Space News Update

— January 20, 2017 —

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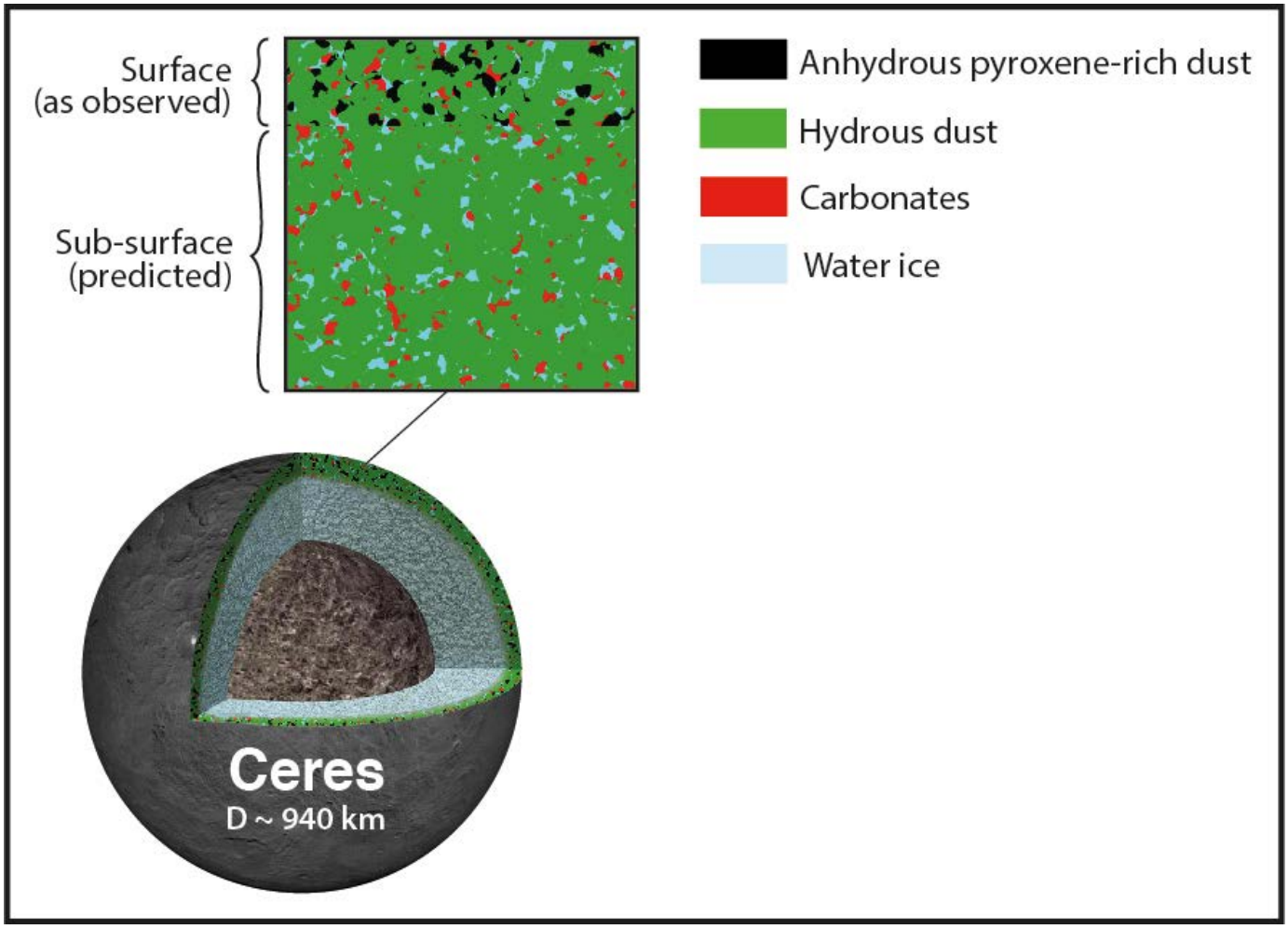
1. Don’t Judge an Asteroid by its Cover: Mid-infrared Data from SOFIA Shows Ceres’ True Composition



New observations show that Ceres, the largest body in the asteroid belt, does not appear to have the carbon-rich surface composition that space- and ground-based telescopes previously indicated.

