Space News Update

— February 15, 2019 —

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1. NASA's Record-Setting Opportunity Rover Mission on Mars Comes to End

One of the most successful and enduring feats of interplanetary exploration, NASA's Opportunity rover mission is at an end after almost 15 years exploring the surface of Mars and helping lay the groundwork for NASA’s return to the Red Planet.

The Opportunity rover stopped communicating with Earth when a severe Mars-wide dust stormblanketed its location in June 2018. After more than a thousand commands to restore contact, engineers in the Space Flight Operations Facility at NASA's Jet Propulsion Laboratory (JPL) made their last attempt to revive Opportunity Tuesday, to no avail. The solar-powered rover's final communication was received June 10.

"It is because of trailblazing missions such as Opportunity that there will come a day when our brave astronauts walk on the surface of Mars," said NASA Administrator Jim Bridenstine. "And when that day arrives, some portion of that first footprint will be owned by the men and women of Opportunity, and a little rover that defied the odds and did so much in the name of exploration."

Designed to last just 90 Martian days and travel 1,100 yards (1,000 meters), Opportunity vastly surpassed all expectations in its endurance, scientific value and longevity. In addition to exceeding its life expectancy by 60 times, the rover traveled more than 28 miles (45 kilometers) by the time it reached its most appropriate final resting spot on Mars – Perseverance Valley.

"For more than a decade, Opportunity has been an icon in the field of planetary exploration, teaching us about Mars' ancient past as a wet, potentially habitable planet, and revealing uncharted Martian landscapes," said Thomas Zurbuchen, associate administrator for NASA's Science Mission Directorate. "Whatever loss we feel now must be tempered with the knowledge that the legacy of Opportunity continues – both on the surface of Mars with the Curiosity rover and InSight lander – and in the clean rooms of JPL, where the upcoming Mars 2020 rover is taking shape."

The final transmission, sent via the 70-meter Mars Station antenna at NASA's Goldstone Deep Space Complex in California, ended a multifaceted, eight-month recovery strategy in an attempt to compel the rover to communicate.

“We have made every reasonable engineering effort to try to recover Opportunity and have determined that the likelihood of receiving a signal is far too low to continue recovery efforts," said John Callas, manager of the Mars Exploration Rover (MER) project at JPL.

Opportunity landed in the Meridiani Planum region of Mars on Jan. 24, 2004, seven months after its launch from Cape Canaveral Air Force Station in Florida. Its twin rover, Spirit, landed 20 days earlier in the 103-mile-wide (166-kilometer-wide) Gusev Crater on the other side of Mars. Spirit logged almost 5 miles (8 kilometers) before its mission wrapped up in May 2011.

From the day Opportunity landed, a team of mission engineers, rover drivers and scientists on Earth collaborated to overcome challenges and get the rover from one geologic site on Mars to the next. They plotted workable avenues over rugged terrain so that the 384-pound (174-kilogram) Martian explorer could maneuver around and, at times, over rocks and boulders, climb gravel-strewn slopes as steep as 32-degrees (an off-Earth record), probe crater floors, summit hills and traverse possible dry riverbeds. Its final venture brought it to the western limb of Perseverance Valley.

"I cannot think of a more appropriate place for Opportunity to endure on the surface of Mars than one called Perseverance Valley," said Michael Watkins, director of JPL. "The records, discoveries and sheer tenacity of this intrepid little rover is testament to the ingenuity, dedication, and perseverance of the people who built and guided her."

More Opportunity Achievements

- Set a one-day Mars driving record March 20, 2005, when it traveled 721 feet (220 meters).
- Returned more than 217,000 images, including 15 360-degree color panoramas.
- Exposed the surfaces of 52 rocks to reveal fresh mineral surfaces for analysis and cleared 72 additional targets with a brush to prepare them for inspection with spectrometers and a microscopic imager.
- Found hematite, a mineral that forms in water, at its landing site.
- Discovered strong indications at Endeavour Crater of the action of ancient water similar to the drinkable water of a pond or lake on Earth.

All of the off-roading and on-location scientific analyses were in service of the Mars Exploration Rovers' primary objective: To seek out historical evidence of the Red Planet's climate and water at sites where conditions may once have been favorable for life. Because liquid water is required for life, as we know it, Opportunity's discoveries implied that conditions at Meridiani Planum may have been habitable for some period of time in Martian history.

"From the get-go, Opportunity delivered on our search for evidence regarding water," said Steve Squyres, principal investigator of the rovers' science payload at Cornell University. "And when you combine the discoveries of Opportunity and Spirit, they showed us that ancient Mars was a very different place from Mars today, which is a cold, dry, desolate world. But if you look to its ancient past, you find compelling evidence for liquid water below the surface and liquid water at the surface."

