Space News Update

— July 6, 2018 —

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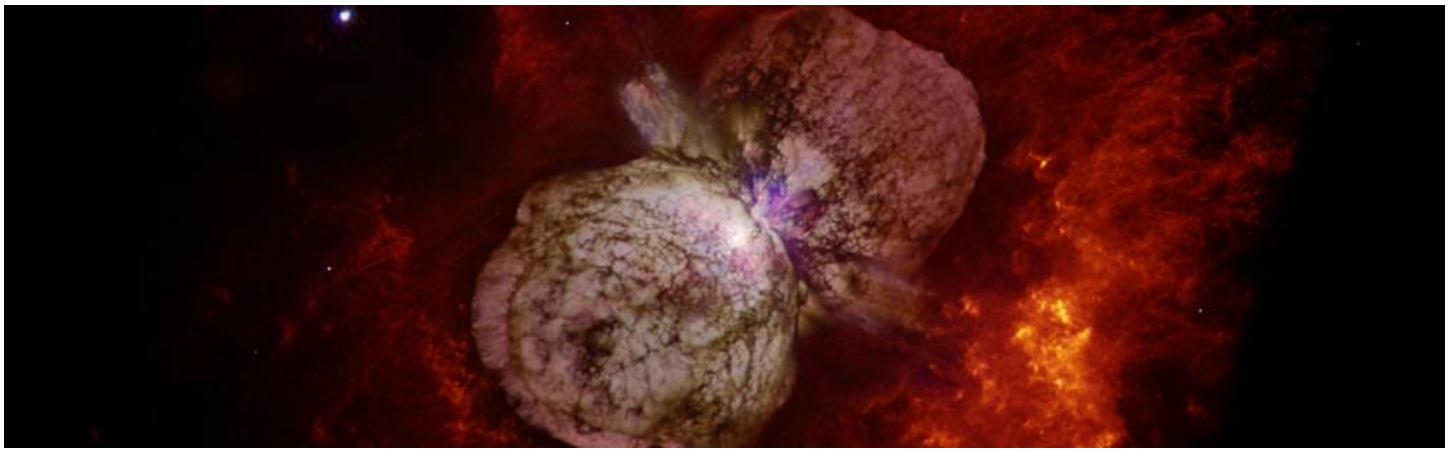
1. NASA's NuSTAR Mission Proves Superstar Eta Carinae Shoots Cosmic Rays



A new study using data from NASA's NuSTAR space telescope suggests that Eta Carinae, the most luminous and massive stellar system within 10,000 light-years, is accelerating particles to high energies — some of which may reach Earth as cosmic rays.

"We know the blast waves of exploded stars can accelerate cosmic ray particles to speeds comparable to that of light, an incredible energy boost," said Kenji Hamaguchi, an astrophysicist at NASA's Goddard Space Flight Center in Greenbelt, Maryland, and the lead author of the study. "Similar processes must occur in other extreme environments. Our analysis indicates Eta Carinae is one of them."

Astronomers know that cosmic rays with energies greater than 1 billion electron volts (eV) come to us from beyond our solar system. But because these particles — electrons, protons and atomic nuclei — all carry an electrical charge, they veer off course whenever they encounter magnetic fields. This scrambles their paths and masks their origins.

Eta Carinae, located about 7,500 light-years away in the southern constellation of Carina, is famous for a 19th century outburst that briefly made it the second-brightest star in the sky. This event also ejected a massive hourglass-shaped nebula, but the cause of the eruption remains poorly understood.

The system contains a pair of massive stars whose eccentric orbits bring them unusually close every 5.5 years. The stars contain 90 and 30 times the mass of our Sun and pass 140 million miles (225 million kilometers) apart at their closest approach — about the average distance separating Mars and the Sun.

"Both of Eta Carinae's stars drive powerful outflows called stellar winds," said team member Michael Corcoran, also at Goddard. "Where these winds clash changes during the orbital cycle, which produces a periodic signal in low-energy X-rays we've been tracking for more than two decades."

NASA's Fermi Gamma-ray Space Telescope also observes a change in gamma rays — light packing far more energy than X-rays — from a source in the direction of Eta Carinae. But Fermi's vision isn't as sharp as X-ray telescopes, so astronomers couldn't confirm the connection.