Using data primarily from NASA’s Stratospheric Observatory for Infrared Astronomy, SOFIA, a team of astronomers has detected the presence of substantial amounts of material on the surface of Ceres that appear to be fragments of other asteroids containing mostly rocky silicates. These observations are contrary to the currently accepted surface composition classification of Ceres as a carbon-rich body, suggesting that it is cloaked by material that partially disguises its real makeup.

“This study resolves a long-time question about whether asteroid surface material accurately reflects the intrinsic composition of the asteroid,” said Pierre Vernazza, research scientist in the Laboratoire d’Astrophysique de Marseille (LAM–CNRS/AMU). Our results show that by extending observations to the mid-infrared, the asteroid’s underlying composition remains identifiable despite contamination by as much as 20 percent of material from elsewhere,” said Vernazza.

Astronomers have classified the Ceres asteroid, as well as 75 percent of all asteroids, in composition class “C” based on their similar colors. The mid-infrared spectra from SOFIA show that Ceres differs substantially from neighboring C-type asteroids, challenging the conventional understanding of the relationship between Ceres and smaller asteroids.

“SOFIA, with its airborne location and sensitive FORCAST instrument, is the only observatory, currently operating or planned, that can make these kind of observations,” said Franck Marchis, planetary astronomer at the SETI Institute and one of Vernazza’s co-authors. “These and future mid-infrared observations are key to understanding the true nature and history of the asteroids.”

Ceres and asteroids are not the only context where material transported from elsewhere has affected the surfaces of solar system bodies. Dramatic examples include Saturn’s two-faced moon Iapetus and the red material seen by *New Horizons* on Pluto’s moon Charon. Planetary scientists also hypothesize that material from comets and asteroids provided a final veneer to the then-forming Earth that included substantial amounts of water plus the organic substances of the biosphere.

“Models of Ceres based on data collected by NASA’s Dawn spacecraft plus ground-based telescopes indicated substantial amounts of water- and carbon-bearing minerals such as clays and carbonates,” explains Vernazza. “Only the mid-infrared observations made using SOFIA were able to show that both silicate and carbonate materials are present on the surface of Ceres.”

To identify where the pyroxene on the surface of Ceres came from, Vernazza and his collaborators, including researchers from the SETI Institute in Mountain View, and NASA’s Jet Propulsion Laboratory, both in California, turned to interplanetary dust particles (IDPs) that form meteors when they are seen streaking through Earth’s atmosphere. The research team had previously shown that IDPs blasted into space by asteroid collisions are an important source of material accumulated on the surfaces of other asteroids. The implication is that a coating of IDPs has caused Ceres to take on the coloration of some of its dry and rocky neighbors.

This study was published January 16, 2017 in the Astronomical Journal.

NASA is exploring the solar system and beyond to better understand the universe and our place in it. We explore asteroids and comets, which may hold clues about the history of our solar system and how life arose on Earth.

SOFIA is a Boeing 747SP jetliner modified to carry a 100-inch diameter telescope. It is a joint project of NASA and the German Aerospace Center, DLR. NASA’s Ames Research Center in California’s Silicon Valley manages the SOFIA program, science and mission operations in cooperation with the Universities Space Research Association headquartered in Columbia, Maryland, and the German SOFIA Institute (DSI) at the University of Stuttgart. The aircraft is based at NASA’s Armstrong Flight Research Center's Building 703, in Palmdale, California.

For more information about SOFIA, visit:

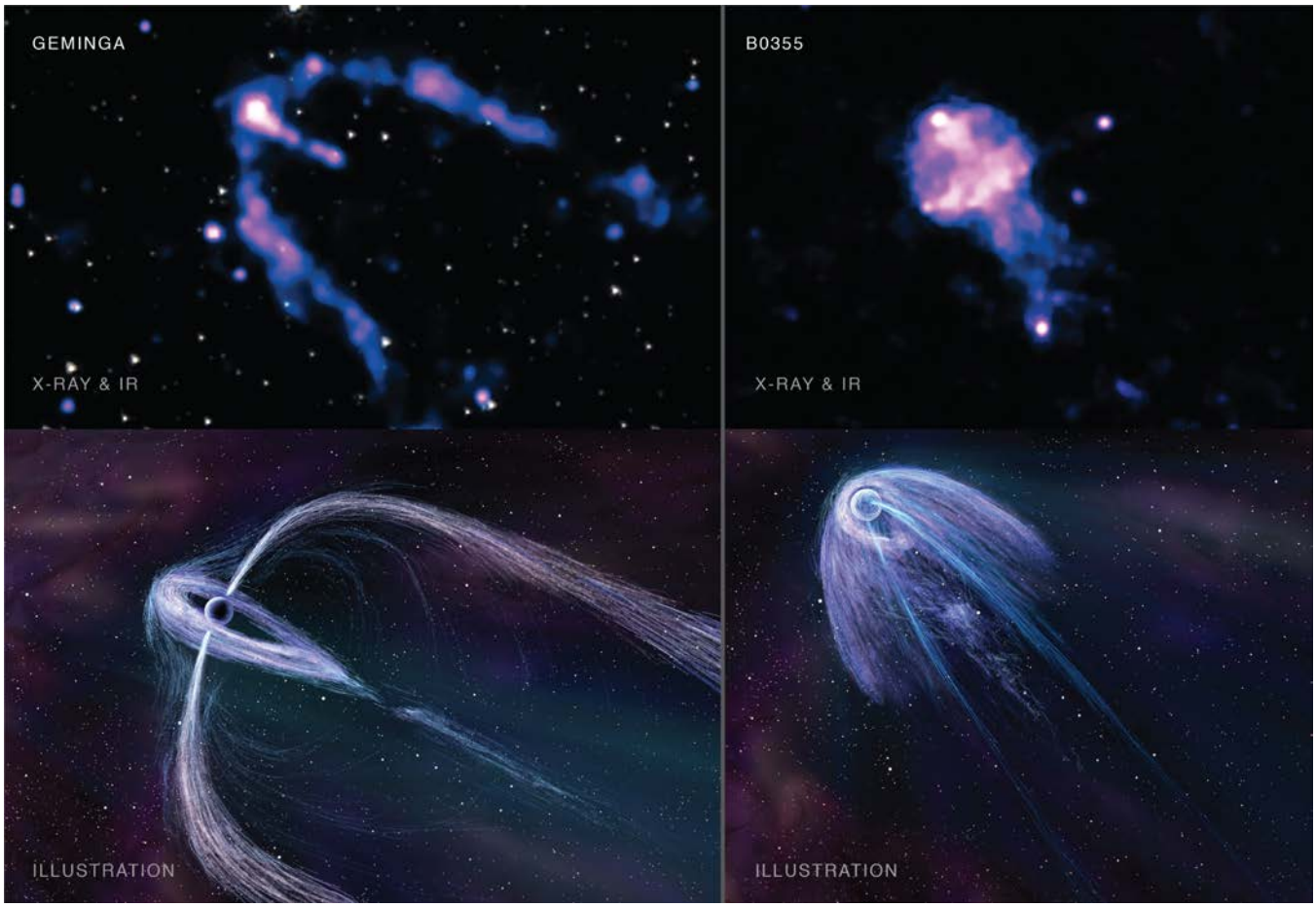
http://www.nasa.gov/sofia • http://www.dlr.de/en/sofia

Study SOFIA's science mission and scientific instruments at:

http://www.sofia.usra.edu • http://www.dsi.uni-stuttgart.de/index.en.html

Source: NASA Return to Contents

2. Chandra Images Show That Geometry Solves a Pulsar Puzzle



NASA'S Chandra X-ray Observatory has taken deep exposures of two nearby energetic pulsars flying through the Milky Way galaxy. The shape of their X-ray emission suggests there is a geometrical explanation for puzzling differences in behavior shown by some pulsars.

Pulsars – rapidly rotating, highly magnetized, neutron stars born in supernova explosions triggered by the collapse of massive stars – were discovered 50 years ago via their pulsed, highly regular, radio emission. Pulsars produce a lighthouse-like beam of radiation that astronomers detect as pulses as the pulsar's rotation sweeps the beam across the sky.

