Seán Doran

https://www.nasa.gov/image-feature/jpl/pia21985/jupiter-s-great-red-spot-spotted

Dorothea Klumpke Roberts (1861–1942) studied music and later astronomy at the University of Paris, receiving a bachelor's degree in 1886 and Ph.D. in 1893. In 1887 she took up a post at the Paris Observatory. There she worked with Guillaume Bigourdan and Lipót Schulhof, and later with the pioneer astrophotographers Paul and Prosper Henry, who were working with a 34-centimeter (~13-inch) refractor and photographing the minor planets (asteroids). Her work consisted of measuring star positions, processing astrophotographs, and studying stellar spectra and meteorites. Photo credit: Public Domain

May 2019

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26	27	28	29	30	31	

July 2019

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14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

JUNE 2019

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1
2	New Moon 3	4	5	6	7	8
9	First Quarter 10	11	12	13	14 Flag Day	15
16 Father's Day	Full Moon 17	18	19	20	21	22
23 30	24	Last Quarter 25	26	27	28	29

Celebrating 50 Years Since America Landed on the Moon. Apollo 11 launched from Cape Kennedy on July 16, 1969, carrying Commander Neil Armstrong, Command Module Pilot Michael Collins, and Lunar Module Pilot Edwin "Buzz" Aldrin. On July 20, 1969, Armstrong and Aldrin landed on the Moon in the Lunar Module *Eagle*. Collins stayed in orbit around the Moon in the Command Module *Columbia*, photographing the lunar surface, and Armstrong became the first human to step on the Moon almost 7 hours after landing.

This iconic photo, taken by Neil Armstrong, shows Buzz Aldrin next to the Solar Wind Composition Experiment. Led by Dr. Johannes Geiss of the University of Bern in Switzerland, the experiment helped collect samples of the solar wind for analysis back on Earth. The Moon provides an excellent location to study the solar wind because, unlike Earth, the Moon has no global magnetic field to deflect the solar wind, as happens on Earth. On July 24, 1969, all three astronauts came back to Earth safely, and the era of Apollo scientific sample analysis began!

Now, 50 years later, NASA is building a plan for Americans to return to the Moon. A key component of establishing the first permanent American presence and infrastructure on and around the Moon is the *Gateway*, a lunar orbiting platform to host astronauts farther from Earth than ever before. On the *Gateway*, America and its partners will prepare for the epochal mission to Mars. **Image and text credit:** NASA

https://spaceflight.nasa.gov/gallery/images/apollo/apollo11/html/as11-40-5873.html

Born in July 1935, Harrison Schmitt is an American geologist, retired NASA astronaut, university professor, former U.S. senator from New Mexico, and the most recent living person to have walked on the Moon. As of 2018, he is also the last living crew member of Apollo 17. Photo credit: NASA

June 2019

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August 2019

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18	19	20	21	22	23	24
25	26	27	28	29	30	31

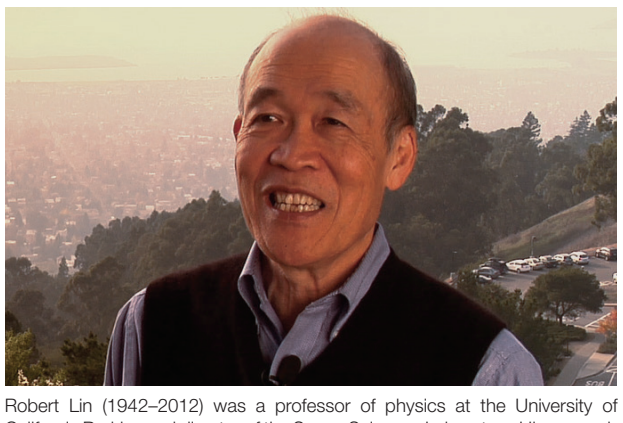
JULY 2019

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	New Moon 2	3	4 Independence Day	5	6
7	8	First Quarter 9	10	11	12	13
14	15	Full Moon 16 7/16/1969 Launch of Apollo 11	17	18	19	07/20/1969 Apollo 11 landed on the Moon. 20
21	22	23	07/24/1969 Apollo 11 returned to Earth. 24	Last Quarter 25	26	27
28	29	30	31			

Finding STEVE with Citizen Scientists. Glowing in mostly purple and green colors, a recently discovered celestial phenomenon is sparking the interest of scientists, photographers, and astronauts. The display of unusual lights was playfully named “Steve” by a group of citizen scientists working together with NASA space scientists on the Aurorasaurus project.

