Space News Update

— June 12, 2018 —

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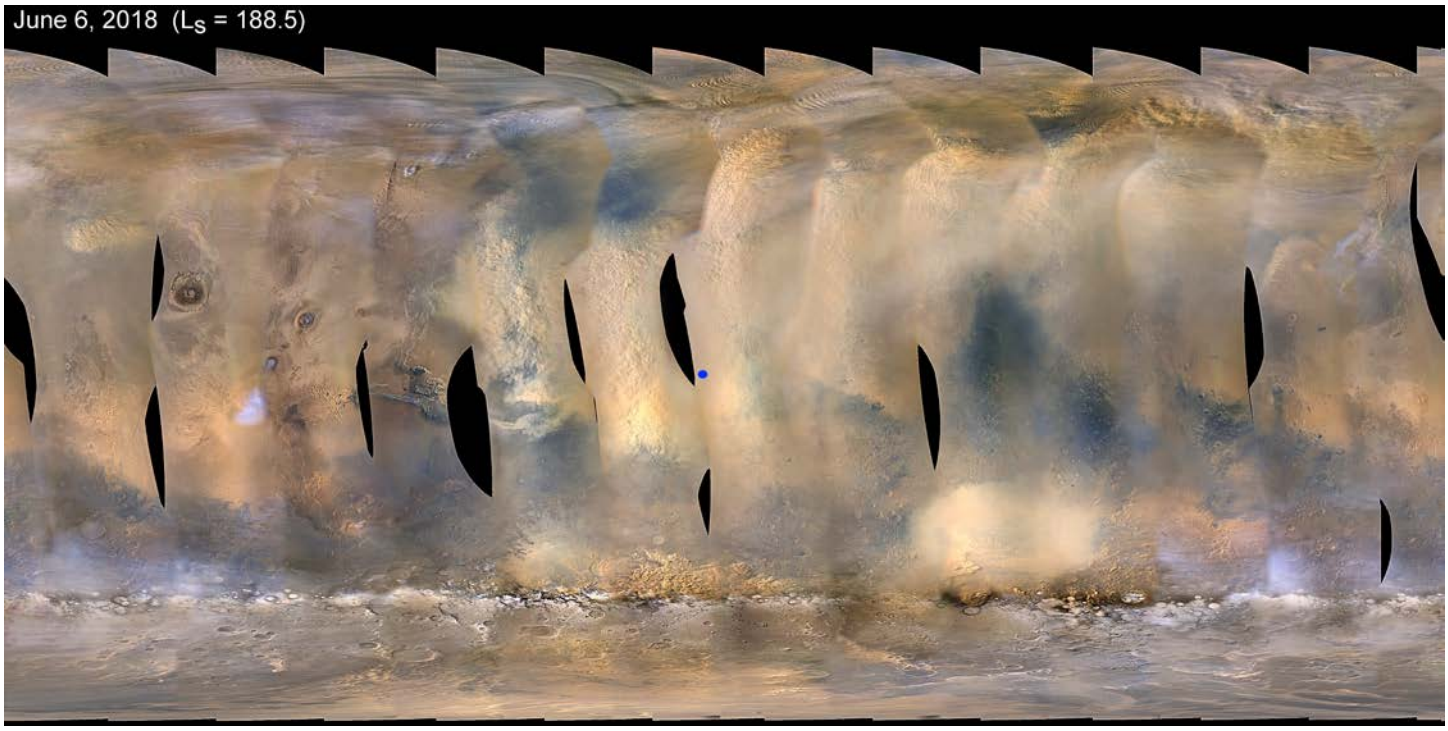
1. Opportunity Hunkers Down During Dust Storm



Science operations for NASA's Opportunity rover have been temporarily suspended as it waits out a growing dust storm on Mars.

NASA's Mars Reconnaissance Orbiter first detected the storm on Friday, June 1. As soon as the orbiter team saw how close the storm was to Opportunity, they notified the rover's team to begin preparing contingency plans.

In a matter of days, the storm had ballooned. It now spans more than 7 million square miles (18 million square kilometers) -- an area greater than North America -- and includes Opportunity's current location at Perseverance Valley. More importantly, the swirling dust has raised the atmospheric opacity, or "tau," in the valley in the past few days. This is comparable to an extremely smoggy day that blots out sunlight. The rover uses solar panels to provide power and to recharge its batteries.

Opportunity's power levels had dropped significantly by Wednesday, June 6, requiring the rover to shift to minimal operations.

This isn't Opportunity's first time hunkering down in bad weather: in 2007, a much larger stormcovered the planet. That led to two weeks of minimal operations, including several days with no contact from the rover to save power. The project's management prepared for the possibility that Opportunity couldn't balance low levels of power with its energy-intensive survival heaters, which protect its batteries from Mars' extreme cold. It's not unlike running a car in the winter so that the cold doesn't sap its battery charge.There is a risk to the rover if the storm persists for too long and Opportunity gets too cold while waiting for the skies to clear.