All those accomplishments were not without the occasional extraterrestrial impediment. In 2005 alone, Opportunity lost steering to one of its front wheels, a stuck heater threatened to severely limit the rover's available power, and a Martian sand ripple almost trapped it for good. Two years later, a two-month dust storm imperiled the rover before relenting. In 2015, Opportunity lost use of its 256-megabyte flash memory and, in 2017, it lost steering to its other front wheel.

Each time the rover faced an obstacle, Opportunity's team on Earth found and implemented a solution that enabled the rover to bounce back. However, the massive dust storm that took shape in the summer of 2018 proved too much for history's most senior Mars explorer.

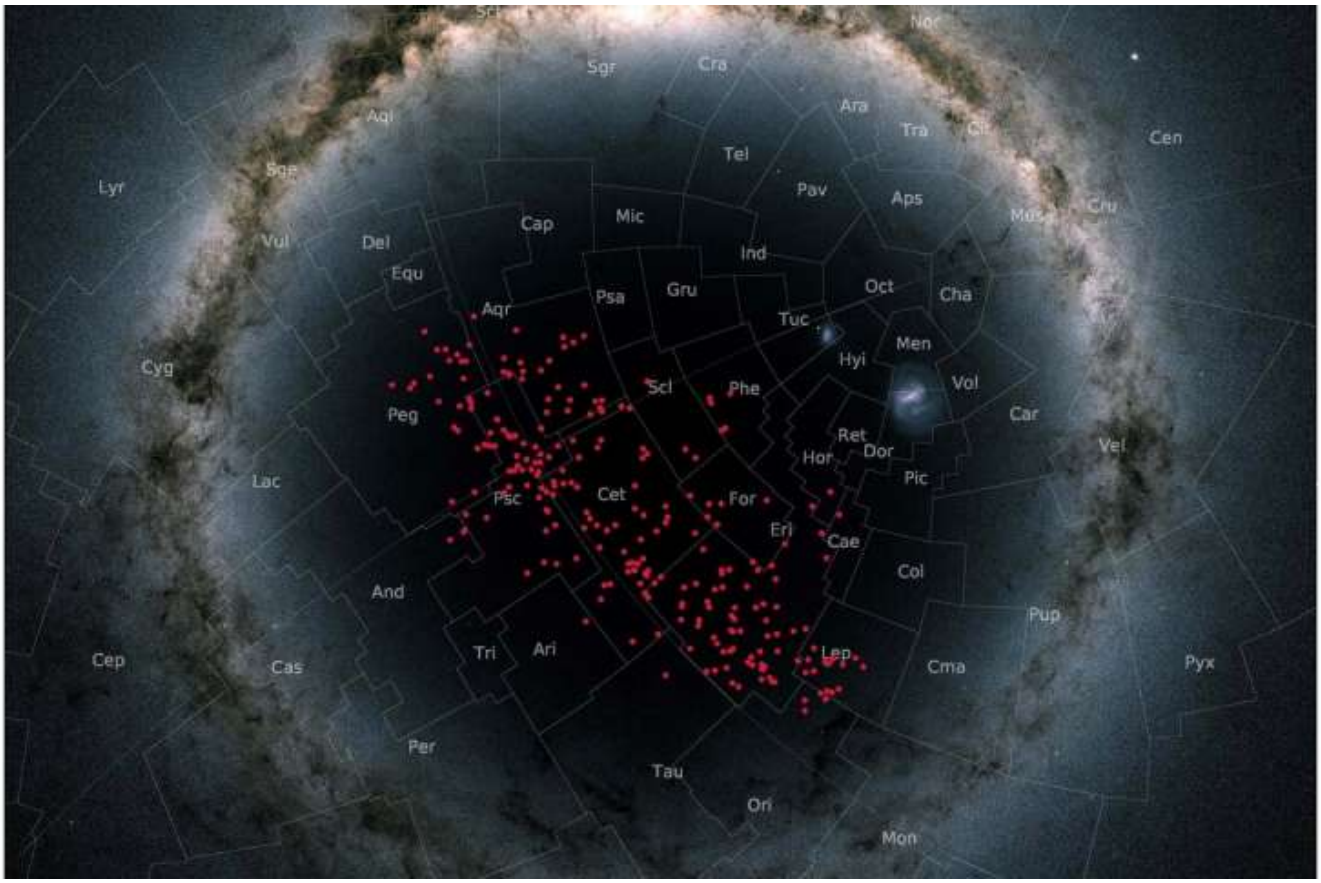
"When I think of Opportunity, I will recall that place on Mars where our intrepid rover far exceeded everyone's expectations," Callas said. "But what I suppose I'll cherish most is the impact Opportunity had on us here on Earth. It's the accomplished exploration and phenomenal discoveries. It's the generation of young scientists and engineers who became space explorers with this mission. It's the public that followed along with our every step. And it's the technical legacy of the Mars Exploration Rovers, which is carried aboard Curiosity and the upcoming Mars 2020 mission. Farewell, Opportunity, and well done."