The phenomenon, now being called a *skyglow* is an important discovery because of its location in the *sub auroral zone*, an area of lower latitude than where most auroras appear that is not well researched. With this discovery, scientists now know there are unknown chemical processes taking place in the sub auroral zone that can lead to this light emission. As for the name “Steve” given by the citizen scientists? The team is keeping it to pay homage to its initial name and discoverers. But now it has its own acronym: Strong Thermal Emission Velocity Enhancement. **Image credit:** Krista Trinder; **Text credit:** NASA

https://www.nasa.gov/feature/goddard/2018/mystery-of-purple-lights-in-sky-solved-with-help-from-citizen-scientists



Robert Lin (1942–2012) was a professor of physics at the University of California Berkley and director of the Space Sciences Laboratory. His research and work spans across a multitude of fields of study, including experimental space physics, high energy astrophysics, solar flares, magnetosphere plasma, lunar and planetary geology, and heliophysics. Lin was well known in the heliophysics community for discovering that high velocity charged particles of solar flares can be observed from Earth. Lin also worked as the Principal Investigator for NASA’s Reuven Ramaty High Energy Solar Spectroscopic Imager, or RHESSI, which used X-ray and gamma-ray detectors to explore the basic physics of particle acceleration and explosive energy release in solar flares. Photo credit: NASA/GSFC

July 2019

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21	22	23	24	25	26	27
28	29	30	31			

September 2019

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15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

AUGUST 2019

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				New Moon 1	2	3
4	5	6	First Quarter 7	8	9	10
11	12	13	14	Full Moon 15	16	17
18	19	20	21	22	Last Quarter 23	24
25	26	27	28	29	New Moon 30	31

Astronomers Spot a Distant and Lonely Neutron Star. Astronomers have discovered a special kind of neutron star for the first time outside of the Milky Way galaxy, using data from NASA's Chandra X-ray Observatory and the European Southern Observatory's Very Large Telescope (VLT) in Chile. The neutron star is located within the remains of a supernova—known as 1E 0102.2-7219 (E0102 for short)—in the Small Magellanic Cloud, located 200,000 light years from Earth. Neutron stars are the ultra-dense cores of massive stars that collapse and undergo a supernova explosion. This newly identified neutron star is a rare variety that has both a low magnetic field and no stellar companion. Oxygen-rich supernova remnants like E0102 are important for understanding how massive stars fuse lighter elements into heavier ones before they explode. In this image, X-rays from Chandra are blue and purple, and visible light data from VLT's Multi Unit Spectroscopic Explorer (MUSE) instrument are bright red. Additional data from the Hubble Space Telescope are dark red and green. **Image and text credit:** X-ray (NASA/CXC/ESO/F.Vogt *et al.*); Optical (ESO/VLT/MUSE and NASA/STScI)

https://www.nasa.gov/mission_pages/chandra/news/astronomers-spot-distant-and-lonely-neutron-star.html

Born in October 1931, Riccardo Giacconi is a Nobel Prize–winning astrophysicist who laid the foundations of X-ray astronomy, with his pioneering work on several NASA missions, including, Uhuru, the Einstein Observatory, and the Chandra X-ray Observatory. He was the first director of the Space Telescope Science Institute, the science operations center for the Hubble Space Telescope. Photo credit: NRAO/AUI/NSF

August 2019

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

October 2019

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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		

SEPTEMBER 2019

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2 Labor Day	3	4	5	First Quarter 6	7
8	9	10	11	12	13	Full Moon 14
15	16	17 Constitution Day	18	19	20	21
Last Quarter 22	23	24	25	26	27	New Moon 28
29	30					

The Bluest Blue. The part of this iceberg in Antarctica's McMurdo Sound that is below the water surface appears vibrant blue primarily due to blue light from the water in the sound. The underside of some icebergs can be eroded away, exposing older, denser, and incredibly blue ice. As erosion changes an iceberg's shape, the berg may flip, bringing blue ice above the surface of the water. The unique step-like shape of this berg—compared to the tabular and more stable berg in the top-right of the image—suggests that it likely rotated sometime after calving. The image was acquired on November 29, 2017, during a polar ice-mapping flight of Operation IceBridge. **Image and text credit:** NASA/Chris Larsen

https://www.nasa.gov/image-feature/the-bluest-of-ice

Inge Lehmann (1888–1993) was a Danish seismologist and geophysicist who, in 1936, was the first to propose that Earth has a solid core surrounded by a molten outer core. Her mathematical analysis of an earthquake's shock waves led Lehmann to publish her theory about the foundation of Earth's inner and outer cores, separated by what came to be known as the *Lehmann Discontinuity*. Her hypothesis was confirmed by seismic technology in 1970. Lehmann received the William Bowie Medal from the American Geophysical Union, later named the Inge Lehmann Medal in her honor. Photo credit: Neuhaus/Courtesy of the Royal Danish Library

September 2019

S	M	T	W	T	F	S
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	26	27	28
29	30					