To bridge the gap between low-energy X-ray monitoring and Fermi observations, Hamaguchi and his colleagues turned to NuSTAR. Launched in 2012, NuSTAR can focus X-rays of much greater energy than any previous telescope. Using both newly taken and archival data, the team examined NuSTAR observations acquired between March 2014 and June 2016, along with lower-energy X-ray observations from the European Space Agency's XMM-Newton satellite over the same period.

Eta Carinae's low-energy, or soft, X-rays come from gas at the interface of the colliding stellar winds, where temperatures exceed 70 million degrees Fahrenheit (40 million degrees Celsius). But NuSTAR detects a source emitting X-rays above 30,000 eV, some three times higher than can be explained by shock waves in the colliding winds. For comparison, the energy of visible light ranges from about 2 to 3 eV.

The team's analysis, presented in a paper published on Monday, July 2, in Nature Astronomy, shows that these "hard" X-rays vary with the binary orbital period and show a similar pattern of energy output as the gamma rays observed by Fermi.

The researchers say that the best explanation for both the hard X-ray and the gamma-ray emission is electrons accelerated in violent shock waves along the boundary of the colliding stellar winds. The X-rays detected by NuSTAR and the gamma rays detected by Fermi arise from starlight given a huge energy boost by interactions with these electrons.

Some of the superfast electrons, as well as other accelerated particles, must escape the system and perhaps some eventually wander to Earth, where they may be detected as cosmic rays.

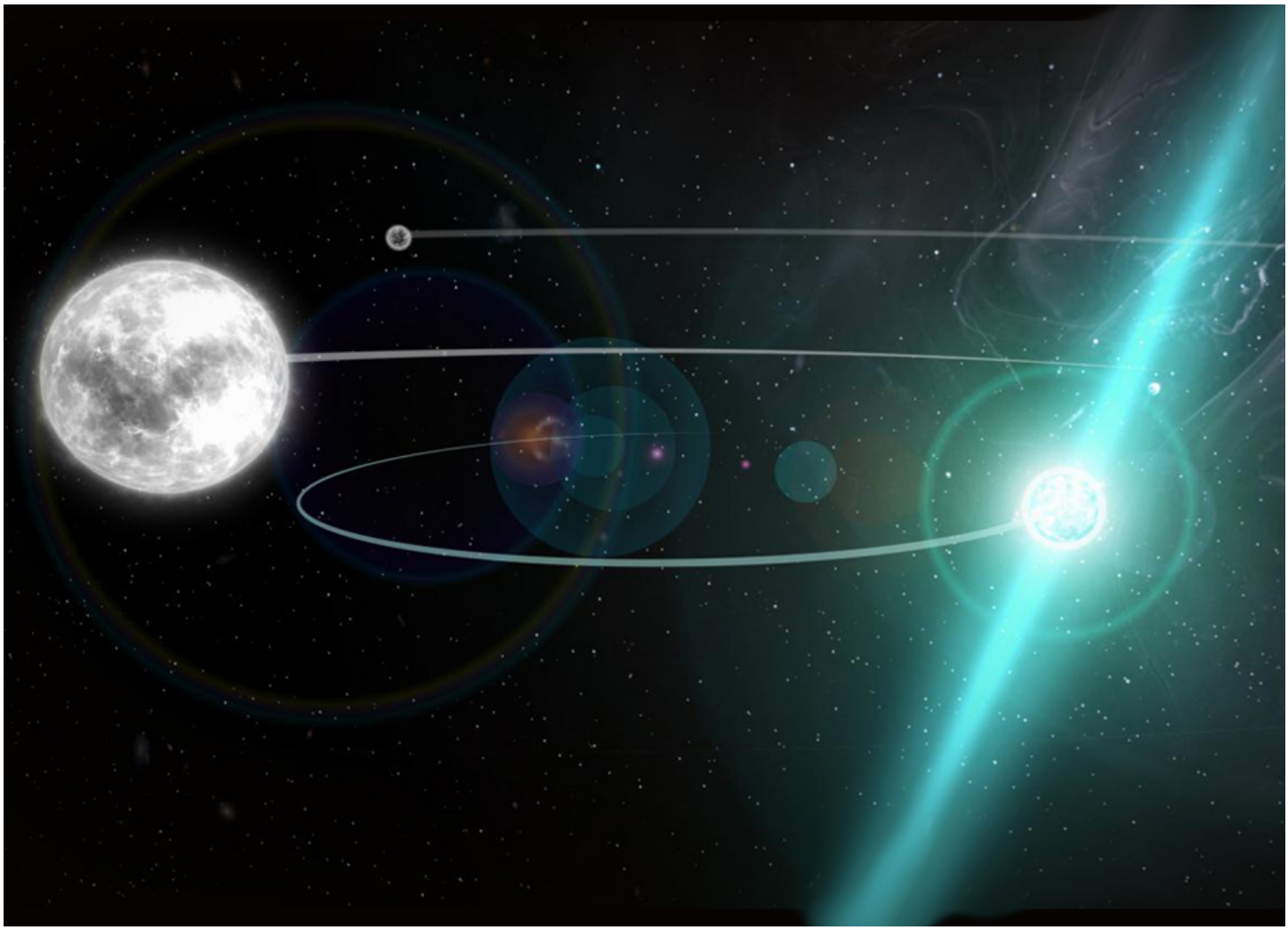
"We've known for some time that the region around Eta Carinae is the source of energetic emission in high-energy X-rays and gamma rays", said Fiona Harrison, the principal investigator of NuSTAR and a professor of astronomy at Caltech in Pasadena, California. "But until NuSTAR was able to pinpoint the radiation, show it comes from the binary and study its properties in detail, the origin was mysterious."