Mars exploration continues unabated. NASA's InSight lander, which touched down on Nov. 26, is just beginning its scientific investigations. The Curiosity rover has been exploring Gale Crater for more than six years. And, NASA's Mars 2020 rover and the European Space Agency's ExoMars rover both will launch in July 2020, becoming the first rover missions designed to seek signs of past microbial life on the Red Planet.

JPL managed the Mars Exploration Rovers Opportunity and Spirit for NASA's Science Mission Directorate in Washington. For more information about the agency's Mars Exploration program, visit https://www.nasa.gov/mars.

Source: NASA Return to Contents

2. A River of Stars in the Solar Neighborhood



Astronomy & Astrophysics publishes the work of researchers from the University of Vienna, who have found a river of stars, a stellar stream in astronomical parlance, covering most of the southern sky. The stream is relatively nearby and contains at least 4000 stars that have been moving together in space since they formed, about 1 billion years ago. Due to its proximity to Earth, this stream is a perfect workbench on which to test the disruption of clusters, measure the gravitational field of the Milky Way, and learn about coeval extrasolar planet populations with upcoming planet-finding missions. For their search, the authors used data from the ESA Gaia satellite.

Our own host galaxy, the Milky Way, is home to star clusters of variable sizes and ages. We find many baby clusters within molecular clouds, fewer middle-age and old age clusters in the Galactic disk, and even fewer massive, old globular clusters in the halo. These clusters, regardless of their origin and age, are all subject to tidal forces along their orbits in the Galaxy. Given enough time, the Milky Way gravitational forces relentlessly pull them apart, dispersing their stars into the collection of stars we know as the Milky Way.

"Most star clusters in the Galactic disk disperse rapidly after their birth as they do not contain enough stars to create a deep gravitational potential well, or in other words, they do not have enough glue to keep them together. Even in the immediate solar neighborhood, there are, however, a few clusters with sufficient stellar mass to remain bound for several hundred million years. So, in principle, similar, large, stream-like remnants of clusters or associations should also be part of the Milky Way disk." says Stefan Meingast, lead author of the paper published in *Astronomy & Astrophysics*.

Thanks to the precision of the Gaia measurements, the authors could measure the 3-D motion of stars in space. When carefully looking at the distribution of nearby stars moving together, one particular group of stars, as yet unknown and unstudied, immediately caught the eye of the researchers. It was a group of stars

that showed precisely the expected characteristics of a cluster of stars born together but being pulled apart by the gravitational field of the Milky Way.

"Identifying nearby disk streams is like looking for the proverbial needle in a haystack. Astronomers have been looking at, and through, this new stream for a long time, as it covers most of the night sky, but only now realize it is there, and it is huge, and shockingly close to the Sun" says João Alves, second author of the paper. "Finding things close to home is very useful, it means they are not too faint nor too blurred for further detailed exploration, as astronomers dream."

Due to sensitivity limitations of the Gaia observations, their selection only contained about 200 sources. An extrapolation beyond these limits suggests the stream should have at least 4000 stars, thereby making the structure more massive than most know clusters in the immediate solar neighborhood. The authors also determined the stream's age to be around one billion years. As such, it already has completed four full orbits around the Galaxy, enough time to develop the stream-like structure as a consequence of gravitational interaction with the Milky Way disk.

"As soon as we investigated this particular group of stars in more detail, we knew that we had found what we were looking for: A coeval, stream-like structure, stretching for hundreds of parsecs across a third of the entire sky." Says Verena Fürnkranz, co-author and Masters student at the University of Vienna. "It was so thrilling to be part of a new discovery" she adds.

This newly discovered nearby system can be used as a valuable gravity probe to measure the mass of the Galaxy. With follow-up work, this stream can tell us how galaxies get their stars, test the gravitational field of the Milky Way, and, because of its proximity, become a wonderful target for planet-finding missions. The authors hope to unravel even more such structures in the future with the help of the rich Gaia database.