November 2019

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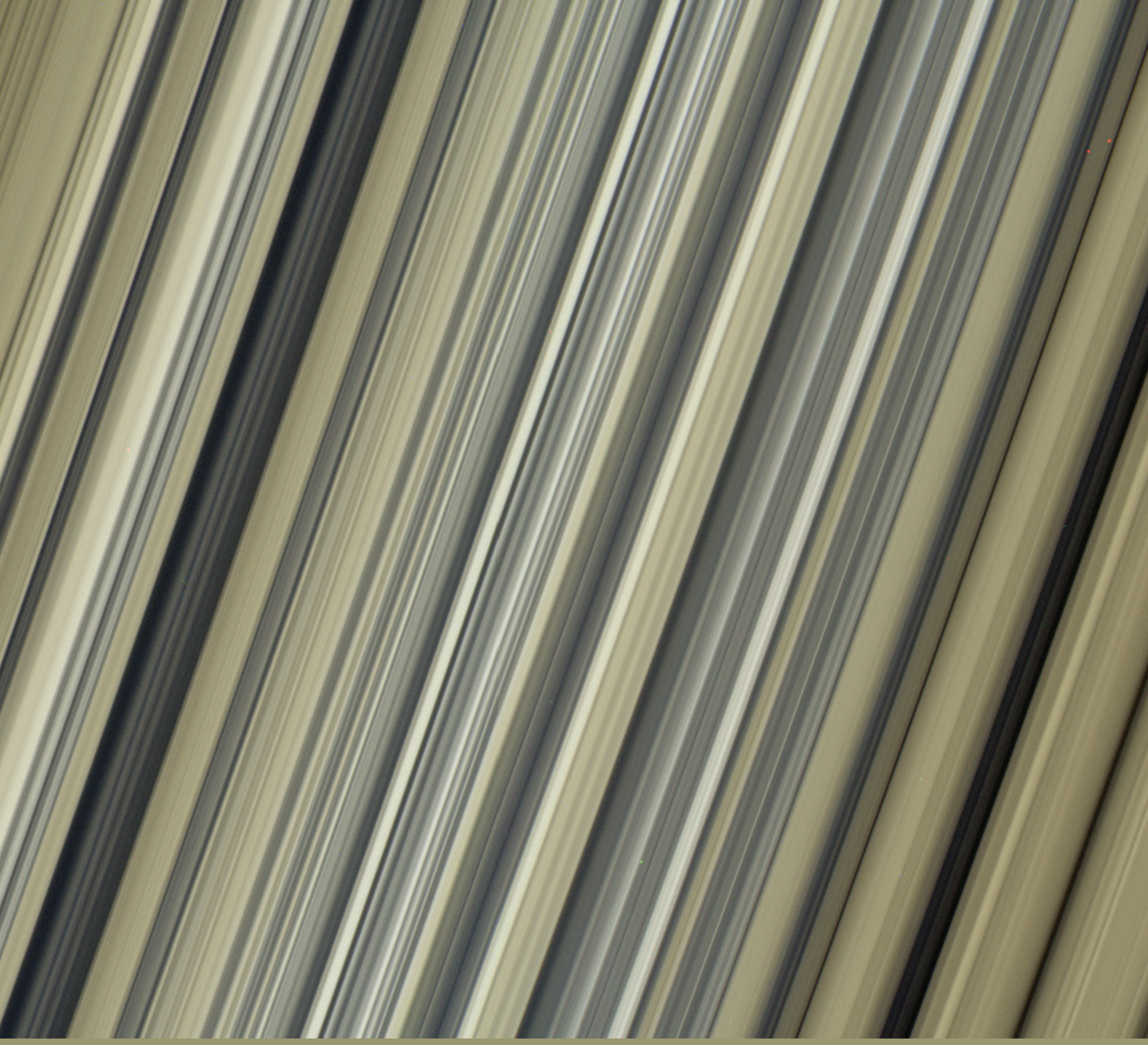
17	18	19	20	21	22	23
24	25	26	27	28	29	30

OCTOBER 2019

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1	2	3	4	5 First Quarter
6	7	8	9	10	11	12
13 Full Moon	14 Columbus Day	15	16	17	18	19
20	21 Last Quarter	22	23	24	25	26
27	28 New Moon	29	30	31 Halloween		



Colorful Structure at Fine Scales. This is the highest-resolution color image of any part of Saturn's rings to date, showing a portion of the inner-central part of the planet's B Ring. This image was taken on July 6, 2017, with the Cassini spacecraft's narrow-angle camera. The view is a mosaic of two images that show a region that lies between 61,300 and 65,600 miles (98,600 and 105,500 kilometers) from Saturn's center.

The image is a natural color composite, created using images taken with red, green, and blue spectral filters. The pale tan color is generally not perceptible with the naked eye in telescopic views, especially given that Saturn has a similar hue. The material responsible for bestowing this color on the rings—which are mostly composed of water ice and would otherwise appear white—is a matter of intense debate among ring scientists.