NuSTAR is a Small Explorer mission led by Caltech and managed by JPL for NASA's Science Mission Directorate in Washington. NuSTAR was developed in partnership with the Danish Technical University and the Italian Space Agency (ASI). The spacecraft was built by Orbital Sciences Corp., Dulles, Virginia. NuSTAR's mission operations center is at UC Berkeley, and the official data archive is at NASA's High Energy Astrophysics Science Archive Research Center. ASI provides the mission's ground station and a mirror archive. Caltech manages JPL for NASA.

For more information on NuSTAR, visit https://www.nasa.gov/nustar and http://www.nustar.caltech.edu.

Source: NASA Return to Contents

2. Even Phenomenally Dense Neutron Stars Fall Like A Feather



Einstein's understanding of gravity, as outlined in his general theory of relativity, predicts that all objects fall at the same rate, regardless of their mass or composition.

This theory has passed test after test here on Earth, but does it still hold true for some of the most massive and dense objects in the known universe, an aspect of nature known as the Strong Equivalence Principle? An international team of astronomers has given this lingering question its most stringent test ever. Their findings, published in the journal Nature, show that Einstein's insights into gravity still hold sway, even in one of the most extreme scenarios the Universe can offer.

Take away all air, and a hammer and a feather will fall at the same rate - a concept explored by Galileo in the late 1500s and famously illustrated on the Moon by Apollo 15 astronaut David Scott.

Though a bedrock of Newtonian physics, it took Einstein's theory of gravity to express how and why this is so. To date, Einstein's equations have passed all tests, from careful laboratory studies to observations of planets in our solar system. But alternatives to Einstein's general theory of relativity predict that compact objects with extremely strong gravity, like neutron stars, fall a little differently than objects of lesser mass. That difference, these alternate theories predict, would be due to a compact object's so-called gravitational binding energy -- the gravitational energy that holds it together.

In 2011, the National Science Foundation's (NSF) Green Bank Telescope (GBT) discovered a natural laboratory to test this theory in extreme conditions: a triple star system called PSR J0337+1715, located about 4,200 light-years from Earth. This system contains a neutron star in a 1.6-day orbit with a white dwarf star, and the pair in a 327-day orbit with another white dwarf further away.

"This is a unique star system," said Ryan Lynch of the Green Bank Observatory in West Virginia, and coauthor on the paper. "We don't know of any others quite like it. That makes it a one-of-a-kind laboratory for putting Einstein's theories to the test."

Since its discovery, the triple system has been observed regularly by the GBT, the Westerbork Synthesis Radio Telescope in the Netherlands, and the NSF's Arecibo Observatory in Puerto Rico. The GBT has spent more than 400 hours observing this system, taking data and calculating how each object moves in relation to the other.

How were these telescopes able to study this system? This particular neutron star is actually a pulsar. Many pulsars rotate with a consistency that rivals some of the most precise atomic clocks on Earth. "As one of the most sensitive radio telescopes in the world, the GBT is primed to pick up these faint pulses of radio waves to study extreme physics," Lynch said. The neutron star in this system pulses (rotates) 366 times per second.