Since their discovery, thousands of pulsars have been discovered, many of which produce beams of radio waves and gamma rays. Some pulsars show only radio pulses and others show only gamma-ray pulses. Chandra observations have revealed steadier X-ray emission from extensive clouds of high-energy particles, called pulsar wind nebulas, associated with both types of pulsars. New Chandra data on pulsar wind nebulas may explain the presence or absence of radio and gamma-ray pulses.

This four-panel graphic shows the two pulsars observed by Chandra. Geminga is in the upper left and B0355+54 is in the upper right. In both of these images, Chandra's X-rays, colored blue and purple, are combined with infrared data from NASA's Spitzer Space Telescope that shows stars in the field of view. Below each data image, an artist's illustration depicts more details of what astronomers think the structure of each pulsar wind nebula looks like.

For Geminga, a deep Chandra observation totaling nearly eight days over several years was analyzed to show sweeping, arced trails spanning half a light year and a narrow structure directly behind the pulsar. A five-day

Chandra observation of the second pulsar, B0355+54, showed a cap of emission followed by a narrow double trail extending almost five light years.

The underlying pulsars are quite similar, both rotating about five times per second and both aged about half a million years. However, Geminga shows gamma-ray pulses with no bright radio emission, while B0355+54 is one of the brightest radio pulsars known yet not seen in gamma rays.

A likely interpretation of the Chandra images is that the long narrow trails to the side of Geminga and the double tail of B0355+54 represent narrow jets emanating from the pulsar's spin poles. Both pulsars also contain a torus of emission spreading from the pulsar's spin equator. These disk-shaped structures and the jets are crushed and swept back as the pulsars fly through the Galaxy at supersonic speeds

In the case of Geminga, the view of the torus is close to edge-on, while the jets point out to the sides. B0355+54 has a similar structure, but with the torus viewed nearly face-on and the jets pointing nearly directly towards and away from Earth. In B0355+54, the swept-back jets appear to lie almost on top of each other, giving a doubled tail.

Both pulsars have magnetic poles quite close to their spin poles, as is the case for the Earth's magnetic field. These magnetic poles are the site of pulsar radio emission so astronomers expect the radio beams to point in a similar direction as the jets. By contrast the gamma-ray emission is mainly produced along the spin equator and so aligns with the torus.

For Geminga, astronomers view the bright gamma-ray pulses along the edge of the torus, but the radio beams near the jets point off to the sides and remain unseen. For B0355+54, a jet points almost along our line of sight towards the pulsar. This means astronomers see the bright radio pulses, while the torus and its associated gamma-ray emission are directed in a perpendicular direction to our line of sight, missing the Earth.

These two deep Chandra images have, therefore, exposed the spin orientation of these pulsars, helping to explain the presence, and absence, of the radio and gamma-ray pulses.

The Chandra observations of Geminga and B0355+54 are part of a large campaign, led by Roger Romani of Stanford University, to study six pulsars that have been seen to emit gamma-rays. The survey sample covers a range of ages, spin-down properties and expected inclinations, making it a powerful test of pulsar emission models.

A paper on Geminga led by Bettina Posselt of Penn State University was accepted for publication in The Astrophysical Journal and is available online. A paper on B0355+54 led by Noel Klingler of the George Washington University was published in the December 20th, 2016 issue of The Astrophysical Journal and is available online. NASA's Marshall Space Flight Center in Huntsville, Alabama, manages the Chandra program for NASA's Science Mission Directorate in Washington. The Smithsonian Astrophysical Observatory in Cambridge, Massachusetts, controls Chandra's science and flight operations.

Image credit: Geminga image: NASA/CXC/PSU/B. Posselt et al; Infrared: NASA/JPL-Caltech; B0355+54: X-ray: NASA/CXC/GWU/N. Klingler et al; Infrared: NASA/JPL-Caltech; Illustrations: Nahks TrEhnl

Read More from NASA's Chandra X-ray Observatory.

For more Chandra images, multimedia and related materials, visit:

http://www.nasa.gov/chandra

Source: NASA Return to Contents

3. Farthest Stars in The Milky Way Might Be Ripped from Another Galaxy

The 11 farthest known stars in our galaxy are located about 300,000 light-years from Earth, well outside the Milky Way's spiral disk.