Ultimately, the storm subsided and Opportunity prevailed. The Martian cold is believed to have resulted in the loss of Spirit, Opportunity's twin in the Mars Exploration Rover mission, back in 2010. Despite this, both rovers have vastly exceeded expectations: they were only designed to last 90 days each. Opportunity is in its 15th year; the team has operated the rover for more than 50 times longer than originally planned.

Full dust storms like this one are not surprising, but are infrequent. They can crop up suddenly but last weeks, even months. During southern summer, sunlight warms dust particles, lifting them higher into the atmosphere and creating more wind. That wind kicks up yet more dust, creating a feedback loop that NASA scientists still seek to understand.

Mars Reconnaissance Orbiter and two other NASA spacecraft orbiting the Red Planet --Odysseyand MAVEN -- routinely support rovers on the ground.

Updated at 4:30 p.m. PDT on June 10, 2018

NASA engineers received a transmission from Opportunity on Sunday morning - a positive sign despite the worsening dust storm. Data from the transmission let engineers know the rover still has enough battery charge to communicate with ground controllers at NASA's Jet Propulsion Laboratory in Pasadena, California. Science operations remain suspended.

Sunday's transmission was especially good news considering the dust storm has intensified in the past several days. A dark, perpetual night has settled over the rover's location in Mars' Perseverance Valley. The storm's atmospheric opacity - the veil of dust blowing around, which can blot out sunlight -- is now much worse than a 2007 storm that Opportunity weathered. The previous storm had an opacity level, or tau, somewhere above 5.5; this new storm had an estimated tau of 10.8 as of Sunday morning.

Opportunity's team has requested additional communications coverage from NASA's Deep Space Network, a global system of antennas that talks to all the agency's deep space probes.

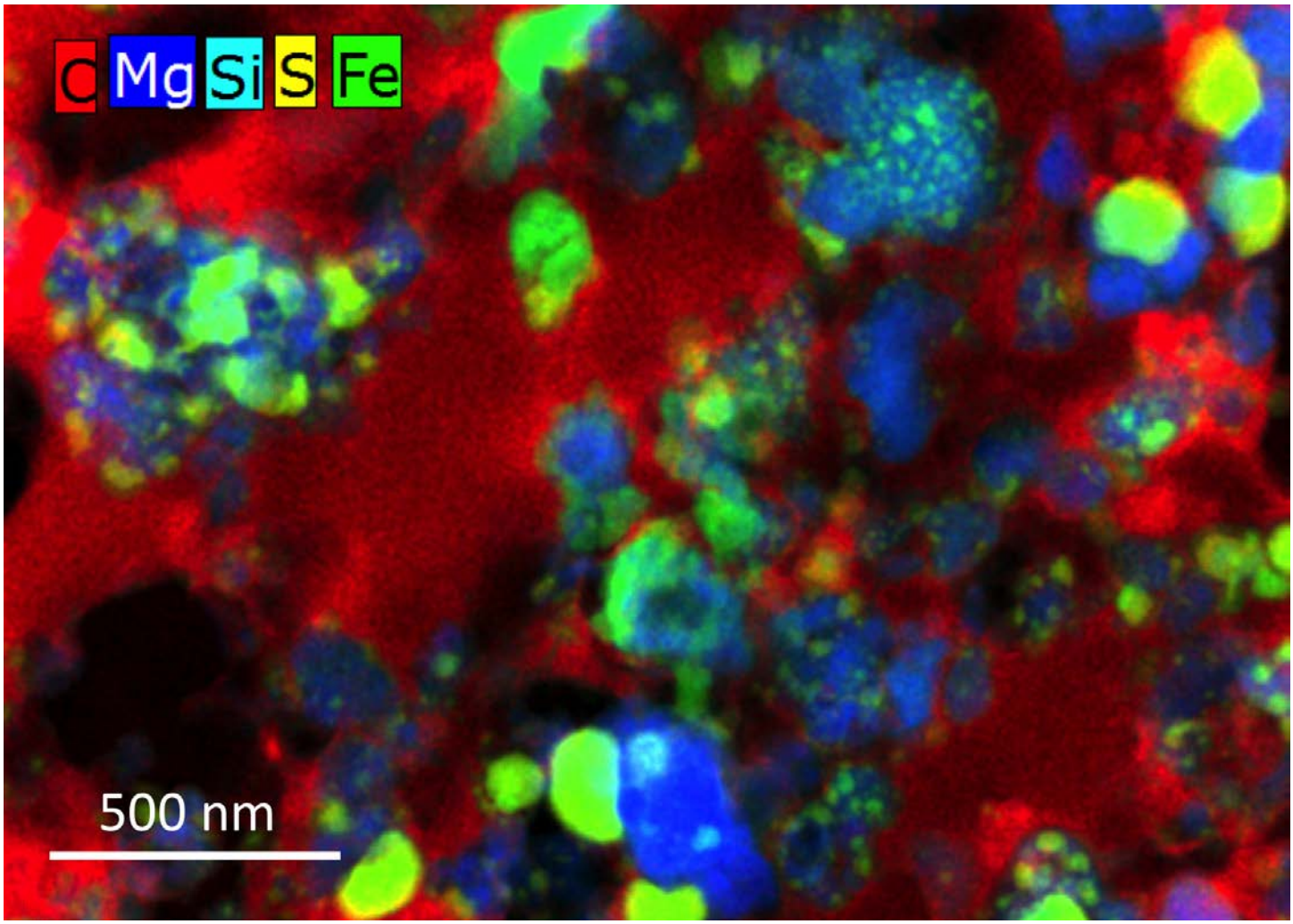
This latest data transmission showed the rover's temperature to be about minus 20 degrees Fahrenheit (minus 29 degrees Celsius). One saving grace of dust storms is that they can actually limit the extreme temperature swings experienced on the Martian surface. The same swirling dust that blocks out sunlight also absorbs heat, raising the ambient temperature surrounding Opportunity.