Based on the article by Meingast et al. 2019, A&A, 622, L13

Explore further: New GAIA data reveals mergers in Milky Way

More information: Stefan Meingast et al, Extended stellar systems in the solar neighborhood, *Astronomy & Astrophysics* (2019). DOI: 10.1051/0004-6361/201834950

Journal reference: Astronomy & Astrophysics

Source: Phys.org

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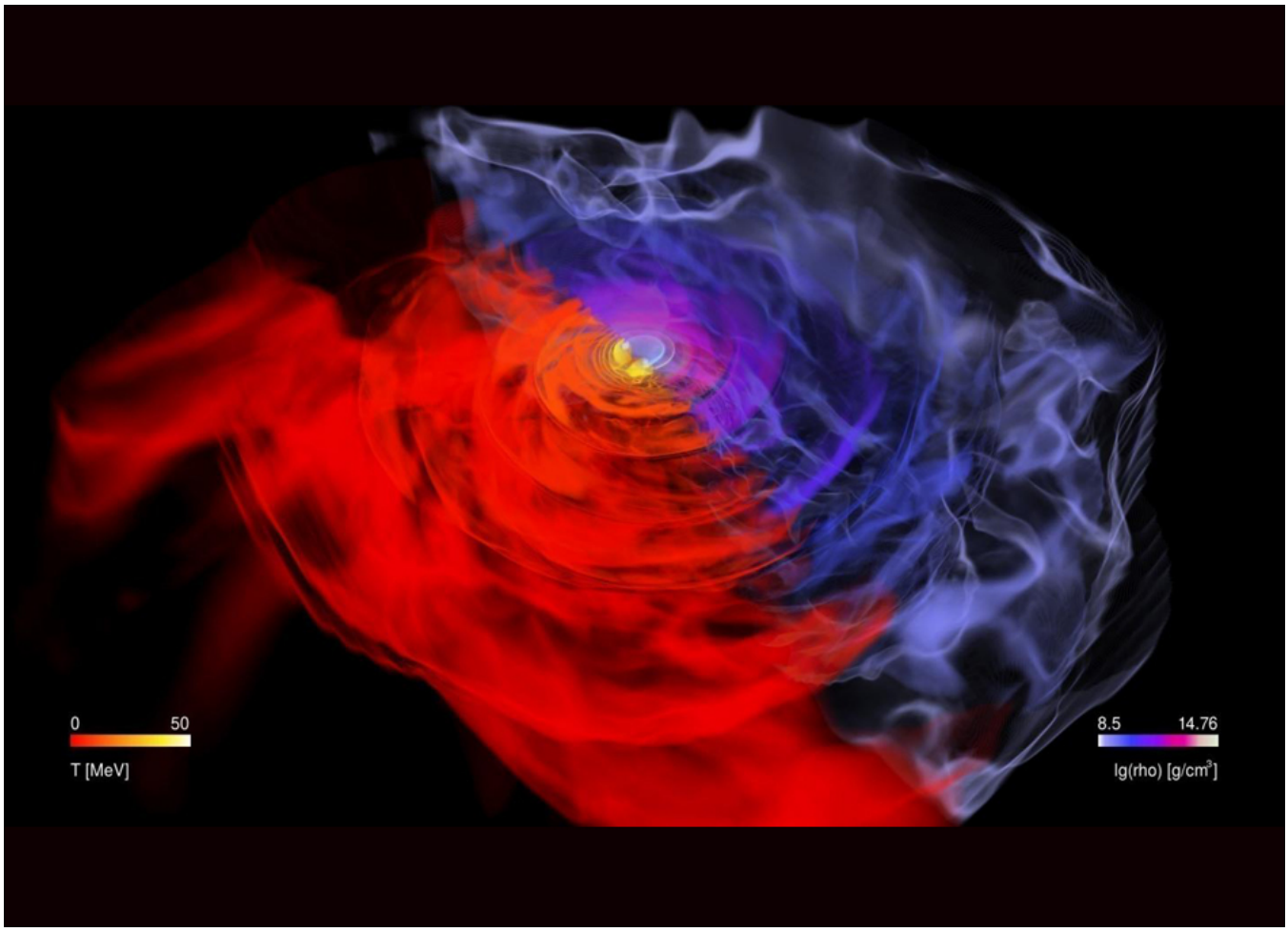
3. Merging Neutron Stars



The option to measure the gravitational waves of two merging neutron stars has offered the chance to answer some of the fundamental questions about the structure of matter.

At the extremely high temperatures and densities in the merger scientists conjecture a phase-transition where neutrons dissolve into their constituents: quarks and gluons. In the current issue of Physical Review Letters, two international research groups report on their calculations of what the signature of such a phase transition in a gravitational wave would look like.