The different ringlets seen here are part of what is called the "irregular structure" of the B ring. Cassini radio occultations of the rings have shown that these features have extremely sharp boundaries on even smaller scales (radially, or along the direction outward from Saturn) than the camera can resolve here. Closer to Saturn, the irregular structures become fuzzier and more rounded, less opaque, and their color contrast diminishes. The narrow ringlets in the middle of this scene are each about 25 miles (40 kilometers) wide, and the broader bands at right are about 200 to 300 miles (roughly 300 to 500 kilometers) across. It remains unclear exactly what causes the variable brightness of these ringlets and bands. The basic brightness of the ring particles themselves, shadowing on their surfaces, their absolute abundance, and how densely the particles are packed, may all play a role. **Image and text credit:** NASA/JPL-Caltech/Space Science Institute

https://www.nasa.gov/image-feature/jpl/pia21628/colorful-structure-at-fine-scales

Paul D. Spudis (1952–2018), a Senior Staff Scientist at the Lunar and Planetary Institute in Houston, was an American geologist and lunar scientist. He was a strong collaborator across multiple teams at the Lunar and Planetary Institute, and with lunar research teams at the Johns Hopkins University/ Applied Physics Laboratory. Spudis' research focused on the processes of impact and volcanism on the planets and studies of the requirements for a sustainable human presence on the Moon. He is the author or co-author of over 115 scientific papers and 7 books. He will be remembered for his outstanding service as a geologist specializing in the terrestrial planets, with extensive background in geology and planetary science, including interpretation of remote-sensing and image data and integrated studies with information from planetary samples. He was a strong advocate for a sustained return of humans to the lunar surface, making use of lunar volatiles. Photo credit: Nathan Lindstrom/Spudis Lunar Resources

October 2019

S	M	T	W	T	F	S
		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	26
27	28	29	30	31		

December 2019

S	M	T	W	T	F	S
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	26	27	28
29	30	31				

NOVEMBER 2019

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3 Daylight Saving Time Ends	4 First Quarter	5 Election Day	6	7	8	9
10	11 Veterans Day	12 Full Moon	13	14	15	16
17	18	19 Last Quarter	20	21	22	23
24	25	26 New Moon	27	28 Thanksgiving Day	29	30

X Marks the Spot—A Solar Flare Seen from Solar Dynamics Observatory. NASA's Solar Dynamics Observatory (SDO) images a wide range of wavelengths invisible to the naked eye, and the light is then colorized into a rainbow of colors such as can be seen in this observation from September 2017. The brighter sections are active regions and the lower right region shows an explosion on the Sun—*a solar flare*—creating a telltale "X" shape in the image. Solar flares occur when magnetic field lines near sunspots tangle, cross, and reorganize. The sudden explosions release radiation and blasts solar wind toward Earth. Earth's magnetosphere keeps the harmful radiation from physically affecting humans on the ground. However—when intense enough—solar flares can disturb the atmosphere in the layer where global positioning systems (GPS) and communications signals travel, as well as astronauts in space. **Image and text credit:** NASA/GSFC/SDO

https://svs.gsfc.nasa.gov/12706

Born in January 1949, Space Physicist Mary K. Hudson has been a Dartmouth College Professor of Physics and served for 8 years as Chair of Physics and Astronomy. Hudson has worked with NASA's Van Allen Probes satellites to study Earth's radiation belts. Hudson studies the weather patterns that originate from solar eruptions, following the energy and mass transfer through the interplanetary medium, all the way to Earth's ionosphere. In 2017 Hudson was awarded the American Geophysical Union's John Adam Fleming Medal for original research and technical leadership in geomagnetism, atmospheric electricity, aeronomy, space physics, and/or related sciences. Photo courtesy of Mary Hudson