New research by Harvard astronomers shows that half of those stars might have been ripped from another galaxy: the Sagittarius dwarf. Moreover, they are members of a lengthy stream of stars extending one million light-years across space, or 10 times the width of our galaxy.

"The star streams that have been mapped so far are like creeks compared to the giant river of stars we predict will be observed eventually," says lead author Marion Dierickx of the Harvard-Smithsonian Center for Astrophysics (CfA).

The Sagittarius dwarf is one of dozens of mini-galaxies that surround the Milky Way. Over the age of the universe it made several loops around our galaxy. On each passage, the Milky Way's gravitational tides tugged on the smaller galaxy, pulling it apart like taffy.

Dierickx and her PhD advisor, Harvard theorist Avi Loeb, used computer models to simulate the movements of the Sagittarius dwarf over the past 8 billion years. They varied its initial velocity and angle of approach to the Milky Way to determine what best matched current observations.

"The starting speed and approach angle have a big effect on the orbit, just like the speed and angle of a missile launch affects its trajectory," explains Loeb.

At the beginning of the simulation, the Sagittarius dwarf weighed about 10 billion times the mass of our Sun, or about one percent of the Milky Way's mass. Dierickx's calculations showed that over time, the hapless dwarf

lost about a third of its stars and a full nine-tenths of its dark matter. This resulted in three distinct streams of stars that reach as far as one million light-years from the Milky Way's center. They stretch all the way out to the edge of the Milky Way halo and display one of the largest structures observable on the sky.

Moreover, five of the 11 most distant stars in our galaxy have positions and velocities that match what you would expect of stars stripped from the Sagittarius dwarf. The other six do not appear to be from Sagittarius, but might have been removed from a different dwarf galaxy.

Mapping projects like the Sloan Digital Sky Survey have charted one of the three streams predicted by these simulations, but not to the full extent that the models suggest. Future instruments like the Large Synoptic Survey Telescope, which will detect much fainter stars across the sky, should be able to identify the other streams.

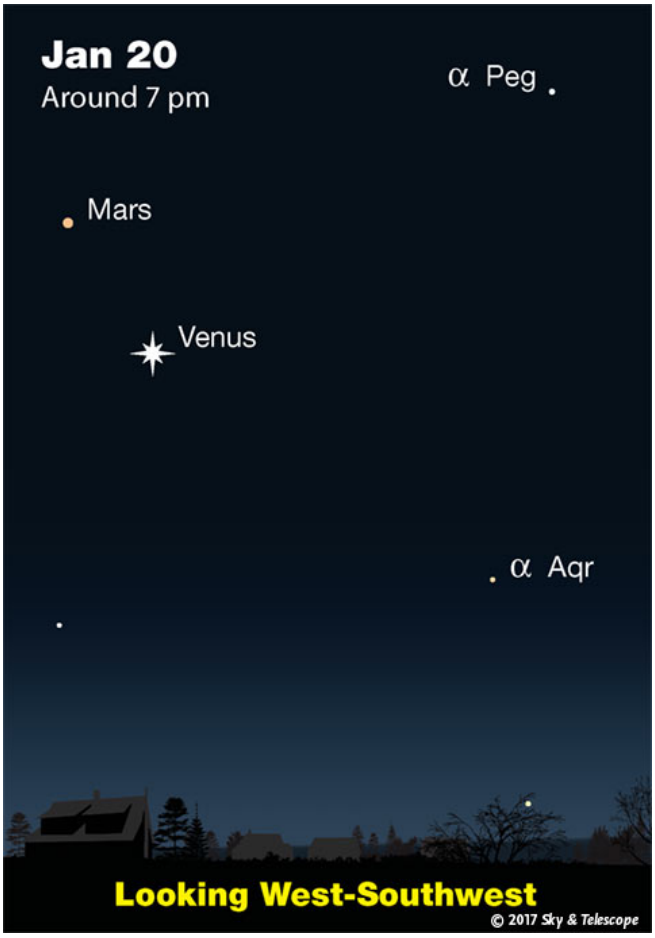
"More interlopers from Sagittarius are out there just waiting to be found," says Dierickx.