Engineers will monitor the rover's power levels closely in the week to come. The rover needs to balance low levels of charge in its battery with sub-freezing temperatures. Its heaters are vitally important to keeping it alive, but also draw more power from the battery. Likewise, performing certain actions draws on battery power, but can actually expel energy and raise the rover's temperature.

The rover has proved hardier than expected by lasting nearly 15 years, despite being designed for a 90-day mission.

Source: JPL Return to Contents

2. Tracing Interstellar Dust Back To The Solar System's Formation



Experiments conducted at Berkeley Lab helped to confirm that samples of interplanetary particles - collected from Earth's upper atmosphere and believed to originate from comets - contain dust leftover from the initial formation of the solar system.

An international team, led by Hope Ishii, a researcher at the University of Hawaii at Manoa (UH Manoa), studied the particles' chemical composition using infrared light at Berkeley Lab's Advanced Light Source (ALS). Scientists also explored their nanoscale chemical makeup using electron microscopes at the Lab's Molecular Foundry, which specializes in nanoscale R&D, and at the University of Hawaii's Advanced Electron Microscopy Center.

The study was published online June 11 in the journal Proceedings of the National Academy of Sciences.

The initial solids from which the solar system formed consisted almost entirely of carbon, ices, and disordered (amorphous) silicate, the team concluded. This dust was mostly destroyed and reworked by processes that led to the formation of planets. Surviving samples of pre-solar dust are most likely to be preserved in comets - small, cold bodies that formed in the outer solar nebula.

In a relatively obscure class of these interplanetary dust particles believed to originate from comets, there are tiny glassy grains called GEMS (glass embedded with metal and sulfides) that are typically only tens to

hundreds of nanometers in diameter, or less than a hundredth of the thickness of a human hair. Researchers embedded the sample grains in an epoxy that was cut into thin slices for the various experiments.

Using transmission electron microscopy at the Molecular Foundry, the research team made maps of the element distributions and discovered that these glassy grains are made up of subgrains that aggregated together in a different environment prior to the formation of the comet.

The nanoscale GEMS subgrains are bound together by dense organic carbon in clusters comprising the GEMS grains. These GEMS grains were later glued together with other components of the cometary dust by a distinct, lower-density organic carbon matrix.

The types of carbon that rim the subgrains and that form the matrix in these particles decompose with even weak heating, suggesting that the GEMS could not have formed in the hot inner solar nebula, and instead formed in a cold, radiation-rich environment, such as the outer solar nebula or pre-solar molecular cloud.

Jim Ciston, a staff scientist at the Molecular Foundry, said the particle-mapping process of the microscopy techniques provided key clues to their origins. "The presence of specific types of organic carbon in both the inner and outer regions of the particles suggests the formation process occurred entirely at low temperatures," he said.

"Therefore, these interplanetary dust particles survived from the time before formation of the planetary bodies in the solar system, and provide insight into the chemistry of those ancient building blocks."

He also noted that the "sticky" organics that covered the particles may be a clue to how these nanoscale particles could gather into larger bodies without the need for extreme heat and melting.

Ishii, who is based at the UH Manoa's Hawaii Institute of Geophysics and Planetology, said, "Our observations suggest that these exotic grains represent surviving pre-solar interstellar dust that formed the very building blocks of planets and stars. If we have at our fingertips the starting materials of planet formation from 4.6 billion years ago, that is thrilling and makes possible a deeper understanding of the processes that formed and have since altered them."