Quarks, the smallest building-blocks of matter, never appear alone in nature. They are always tightly bound inside the protons and neutrons. However, neutron stars, weighing as much as the Sun, but being just the size of a city like Frankfurt, possess a core so dense that a transition from neutron matter to quark matter may occur. Physicists refer to this process as a phase transition, similar to the liquid-vapor transition in water. In particular, such a phase transition is in principle possible when merging neutron stars form a very massive meta-stable object with densities exceeding that of atomic nuclei and with temperatures 10,000 times higher than in the Sun's core.

The measurement of gravitational waves emitted by merging neutron stars could serve as a messenger of possible phase transitions in outer space. The phase transition should leave a characteristic signature in the gravitational-wave signal. The research groups from Frankfurt, Darmstadt and Ohio (Goethe University/FIAS/GSI/Kent University) as well as from Darmstadt and Wroclaw (GSI/Wroclaw University) used modern supercomputers to calculate what this signature could look like. For this purpose, they used different theoretical models of the phase transition.

In case a phase transition takes place more after the actual merger, small amounts of quarks will gradually appear throughout the merged object. "With aid of the Einstein equations, we were able to show for the first time that this subtle change in the structure will produce a deviation in the gravitational-wave signal until the newly formed massive neutron star collapses under its own weight to form a black hole," explains Luciano Rezzolla, who is a professor for theoretical astrophysics at the Goethe University.

In the computer models of Dr. Andreas Bauswein from GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt a phase transition already happens directly after the merger -- a core of quark matter forms in the interior of the central object. "We succeeded to show that in this case there will be a distinct shift in the frequency of the gravitational wave signal," says Bauswein. "Thus, we identified a measurable criterion for a phase transition in gravitational waves of neutron star mergers in the future."

Not all of the details of the gravitational-wave signal are measurable with current detectors yet. However, they will become observable both with the next generation of detectors, as well as with a merger event relatively close to us. A complementary approach to answer the questions about quark matter is offered by two experiments: By colliding heavy ions at the existing HADES setup at GSI and at the future CBM detector at the Facility for Antiproton and Ion Research (FAIR), which is currently under construction at GSI, compressed nuclear matter will be produced. In the collisions, it might be possible to create temperatures and densities that are similar to those in a neutron-star merger. Both methods give new insights into the occurrence of phase transitions in nuclear matter and thus into its fundamental properties.

Source: Spaceref.com Return to Contents

The Night Sky

In Process

Friday, February 15

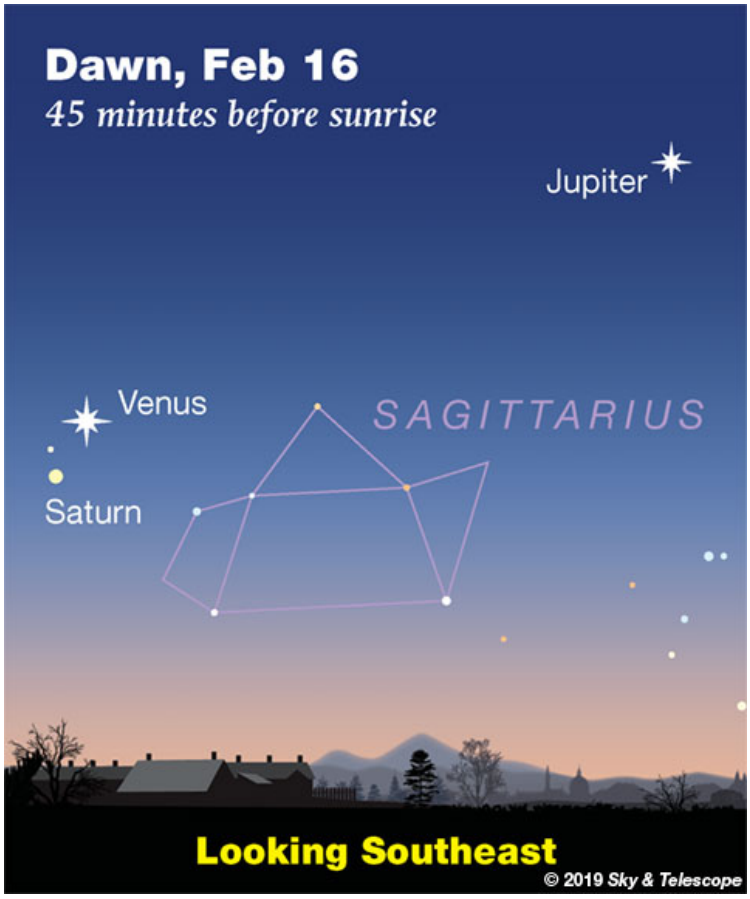
• The waxing gibbous Moon shines in the feet of Gemini this evening. Castor and Pollux are to its left, Procyon is to its lower left, and Orion is to its lower right.