These findings have been accepted for publication in The Astrophysical Journal and are available online at https://arxiv.org/pdf/1611.00089.pdf.

Source: Spaceref.com Return to Contents

The Night Sky

January 20



• After dinnertime, the bright, equilateral Winter Triangle glitters in the southeast. Sirius is its lowest and brightest star. Betelgeuse stands above Sirius by about two fists at arm's length. To the left of their midpoint is Procyon.

• Vesta, the brightest asteroid, is magnitude 6.2 this week. It's just past opposition, looping high near Castor and Pollux. Binoculars will show it; see article and finder chart.

Saturday, January 21

• Is your sky dark enough for you to see the winter Milky Way? After dinnertime it runs vertically up and across the zenith: from Canis Major low in the southeast, up between Orion and Gemini, through Auriga and Perseus almost straight overhead, and down through Cassiopeia, Cepheus, and Cygnus to the northwest horizon.

• Early in the dawn of Sunday the 22nd, spot the waning crescent Moon hanging in the southeastern sky. Some 12° below it (for North America) is Antares. Look 15° to the left or lower left of Antares for Saturn. The same distance lower left of Saturn is Mercury.

Sunday, January 22

• Zero-magnitude Capella high overhead, and equally bright Rigel in Orion's foot, are at almost the same right ascension. This means they cross your sky's meridian at almost exactly the same time: around 9 p.m. now, depending on how far east or west you live in your time zone. (Capella goes exactly *through* the zenith if you're at latitude 46° north: Portland, Oregon; Montreal; central France.) So, whenever Capella passes its very highest, Rigel always marks true south over your landscape. And vice versa.

Monday, January 23

• In early dawn Tuesday morning the 24th, look southeast for the waning crescent Moon hanging 3° upper left of Saturn (when seen by North America), as shown here.

Source: Sky & Telescope

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ISS Sighting Opportunities

For Denver:

Date	Visible	Max Height	Appears	Disappears
Sat Jan 21, 5:25 AM	< 1 min	15°	15° above S	10° above S
Thu Jan 26, 7:14 PM	1 min	19°	11° above SSW	19° above SSW

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

NASA-TV Highlights

(all times Eastern Daylight Time)

Tuesday, January 24

10:30 a.m., ISS Expedition 50 In-Flight Event for the European Space Agency with the European Space Education Resource Office and Flight Engineer Thomas Pesquet of ESA (NTV-1 with English interpretation, NTV-3 in native language) (starts at 10:45 a.m.) (all channels)

Wednesday, January 25

2 p.m., ISS Expedition 52-53 Crew News Conference (Ryazanskiy, Bresnik and Nespoli) (all channels)