November 2019

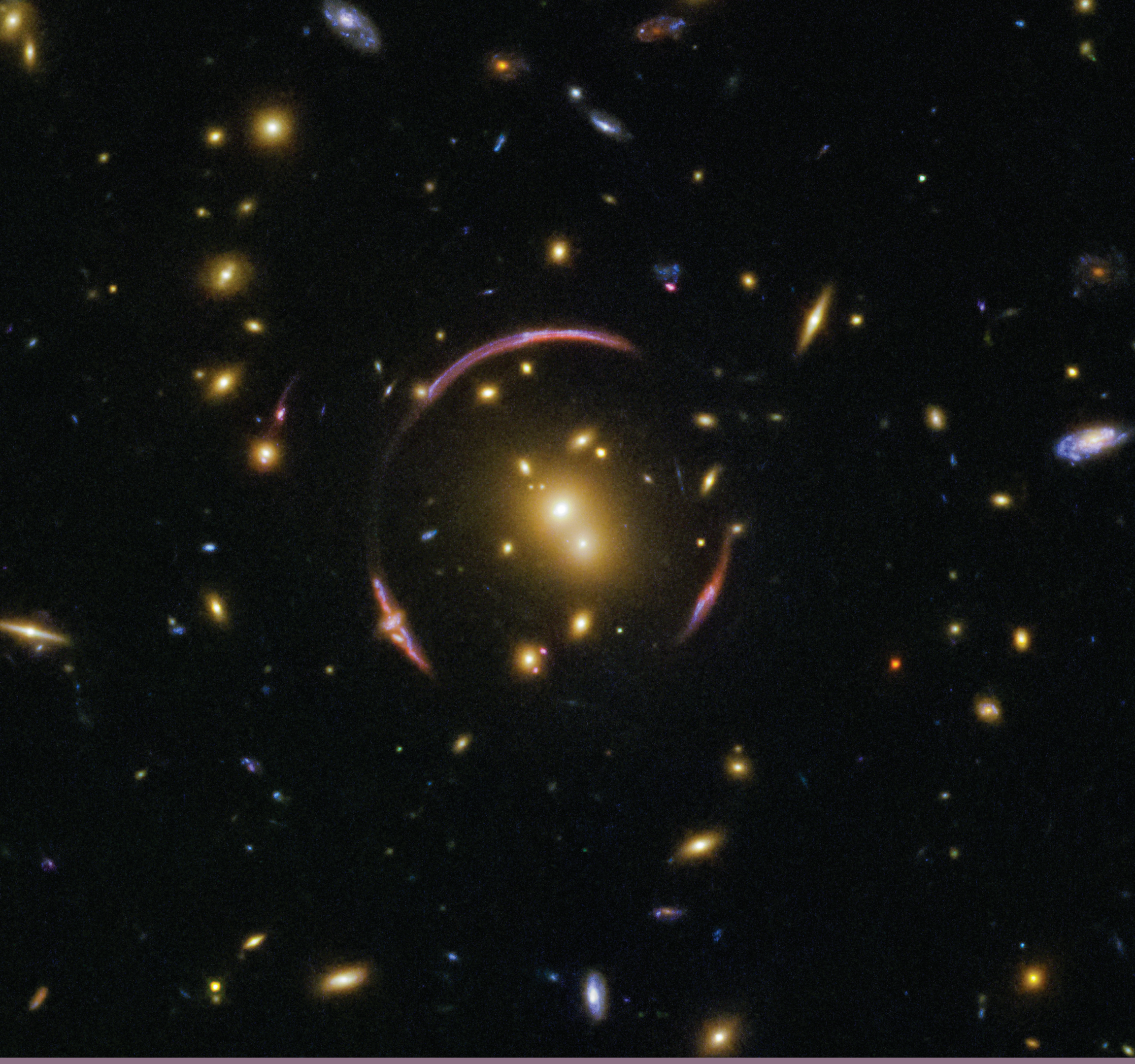
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

January 2020

S	M	T	W	T	F	S
			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
26	27	28	29	30	31	

DECEMBER 2019

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4 First Quarter	5	6	7
8	9	10	11	12 Full Moon	13	14
15	16	17	18	19 Last Quarter	20	21
22	23	24	25 Christmas Day	26 New Moon	27	28
29	30	31				



Cosmic Cloning. This image is packed full of galaxies! A keen eye can spot exquisite ellipticals and spectacular spirals, seen at various orientations: edge-on with the plane of the galaxy visible, face-on to show off magnificent spiral arms, and everything in between. The vast majority of these specks are galaxies, but to spot a foreground star from our own galaxy, you can look for a point of light with tell-tale diffraction spikes.

The galaxies within the image are almost all part of a *galaxy cluster*—a monstrous collection of hundreds of galaxies all shackled together in the unyielding grip of gravity—with the charming name of *SDSSJ0146-0929*. The mass of this galaxy cluster is large enough to severely distort the spacetime, creating the odd, looping curves that almost encircle the central regions of the cluster. These graceful arcs are examples of a cosmic phenomenon known as an *Einstein ring*. The ring is created as the light from a distant objects, like galaxies, pass by an extremely large mass, like this galaxy cluster. In this image, the light from a background galaxy is diverted and distorted around the massive intervening cluster and forced to travel along many different light paths towards Earth, making it seem as though the galaxy is in several places at once. **Image and text credit:** ESA/Hubble and NASA. **Acknowledgement:** Judy Schmidt

http://www.spacetelescope.org/images/potw1814a

Cornelius A. "Neil" Gehrels (1952–2017) who worked at NASA's Goddard Space Flight Center was an American astrophysicist specializing in the field of gamma-ray astronomy. He was the Principal Investigator of the Swift Gamma-Ray Burst (GRB) Mission. His GRB work with Swift resulted in a quantum leap in our knowledge about these mysterious sources. The numerous professional awards he received include the Henry Draper Medal, Dan David Prize, and Milner Breakthrough Prize. Photo credit: NASA

December 2019

S	M	T	W	T	F	S
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	26	27	28
29	30	31				

February 2020

S	M	T	W	T	F	S
						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	26	27	28	29