Saturday, February 16

• Right after dark, the Moon finds itself between Procyon to its lower left and Pollux and Castor closer to its upper right. By 9 or 10 p.m. they're all higher in the south, and the arrangement has turned vertical.

Sunday, February 17

• Have you ever seen Canopus, the second-brightest star after Sirius? It's almost due south of Sirius: by 36°. That's far enough south that it never appears above your horizon unless you're below latitude 37° N (southern Virginia, southern Missouri, central California). And there, you'll need a very flat south horizon. Canopus passes over the south point on your horizon just 21 minutes before Sirius does.



When to look? Canopus is due south when Beta Canis Majoris — Mirzam the Announcer, the star about three finger-widths to the right of Sirius — is at *its* highest due south (roughly 8:00 p.m. now, depending on how far east or west you are in your time zone). Look straight down from Mirzam then.

Monday, February 18

• Right after dark, bright Capella is near the zenith. Face northwest and look 20° (two fists) that way from Capella. The brightest star there is Alpha Persei, Mirfak. Around and upper left of it is the *Perseus OB1 Association,* a loose swarm of modestly bright stars about the size of your thumbtip at arm's length. They show well in binoculars.

• A momentary, partial **asteroid occultation of Sirius** should happen late tonight for well-placed observers along a very narrow path running from northwestern Mexico through the Dakotas and past Winnipeg. See Bob King's Will Sirius Disappear on February 18th?

Source: Sky & Telescope

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ISS Sighting Opportunities

For Denver: No sighting opportunities

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

NASA-TV Highlights

(all times Eastern Daylight Time)

Friday, February 15

1:35 p.m., ISS Expedition 58 In-Flight Interviews with CNN for its' "After the Moon" Mini-Series and National Public Radio's "Weekend Edition" with NASA Flight Engineer Anne McClain (all channels)

Tuesday, February 19

1:25 p.m., ISS Expedition 58 In-Flight Educational Event with Florida Atlantic University in Boca Raton, Florida and NASA Flight Engineer Anne McClain (all channels)

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

Space Calendar

- Feb 15 - Galileo Day
- Feb 15 - Comet P/2003 F2 (NEAT) Closest Approach To Earth (2.590 AU)
- Feb 15 - Comet 229P/Gibbs At Opposition (3.245 AU)
- Feb 15 - Asteroid 433 Eros Occults TYC 727-324-1 (10.9 Magnitude Star)
- Feb 15 - NEW [Feb 15] Apollo Asteroid 2019 CS5 Near-Earth Flyby (0.003 AU)
- Feb 15 - Asteroid 1862 Apollo Closest Approach To Earth (1.312 AU)
- Feb 15 - Asteroid 3767 DiMaggio Closest Approach To Earth (1.388 AU)
- Feb 15 - NEW [Feb 11] Lecture: The Universe at Cosmic Noon, Pasadena, California
- Feb 15 - 10th Anniversary (2009), Ash Creek Meteorite Fall (Hit Farm House in Texas)
- Feb 15 - Aleksandr Serebrov's 75th Birthday (1944)
- Feb 15 - Galileo Galilei's 450th Birthday (1564)
- Feb 16 - Comet P/2019 A1 (PANSTARRS) At Opposition (1.484 AU)
- Feb 16 - Comet C/2018 A6 (Gibbs) At Opposition (2.814 AU)
- Feb 16 - Comet 10P/Tempel At Opposition (3.567 AU)
- Feb 16 - Asteroid 433 Eros Occults UCAC4 517-16569 (11.1 Magnitude Star)
- Feb 16 - Asteroid 3 Juno Occults HIP 19495 (8.7 Magnitude Star)
- Feb 16 - NEW [Feb 14] Apollo Asteroid 2019 CG5 Near-Earth Flyby (0.015 AU)
- Feb 16 - Amor Asteroid 5797 Bivoj Closest Approach To Earth (0.364 AU)
- Feb 16 - Aten Asteroid 367943 Duende Closest Approach To Earth (0.481 AU)
- Feb 16 - Atira Asteroid 2015 DR215 Closest Approach To Earth (1.208 AU)
- Feb 16 - Asteroid 9325 Stonehenge Closest Approach To Earth (1.290 AU)
- Feb 16 - Aten Asteroid 341843 (2008 EV5) Closest Approach To Earth (1.644 AU)
- Feb 16 - Asteroid 7644 Cslewis Closest Approach To Earth (1.917 AU)
- Feb 16 - Asteroid 1065 Amundsenia Closest Approach To Earth (2.074 AU)
- Feb 16 - Asteroid 334 Chicago Closest Approach To Earth (2.964 AU)
- Feb 16 - 1st KAGRA-Virgo-3G Detectors Workshop, Perugia, Italy
- Feb 17 - Comet 149P/Mueller Perihelion (2.634 AU)
- Feb 17 - Comet P/2005 L1 (McNaught) At Opposition (3.544 AU)
- Feb 17 - Asteroid 9258 Johnpauljones Closest Approach To Earth (1.405 AU)
- Feb 17 - Asteroid 316020 Linshuhow Closest Approach To Earth (1.499 AU)
- Feb 17 - Asteroid 2985 Shakespeare Closest Approach To Earth (1.987 AU)
- Feb 17 - Asteroid 11094 Cuba Closest Approach To Earth (2.569 AU)
- Feb 17 - 10th Anniversary (2009), Dawn, Mars Flyby
- Feb 17 - 15th Anniversary (2004), Mike Brown, et al, Discovery of Plutino 90482 Orcus
- Feb 17 - 25th Anniversary (1994), Ann Harch Discovers Dactyl (Ida moon) from Galileo Images
- Feb 17 - 60th Anniversary (1959), Vanguard 2 Launch
- Feb 18 - Venus Passes 1.1 Degrees From Saturn
- Feb 18 - Comet 355P/LINEAR-NEAT Closest Approach To Earth (2.936 AU)
- Feb 18 - Comet C/2018 E1 (ATLAS) At Opposition (3.065 AU)
- Feb 18 - Asteroid 396 Aeolia Occults HIP 61740 (4.2 Magnitude Star)
- Feb 18 - Apollo Asteroid 2016 CA138 Near-Earth Flyby (0.055 AU)
- Feb 18 - Asteroid 36800 Katarinawitt Closest Approach To Earth (1.541 AU)
- Feb 18 - Asteroid 4701 Milani Closest Approach To Earth (1.861 AU)
- Feb 18 - Asteroid 6775 Giorgini Closest Approach To Earth (2.003 AU)
- Feb 18 - Jerome Coggia's 170th Birthday (1849)