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

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Space Calendar

- Jan 20 - UPDATED[Jan 20] SBIRS GEO 3 Atlas 5 Launch
- Jan 20 - Comet P/2010 A2 (LINEAR) At Opposition (1.046 AU)
- Jan 20 - Comet P/2013 YG46 (Spacewatch) Perihelion (1.804 AU)
- Jan 20 - Comet 220P/McNaught At Opposition (3.092 AU)
- Jan 20 - Asteroid 4 Vesta Closest Approach To Earth (1.522 AU)
- Jan 20 - NEW[Jan 19] Asteroid 391257 Wilwheaton Closest Approach To Earth (2.484 AU)
- Jan 20 - Kuiper Belt Object 20000 Varuna At Opposition (42.859 AU)
- Jan 21 - Comet C/2017 A1 (PANSTARRS) Closest Approach To Earth (1.978 AU)
- Jan 21 - Comet 73P-T/Schwassmann-Wachmann At Opposition (3.069 AU)
- Jan 21 - Comet 44P/Reinmuth At Opposition (3.375 AU)
- Jan 21 - Comet 205P-C/Giacobini At Opposition (3.583 AU)
- Jan 21 - Comet 205P/Giacobini At Opposition (3.585 AU)
- Jan 21 - Comet 205P-A/Giacobini At Opposition (3.585 AU)
- Jan 21 - Comet C/2015 X5 (PANSTARRS) At Opposition (6.184 AU)
- Jan 21 - Amor Asteroid 2015 BG4 Near-Earth Flyby (0.069 AU)
- Jan 21 - Educators Workshop: Utilizing Renewable Energy, Downey, California
- Jan 22 - Comet 323P/SOHO At Opposition (0.541 AU)
- Jan 22 - Comet P/2011 CR42 (Catalina) At Opposition (2.597 AU)
- Jan 22 - Comet C/2017 A3 (Elenin) At Opposition (3.451 AU)
- Jan 22 - NEW[Jan 20] Apollo Asteroid 2017 BK Near-Earth Flyby (0.039 AU)
- Jan 22 - 20th Anniversary (1997), Lottie Williams Becomes 1st Person to be Hit by Space Debris
- Jan 22 - 25th Anniversary (1992), 1st Exoplanet Discovered (PSR B1257+12 B)
- Jan 22 - 25th Anniversary (1992), STS-42 Launch (Space Shuttle Discovery, Spacelab)
- Jan 22 - Gianluca Masi's 45th Birthday (1972)
- Jan 22 - Pierre Gassendi's 425th Birthday (1592)
- Jan 22 - 545th Anniversary (1472), Great Comet of 1472 Near-Earth Flyby (10.5 million km)
- Jan 23 - Cassini, Distant Flyby of Daphnis, Enceladus, Pandora & Atlas
- Jan 23 - Comet 197P/LINEAR Closest Approach To Earth (2.583 AU)
- Jan 23 - Asteroid 9661 Hohmann Closest Approach To Earth (3.608 AU)
- Jan 23 - Plutino 208996 (2003 AZ84) At Opposition (43.718 AU)
- Jan 23 - Webinar: Advanced Instrumentation Techniques for Finding Biosignatures
- Jan 23 - NEW[Jan 14] Lecture: Exocomets: Now You See Them, Now You Don't, Mountain View, California
- Jan 23 - Hideki Yukawa's 110th Birthday (1907)

Pierre Gassendi

Source: JPL Space Calendar

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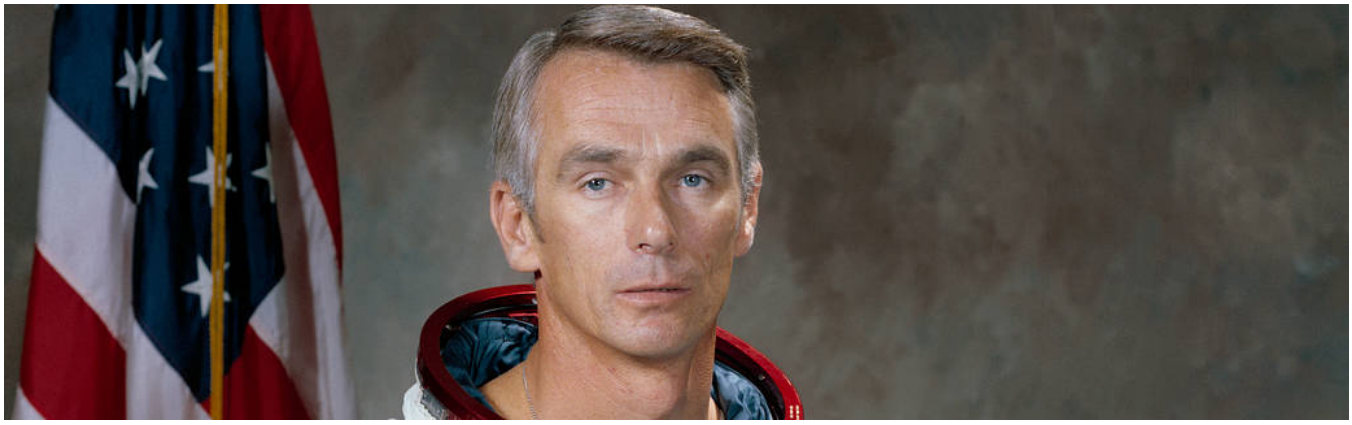
Food for Thought

Remembering Gene Cernan



Eugene Cernan, the last man to walk on the moon, died Monday, Jan. 16, surrounded by his family.