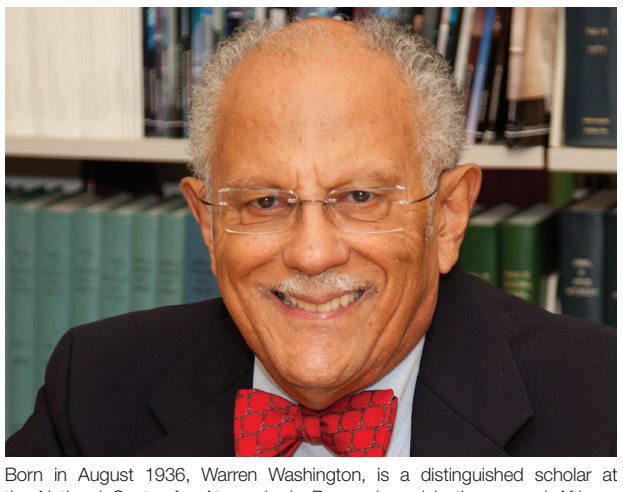
JANUARY 2020

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1 New Year's Day	2	3 First Quarter	4
5	6	7	8	9	10 Full Moon	11
12	13	14	15	16	17 Last Quarter	18
19	20 Birthday of Martin Luther King, Jr. (observed date)	21	22	23	24 New Moon	25
26	27	28	29	30	31	

The Meandering Estuaries of Guinea–Bissau. Estuaries near the coast of Guinea–Bissau in West Africa branch out like a network of roots from a plant. With their long tendrils, the rivers meander through the country's lowland plains to join the Atlantic Ocean. On the way, they carry water, nutrients, and sediments from the land.

This natural-color image captures the movement of the sediments as the rivers move east to west. The image was acquired on May 17, 2018, by the Operational Land Imager (OLI) on Landsat 8. The discoloration is most apparent upstream in Rio Geba [*top right quadrant*], which runs past the country's capital city of Bissau. Organic matter—such as leaves, roots, or bark—contain pigments and chemicals that can color the water when they dissolve. Depending on the amount of dissolved particles, the water in natural-color imagery can appear blue, green, yellow, or even brown as the organic matter concentration increases. **Image and text credit:** NASA's Earth Observatory/U.S. Geological Survey

https://earthobservatory.nasa.gov/images/92266/the-meandering-estuaries-of-guineabissau



Born in August 1936, Warren Washington, is a distinguished scholar at the National Center for Atmospheric Research and is the second African-American to earn a doctorate in the atmospheric sciences. He was one of the first to develop computer models that use physics to predict the state of the atmosphere and climate change. He served on the President's National Advisory Committee on Oceans and Atmosphere, served as Chair of the National Science Board, and received the Nation's highest science award, the National Medal of Science. Photo credit: NCAR/UCAR/NSF

January 2020

S	M	T	W	T	F	S
			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
26	27	28	29	30	31	

March 2020

S	M	T	W	T	F	S
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	26	27	28
29	30	31				

FEBRUARY 2020

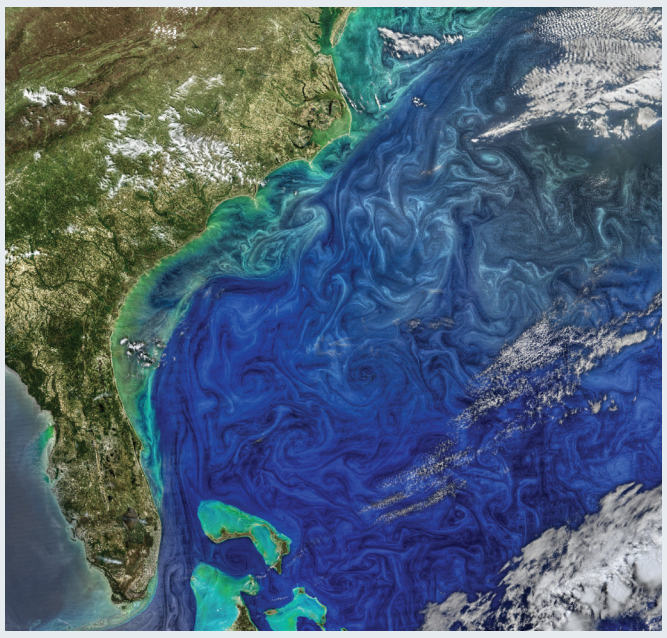
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1
First Quarter 2	3	4	5	6	7	8
Full Moon 9	10	11	12	13	14	Last Quarter 15
16	17 Washington's Birthday (observed date)	18	19	20	21	22
New Moon 23	24	25	26	27	28	29