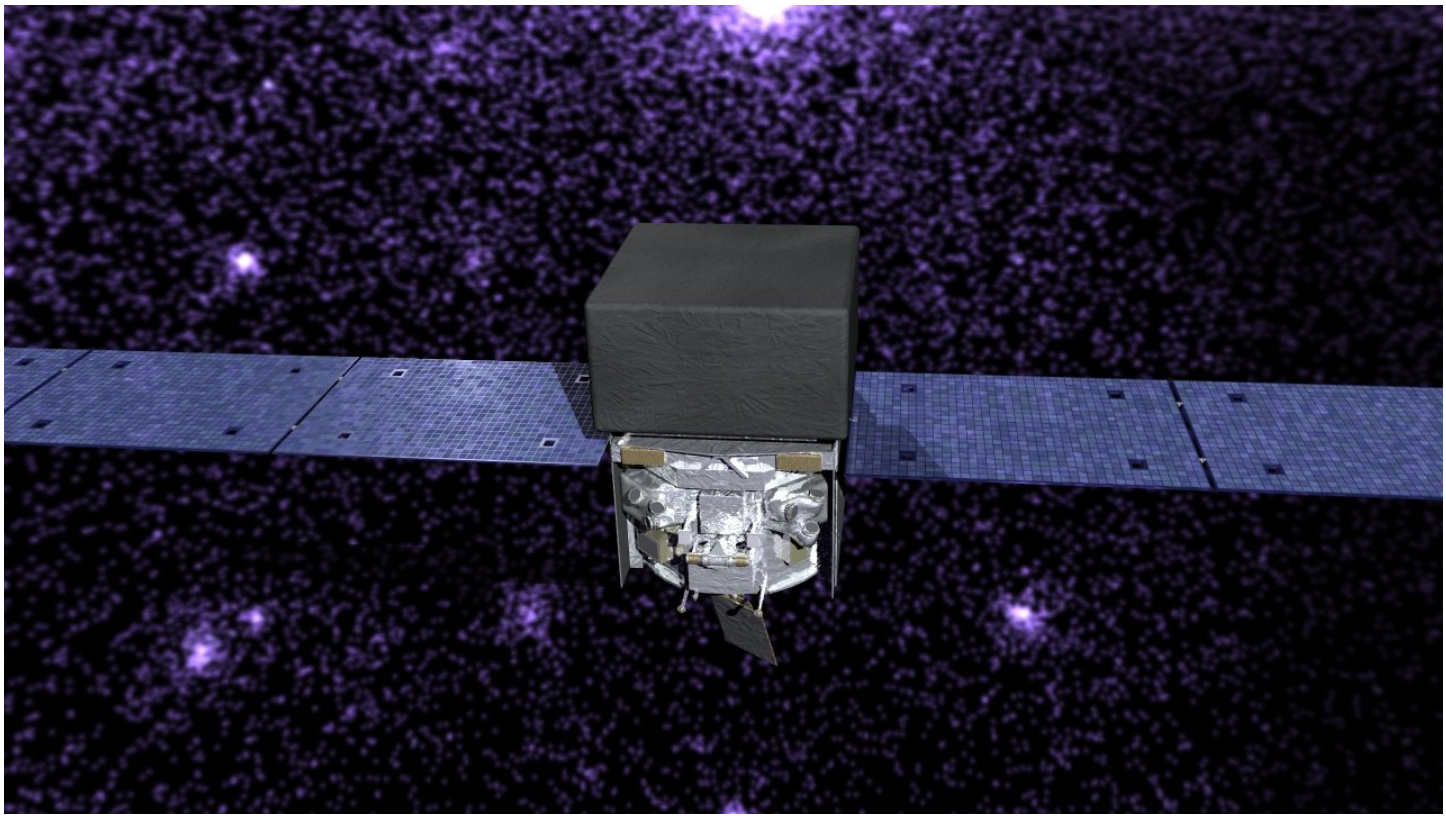
Hans Bechtel, a research scientist in the Scientific Support Group at Berkeley Lab's ALS, said that the research team also employed infrared spectroscopy at the ALS to confirm the presence of organic carbon and identify the coupling of carbon with nitrogen and oxygen, which corroborated the electron microscopy measurements.

The ALS measurements provided micron-scale (millionths of a meter) resolution that gave an average of measurements for entire samples, while the Molecular Foundry's measurements provided nanometer-scale (billionths of a meter) resolution that allowed scientists to explore tiny portions of individual grains.

In the future, the team plans to search the interiors of additional comet dust particles, especially those that were well-protected during their passage through the Earth's atmosphere, to increase understanding of the distribution of carbon within GEMS and the size distributions of GEMS subgrains.

Source: SpaceRef.com Return to Contents

3. Fermi satellite celebrates 10 years of discoveries



On June 11, NASA's Fermi Gamma-ray Space Telescope celebrates a decade of using gamma rays, the highest-energy form of light in the cosmos, to study black holes, neutron stars, and other extreme cosmic objects and events.

"Fermi's first 10 years have produced numerous scientific discoveries that have revolutionized our understanding of the gamma-ray universe," said Paul Hertz, Astrophysics Division director at NASA Headquarters in Washington.

By scanning the sky every three hours, Fermi's main instrument, the Large Area Telescope (LAT), has observed more than 5,000 individual gamma-ray sources, including an explosion called GRB 130427A, the most powerful gamma-ray burst scientists have detected.

In 1949, Enrico Fermi—an Italian-American pioneer in high-energy physics and Nobel laureate for whom the mission was named—suggested that cosmic rays, particles traveling at nearly the speed of light, could be propelled by supernova shock waves. In 2013, Fermi's LAT used gamma rays to prove these stellar remnants are at least one source of the speedy particles.