Source: JPL Space Calendar

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Food for Thought

NASA Heading Back to Moon Soon, and This Time to Stay

NASA is accelerating plans to return Americans to the Moon, and this time, the US space agency says it will be there to stay.

Jim Bridenstine, NASA's administrator, told reporters Thursday that the agency plans to speed up plans backed by President Donald Trump to return to the moon, using private companies.

"It's important that we get back to the moon as fast as possible," said Bridenstine in a meeting at NASA's Washington headquarters, adding he hoped to have astronauts back there by 2028.

"This time, when we go to the Moon, we're actually going to stay. We're not going to leave flags and footprints and then come home to not go back for another 50 years" he said.

"We're doing it entirely different than every other country in the world. What we're doing is, we're making it sustainable so you can go back and forth regularly with humans."

The last person to walk on the Moon was Eugene Cernan in December 1972, during the Apollo 17 mission.

Before humans set foot on the lunar surface again, NASA aims to land an unmanned vehicle on the Moon by 2024, and is already inviting bids from the burgeoning private sector to build the probe.

The deadline for bids is March 25, with a first selection due in May, a tight timeline for an agency whose past projects have run years behind schedule and billions over budget.

"For us, if we had any wish, I would like to fly this calendar year. We want to go fast," said Thomas Zurbuchen, the associate administrator of NASA's Science Mission Directorate.

However, he admitted that "we may not be able to."

NASA's accelerated plans flesh out the Space Policy Directive that Trump signed in December 2017, envisaging a return to the Moon before a manned mission to Mars, possibly in the 2030s.

NASA plans to build a small space station, dubbed Gateway, in the Moon's orbit by 2026. It will serve as a way-station for trips to and from the lunar surface, but will not be permanently crewed like the International Space Station (ISS), currently in Earth's orbit.

As with the ISS, NASA would seek the participation of other countries, who could provide some of the necessary needed, such as modules for the Moon station or vehicles to allow landings on the surface.

"We want numerous providers competing on cost and innovation," Bridenstine said.

Before this manned program, NASA is also pushing to send scientific instruments and other technological tools to the Moon in 2020 or even before the end of this year.