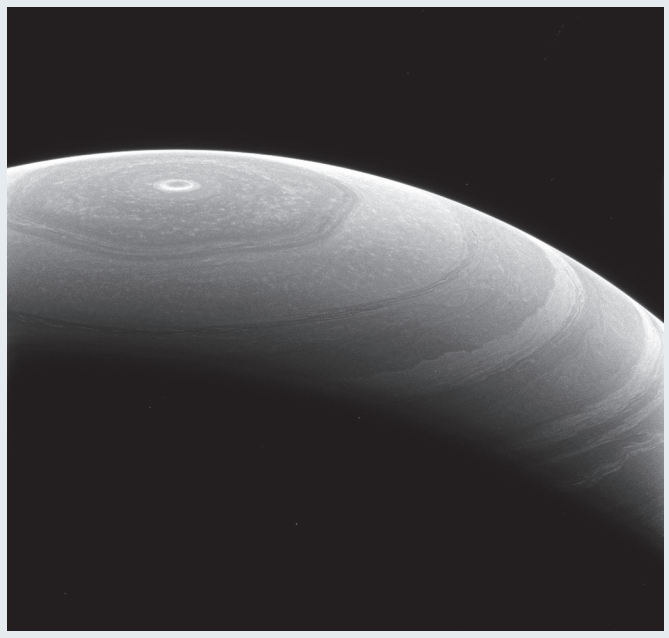
EXPLORE SCIENCE

OPERATING & FUTURE MISSIONS

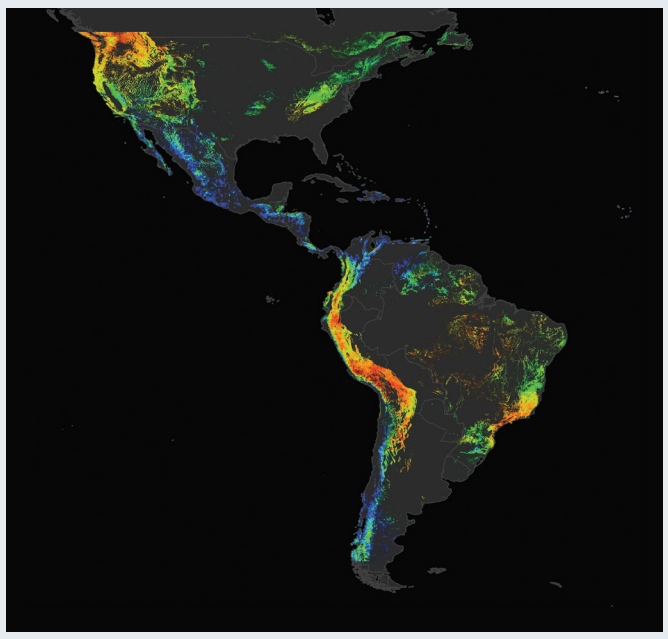
HUBBLE
WEBB
XMM-NEWTON*
XRISM*
ISS-CREAM
IXPE
CHANDRA
NEW HORIZONS
FERMI
ISS-NICER
EUCLID*
GEHRELS SWIFT
NEOWISE
VOYAGER 1
VOYAGER 2
TESS
NUSTAR
SOLAR ORBITER*
SPITZER
WFIRST
THEMIS
WIND
PARKER SOLAR PROBE
SOFIA
VAN ALLEN PROBES
MMS
HINODE*
ICON
GEOTAIL
TIMED
IMAP
GOLD
ACE
AIM
BEPICOLOMBO*
SET-1
SDO
IBEX
SOHO*
IRIS
STEREO
JUICE*
PSYCHE
JUNO
EUROPA CLIPPER
LUCY
DART
OSIRIS-REX
MARS ODYSSEY
ISS (6)
TEMPO
MAIA
TROPICS
MMX*
MARS EXPRESS*
PACE
ISS (4)
ICESAT-2
CALIPSO
OCO-2
NISAR
OPPORTUNITY
EXOMARS 2016*
CYGNSS
CLOUDSAT
CURIOSITY
AQUA
LANDSAT 9
MAVEN
EXOMARS 2020*
LANDSAT 7, 8
INSIGHT
MRO
MARS 2020
SUOMI NPP
GRACE-FO
SENTINEL-6A/B*
SMAP
GPM
ARTEMIS
LAGEOS
JPSS-2*
ASTROPHYSICS
LRO
TERRA
PLANETARY SCIENCE
AURA
HELIOPHYSICS
DSCOVR*
EARTH SCIENCE
FUTURE MISSIONS IN BOLD
SWOT
* PARTNER-LED
SORCE
GEOCARB
OSTM/JASON 2
science.nasa.gov/missions