Fermi's all-sky map, produced by the LAT, has revealed two massive structures extending above and below the plane of the Milky Way. These two "bubbles" span 50,000 light-years and were probably produced by the supermassive black hole at the center of the galaxy only a few million years ago.

"The astronomy of gamma rays is the science of extremes," said Julie McEnery, the Fermi project scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "Extreme gravity, extreme magnetic fields—Fermi has opened a window on to some of the most interesting physics and structures in the universe."

The Gamma-ray Burst Monitor (GBM), Fermi's secondary instrument, can see the entire sky at any instant, except the portion blocked by Earth. The satellite has observed over 2,300 gamma-ray bursts, the most luminous events in the universe. Gamma-ray bursts occur when massive stars collapse or neutron stars or black holes merge and drive jets of particles at nearly the speed of light. In those jets, matter travels at different speeds and collides, emitting gamma rays.

On Aug. 17, 2017, Fermi detected a gamma-ray burst from a powerful explosion in the constellation Hydra. At almost the same time, the National Science Foundation's Laser Interferometer Gravitational-wave Observatory detected ripples in space-time from the same event, the merger of two neutron stars. This was the first time light and gravitational waves were detected from the same source. Scientists also used another gamma-ray burst detected by Fermi to confirm Einstein's theory that space-time is smooth and continuous.

The GBM has also spotted over 5,000 terrestrial gamma-ray flashes in Earth's atmosphere associated with thunderstorms, as well as particles of antimatter those flashes can produce.

"Fermi has fundamentally improved our understanding of how the universe operates," said David Thompson, a Fermi deputy project scientist at Goddard. "This spacecraft has both provided evidence for long-cherished theories and has also forced the scientific community to reevaluate some of its assumptions."

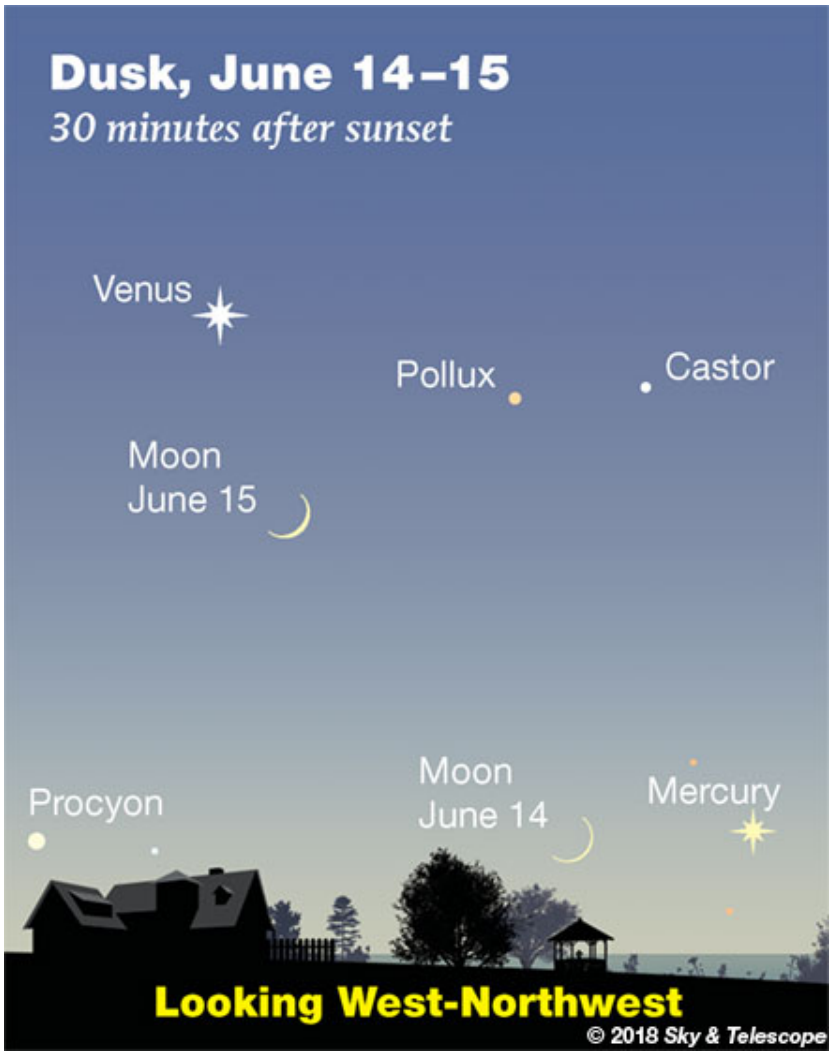
But space can be a difficult working environment. On April 3, 2012, Fermi dodged a potential collision with Cosmos 1805, a defunct Soviet Cold War spy satellite, when the team fired Fermi's decommissioning thrusters to move it to safety.

Fermi experienced its first hardware failure on March 16, 2018, when one of its solar panels became stuck. The Fermi team has adopted a new observation strategy to accommodate the jammed solar panel, and both instruments continue to scan the gamma-ray universe.