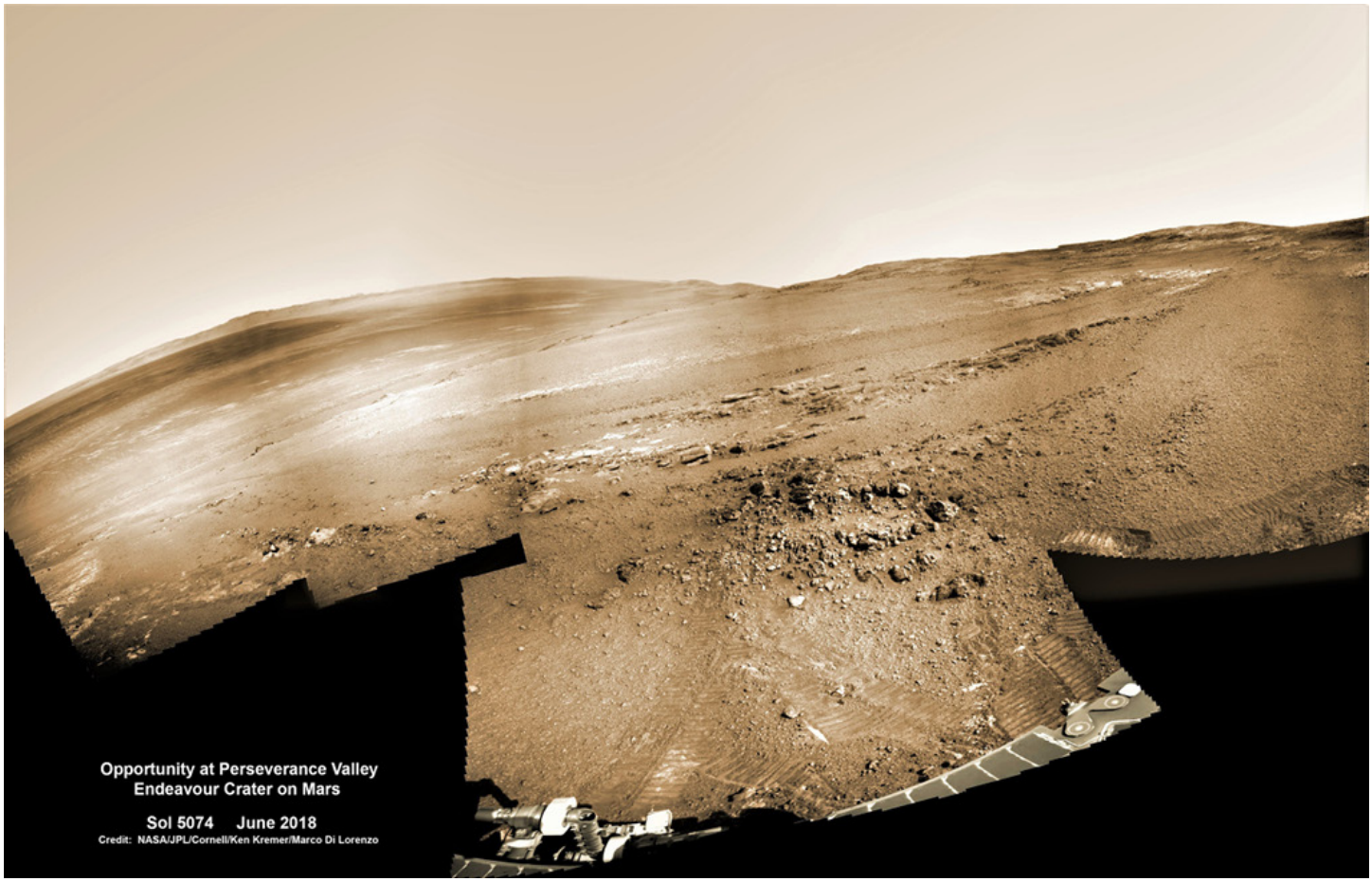
The agency is also calling for quick-turnaround bids to manufacture and launch such instruments, offering financial incentives to make it happen fast.

"We care about speed," said Thomas Zurbuchen, associate administrator of NASA's Science Mission Directorate. "We do not expect that every one of those launches or every one of those landings will be successful. We are taking risks."

Explore further: Next US moon landing will be by private companies, not NASA

Source: Phys.org Return to Contents

Space Image of the Week



Opportunity at Perseverance Valley

Explanation Opportunity had already reached Perseverance Valley by June of 2018. Its view is reconstructed in a colorized mosaic of images taken by the Mars Exploration Rover's Navcam. In fact, Perseverance Valley is an appropriate name for the destination. Designed for a 90 day mission, Opportunity had traveled across Mars for over 5,000 sols (martian solar days) following a January 2004 landing in Eagle crater. Covering a total distance of over 45 kilometers (28 miles), its intrepid journey of exploration across the Martian landscape has come to a close here. On June 10, 2018, the last transmission from the solar-powered rover was received as a dust storm engulfed the Red Planet. Though the storm has subsided, eight months of attempts to contact Opportunity have not been successful and its trailblazing mission ended after almost 15 years of exploring the surface of Mars.

Image Credit: NASA, JPL-Caltech, Kenneth Kremer, Marco Di Lorenzo

Source: APOD

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