Photo gallery of Eugene Cernan

Clips of Eugene Cernan from "The Last Man on the Moon", a documentary by director Mark Shepard. Used by permission; all rights reserved.

Cernan, a Captain in the U.S. Navy, left his mark on the history of exploration by flying three times in space, twice to the moon. He also holds the distinction of being the second American to walk in space and the last human to leave his footprints on the lunar surface.

NASA Administrator Charles Bolden said in a statement after Cernan's death, "Truly, America has lost a patriot and pioneer who helped shape our country's bold ambitions to do things that humankind had never before achieved."

A statement from Cernan's family said in part, "Even at the age of 82, Gene was passionate about sharing his desire to see the continued human exploration of space and encouraged our nation's leaders and young people to not let him remain the last man to walk on the Moon,"

Cernan was one of 14 astronauts selected by NASA in October 1963. He piloted the Gemini 9 mission with Commander Thomas P. Stafford on a three-day flight in June 1966. Cernan logged more than two hours outside the orbiting capsule.

In May 1969, he was the lunar module pilot of Apollo 10, the first comprehensive lunar-orbital qualification and verification test of the lunar lander. The mission confirmed the performance, stability, and reliability of the Apollo command, service and lunar modules. The mission included a descent to within eight nautical miles of the moon's surface.

In a 2007 interview for NASA's oral histories, Cernan said, "I keep telling Neil Armstrong that we painted that white line in the sky all the way to the Moon down to 47,000 feet so he wouldn't get lost, and all he had to do was land. Made it sort of easy for him."

Full oral history interview with Eugene Cernan.

Apollo 17 built upon all of the other missions scientifically," said Cernan in 2008, recalling the mission as the agency celebrated its 50th Anniversary. "We had a lunar rover, we were able to cover more ground than most of the other missions. We stayed there a little bit longer. We went to a more challenging unique area in the mountains, to learn something about the history and the origin of the moon itself."

On their way to the moon, the Apollo 17 crew took one of the most iconic photographs in space-program history, the full view of the Earth dubbed "The Blue Marble." Despite its fame, the photograph hasn't really been appreciated, Cernan said in 2007.

"What is the real meaning of seeing this picture? I've always said, I've said for a long time, I still believe it, it's going to be -- well it's almost fifty now, but fifty or a hundred years in the history of mankind before we look back and really understand the meaning of Apollo. Really understand what humankind had done when we left, when we truly left this planet, we're able to call another body in this universe our home. We did it way too early considering what we're doing now in space. It's almost as if JFK reached out into the twenty-first century where we are today, grabbed hold of a decade of time, slipped it neatly into the (nineteen) sixties and seventies (and) called it Apollo."

On July 1, 1976, Cernan retired from the Navy after 20 years and ended his NASA career. He went into private business and served as television commentator for early flights of the space shuttle.

Cernan was born in Chicago on March 14, 1934. He graduated from Proviso Township High School in Maywood, Ill., and received a bachelor of science degree in electrical engineering from Purdue University in 1956. He earned a master of science degree in aeronautical engineering from the U.S. Naval Postgraduate School in Monterey, Calif.

Cernan is survived by his wife, Jan Nanna Cernan, his daughter and son-in-law, Tracy Cernan Woolie and Marion Woolie, step-daughters Kelly Nanna Taff and husband, Michael, and Danielle Nanna Ellis and nine grandchildren.

Source: NASA

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Space Image of the Week

Layer Cake Sunset

Explanation: On January 18 a tantalizing sunset was captured in this snapshot. Seemingly sliced into many horizontal layers the Sun shimmered moments before it touched the horizon, setting over the Pacific Ocean as seen from the mountaintop Las Campanas Observatory in Chile. Pink hues of filtered sunlight were created by the long sight-line through the hazy atmosphere. But the remarkable layers correspond to low atmospheric layers of sharply different temperature and density also along the line of sight. Over a long path through each layer the rays of sunlight are refracted strongly and create different images or mirages of sections of the setting Sun.

Image Credit & Copyright: Yuri Beletsky (Carnegie Las Campanas Observatory, TWAN)

Source: Astronomy Picture of the Day

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