"The Fermi observatory has so much flexibility that this glitch has only minor impact on science operations," McEnery said. "Fermi is well prepared to continue operations for many years, and we look forward to many more discoveries about the high-energy universe."

Source: Phys.org Return to Contents

The Night Sky



Tuesday, June 12
• The Big Dipper hangs high in the northwest as the stars come out. The Dipper's Pointers, currently its bottom two stars, point lower right toward Polaris.

Above Polaris, and looking very similar to it, is Kochab, the lip of the dim Little Dipper's bowl. Kochab stands precisely above Polaris around the end of twilight or a little after. How precisely can you time this event for your location? How fast can you see a change, perhaps using a hanging plumb bob or the vertical edge of a building?

Wednesday, June 13
• Bright yellow Arcturus, magnitude 0, shines high overhead toward the southwest these evenings, high to the upper right of Jupiter. The kite shape of Bootes, its constellation, extends up from Arcturus. The kite is narrow, slightly bent, and 23° tall: about two fists at arm's length.

• Just east (left) of the Bootes kite is Corona Borealis, the pretty but mostly dim Northern Crown. Get to know its half-circle of stars with Matt Wedel's Binocular Highlight column and chart in the June *Sky & Telescope*, page 22.

• New Moon (exact at 3:43 p.m. EDT).

Thursday, June 14
• Can you see Mercury after sunset yet? Use the Venus and the Moon to guide you to it using the chart at right. Note: The visibility of objects in bright twilight is exaggerated here.

• *Action at Jupiter:* Io disappears behind Jupiter's western limb tonight at 11:16 p.m. EDT, followed by Ganymede at 11:55 p.m. EDT. Then Ganymede reappears from behind Jupiter's eastern limb at 1:32 a.m. EDT. Io reappears out of eclipse by Jupiter's shadow *just off* the planet's eastern limb at 2:15 a.m. EDT.

And by that time, the Great Red Spot should be 40 minutes from crossing Jupiter's central meridian. For all such events at Jupiter this month, for all time zones worldwide, see the tables in the June *Sky & Telescope*, pages 50-51.

Friday, June 15
• Here it is almost summer. But as twilight fades, look very low in the north-northwest for wintry Capella very out of season. The farther north you are, the higher it will appear. You may need binoculars. If you're as far north as Portland Oregon and Portland Maine, Capella is actually circumpolar.

Source: Sky & Telescope

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ISS Sighting Opportunities

For Denver:

There are no sightings in Denver for the period of **Monday June 11, 2018 through Wednesday June 27, 2018**

Sighting information for other cities can be found at NASA's Satellite Sighting Information

NASA-TV Highlights

(all times Eastern Daylight Time)

June 12, Tuesday
11 a.m. - What's New in Aerospace featuring astronauts Joe Acaba and Mark Vande Hai: Live from the Smithsonian's National Air and Space Museum (Media Channel)
11:25 a.m. – Space Station In-Flight News Conference for the European Space Agency (ESA) with European media with ESA astronaut Alexander Gerst (Public Channel with interpretation; Media Channel is in native language)

June 14, Thursday
6:30 a.m. - U.S. Spacewalk #51 Coverage with astronauts Ricky Arnold and Drew Feustel; spacewalk begins at 8 a.m. EDT; scheduled to last about 6 ½ hours (All Channels)
11 a.m. -- What's New in Aerospace featuring astronauts Joe Acaba and Mark Vande Hai: Live from the Smithsonian's National Air and Space Museum (Media Channel)

June 15, Friday
1:30 p.m. – Space Station Crew Presentation with astronauts Joe Acaba and Mark Vande Hei (All Channels)