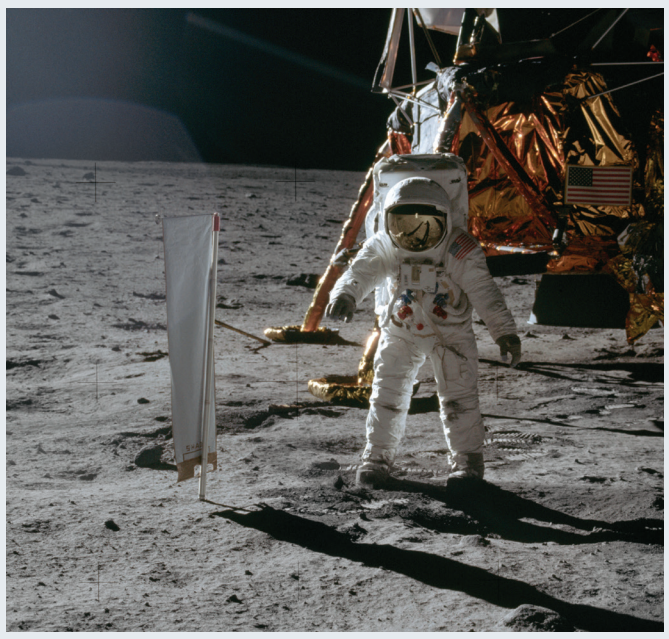
OCTOBER 2018

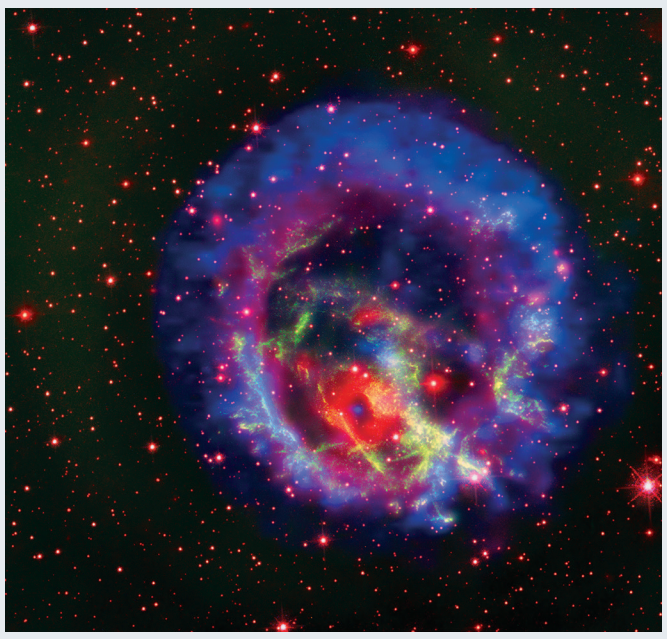


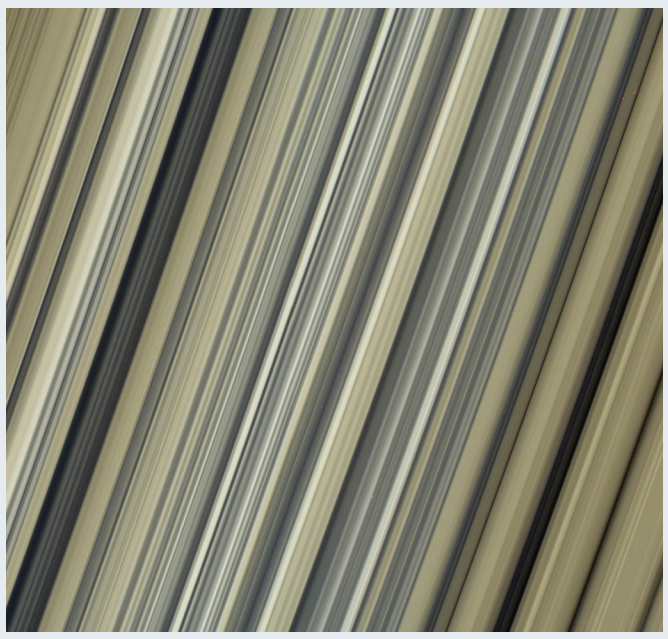


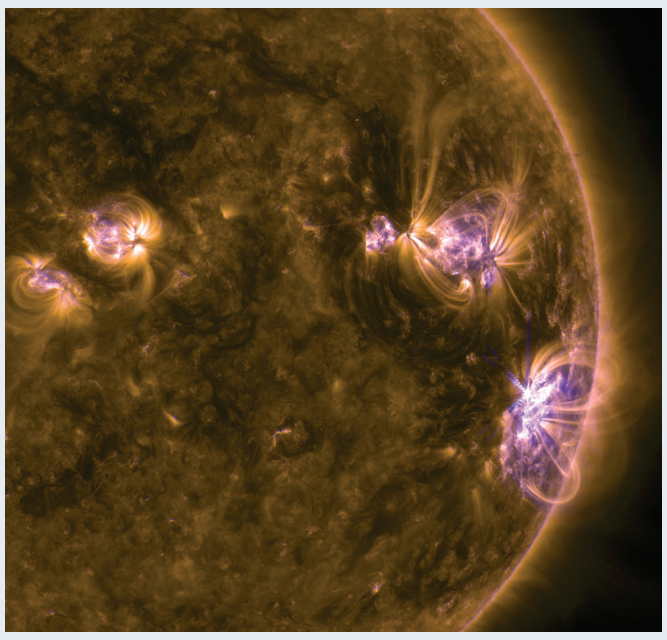
National Aeronautics and
Space Administration











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