Watch NASA TV on the Net by going to the NASA website. Return to Contents

Space Calendar

- Jun 12 - Gaofen 6/ Luijia 1 CZ-2D Launch
- Jun 12 - UPDATED [Jun 11] IGS Radar-6 H-2A Launch
- Jun 12 - Comet 354P/LINEAR Closest Approach To Earth (1.559 AU)
- Jun 12 - Asteroid 14593 Everett Closest Approach To Earth (1.598 AU)
- Jun 12 - Asteroid 1241 Dysona Closest Approach To Earth (1.982 AU)
- Jun 12 - Asteroid 70715 Allancheuvront Closest Approach To Earth (2.028 AU)
- Jun 12 - David Gill's 175th Birthday (1843)
- Jun 12-15 - Space Resources Roundtable (SRR) & Planetary & Terrestrial Mining Sciences Symposium (PTMSS), Golden, Colorado
- Jun 12-15 - 11th Coastal Altimetry Workshop, Frascati, Italy
- Jun 13 - Progress MS-7 Reenters Earth's Atmosphere (International Space Station)
- Jun 13 - Comet C/2018 K1 (Weiland) At Opposition (1.030 AU)
- Jun 13 - Comet 354P/LINEAR At Opposition (1.559 AU)
- Jun 13 - Comet 182P/LONEOS Closest Approach To Earth (2.859 AU)
- Jun 13 - Asteroid 4 Vesta Occults 2UCAC 24411081 (11.8 Magnitude Star)
- Jun 13 - Asteroid 770 Bali Closest Approach To Earth (1.523 AU)
- Jun 13 - 20th Anniversary (1998), Portales Valley Meteorite Fall (Hit Barn in New Mexico)
- Jun 13 - Willard Bennett's 115th Birthday (1903)
- Jun 13 - Alan Griffith's 125th Birthday (1893)
- Jun 13 - Reinhold Tiling's 125th Birthday (1893)
- Jun 13 - Thomas Young's 245th Birthday (1773)
- Jun 13-16 - 2018 Bryce Canyon Astronomy Festival, Bryce Canyon, Utah
- Jun 14 - Comet 112P/Urata-Niijima At Opposition (3.604 AU)
- Jun 14 - Comet 204P/LINEAR-NEAT At Opposition (4.051 AU)
- Jun 14 - Comet C/2017 X1 (PANSTARRS) Perihelion (4.663 AU)
- Jun 14 - Asteroid 2032 Ethel Occults HIP 93993 (6.3 Magnitude Star)
- Jun 14 - NEW [Jun 08] Apollo Asteroid 2018 LD1 Near-Earth Flyby (0.004 AU)
- Jun 14 - Apollo Asteroid 3361 Orpheus Closest Approach To Earth (0.448 AU)
- Jun 14 - Asteroid 3720 Hokkaido Closest Approach To Earth (1.092 AU)
- Jun 14 - Asteroid 4987 Flamsteed Closest Approach To Earth (1.147 AU)
- Jun 14 - Asteroid 8277 Machu-Picchu Closest Approach To Earth (1.418 AU)
- Jun 14 - Asteroid 7220 Philnicholson Closest Approach To Earth (1.536 AU)
- Jun 14 - Asteroid 4808 Ballaero Closest Approach To Earth (2.094 AU)
- Jun 14 - 50th Anniversary (1968), 1st Asteroid Observed by Radar (1566 Icarus)
- Jun 15 - NEW [Jun 06] Apollo Asteroid 2018 LK Near-Earth Flyby (0.020 AU)
- Jun 15 - Aten Asteroid 2004 LO2 Near-Earth Flyby (0.064 AU)
- Jun 15 - Asteroid 6600 Qwerty Closest Approach To Earth (1.518 AU)
- Jun 15 - Hubertus Strughold's 120th Birthday (1898)

Source: JPL Space Calendar

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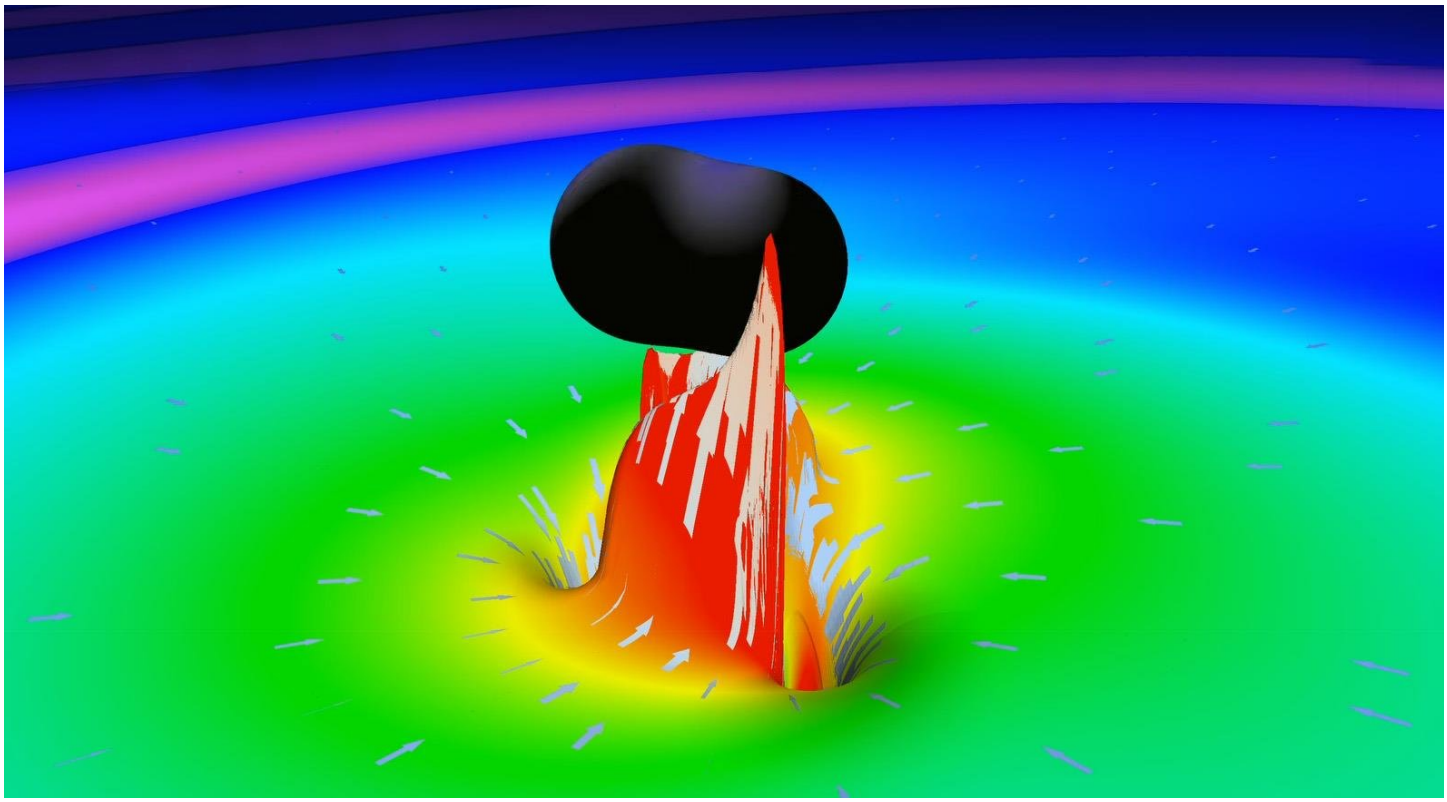
Food for Thought

Speculative wormhole echoes could revolutionize astrophysics



The scientific collaborations LIGO and Virgo have detected gravitational waves from the fusion of two black holes, inaugurating a new era in the study of the cosmos. But what if those ripples of space-time were not produced by black holes, but by other exotic objects? A team of European physicists suggest an alternative—wormholes that can be traversed to appear in another universe.

Scientists have deduced the existence of black holes from a multitude of experiments, theoretical models and indirect observations such as the recent LIGO detections, which are believed to originate from the collision of two of these dark gravitational monsters.

But there is a problem with black holes—they present an edge, called an event horizon, from which nothing can escape. This is in conflict with quantum mechanics, whose postulates ensure that information is always preserved, not lost.

One of the theoretical ways to deal with this conflict is to explore the possibility that the alleged black holes we 'observe' in nature are no such thing, but rather some type of exotic compact objects (ECOs), such as wormholes, which do not have an event horizon.

"The final part of the gravitational signal detected by these two detectors – what is known as ringdown – corresponds to the last stage of the collision of two black holes, and has the property of completely extinguishing after a short period of time due to the presence of the event horizon," explain the Spanish researchers Pablo Bueno and Pablo A. Cano from KU Leuven University (Belgium).

"However, if there were no horizon, those oscillations would not disappear completely; instead, after a certain time, they would produce a series of 'echoes,' similar to what happens with sound in a well. Interestingly, if

instead of black holes, we had an ECO, the ringdown could be similar, so we need to determine the presence or absence of the echoes to distinguish the two types of objects."

This possibility has been explored theoretically by several groups and tentative experimental analyses using the original LIGO data have been already performed, but the verdict is inconclusive.

Rotating wormholes

The team of the KU Leuven University, in which Professor Thomas Hertog also participated, has presented a model that predicts how gravitational waves caused by the collision of two rotating wormholes would be detected.

The gravitational wave signals observed so far are completely extinguished after a few moments as a consequence of the presence of the event horizon. But if this did not exist, these oscillations would not disappear altogether; rather, after some time, there would be echoes in the signal, which may have gone unnoticed until now due to a lack of models or theoretical references with which to compare.

"Wormholes do not have an event horizon, but act as a space-time shortcut that can be traversed, a kind of very long throat that takes us to another universe," Bueno explains, "and the fact that they also have rotation changes the gravitational waves they produce."

According to the study, published by *Physical Review D*, the graphs obtained with the new model do not differ much from those recorded so far, except for the echoes, which act as a clear differentiating element.

"The confirmation of echoes in the LIGO or Virgo signals would be a practically irrefutable proof that astrophysical black holes don't exist," Bueno says, adding, "Time will tell if these echoes exist or not. If the result were positive, it would be one of the greatest discoveries in the history of physics."

Source: Phys.org Return to Contents

Space Image of the Week

The Cat's Eye Nebula from Hubble
Image Credit: NASA, ESA, HEIC, and The Hubble Heritage Team (STScI/AURA)

Explanation: To some, it may look like a cat's eye. The alluring Cat's Eye nebula, however, lies three thousand light-years from Earth across interstellar space. A classic planetary nebula, the Cat's Eye (NGC 6543) represents a final, brief yet glorious phase in the life of a sun-like star. This nebula's dying central star may have produced the simple, outer pattern of dusty concentric shells by shrugging off outer layers in a series of regular convulsions. But the formation of the beautiful, more complex inner structures is not well understood. Seen so clearly in this digitally sharpened Hubble Space Telescope image, the truly cosmic eye is over half a light-year across. Of course, gazing into this Cat's Eye, astronomers may well be seeing the fate of our sun, destined to enter its own planetary nebula phase of evolution ... in about 5 billion years.

Source: APOD

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