"We can account for every single pulse of the neutron star since we began our observations," said Anne Archibald of the University of Amsterdam and the Netherlands Institute for Radio Astronomy and principal author on the paper. "We can tell its location to within a few hundred meters. That is a really precise track of where the neutron star has been and where it is going."

If alternatives to Einstein's picture of gravity were correct, then the neutron star and the inner white dwarf would each fall differently toward the outer white dwarf. "The inner white dwarf is not as massive or compact as the neutron star, and thus has less gravitational binding energy," said Scott Ransom, an astronomer with the National Radio Astronomy Observatory in Charlottesville, Virginia, and co-author on the paper.

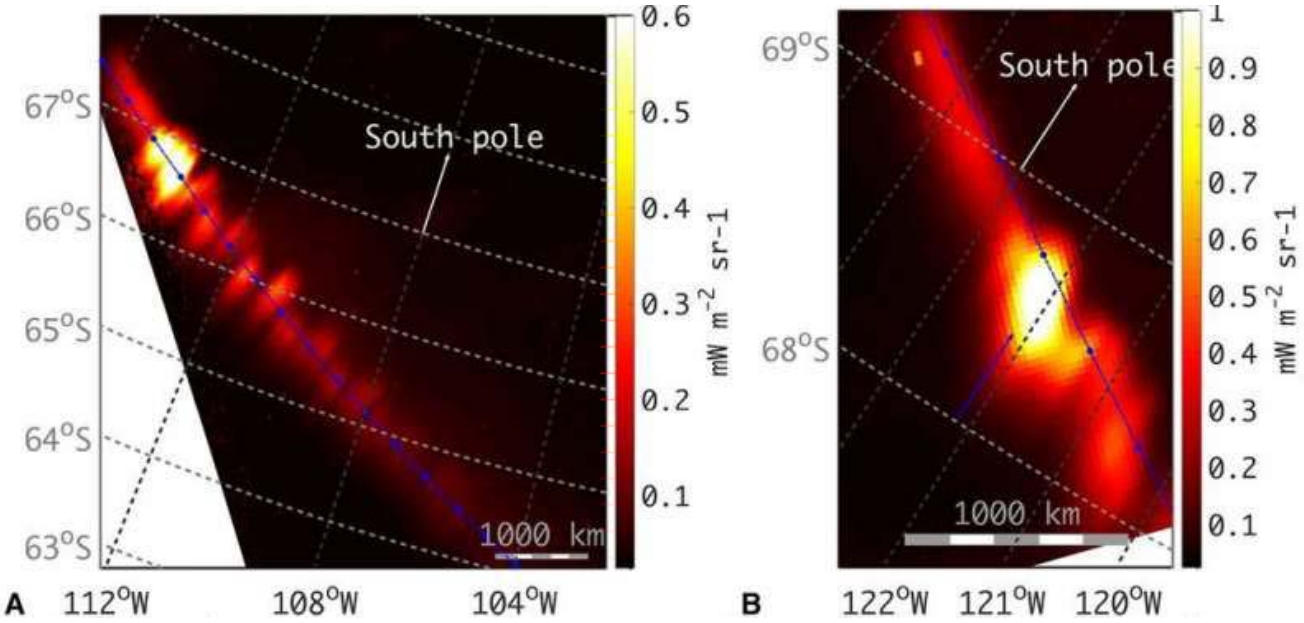
Through meticulous observations and careful calculations, the team was able to test the system's gravity using the pulses of the neutron star alone. They found that any acceleration difference between the neutron star and inner white dwarf is too small to detect.

"If there is a difference, it is no more than three parts in a million," said coauthor Nina Gusinskaia of the University of Amsterdam. This places severe constraints on any alternative theories to general relativity.

This result is ten times more precise that the previous best test of gravity, making the evidence for Einstein's Strong Equivalence Principle that much stronger. "We're always looking for better measurements in new places, so our quest to learn about new frontiers in our Universe is going to continue," concluded Ransom.

Source: Spaceref.com Return to Contents

3. Data from Juno Shows Jupiter Moons Causing Footprints in Aurorae



A team of researchers with members from Italy, the U.S. and Belgium has discovered that two of Jupiter's moons cause "footprints" in the planet's aurorae. In their paper published in the journal *Science*, the researchers describe what they found and how it helps better understand both the planet and its moons.

On Earth, as the authors note, an aurora is seen as the Northern or Southern lights—dazzling displays of light in the night sky. Jupiter also has aurorae, but they are caused by a different process. Jupiter has a surrounding magnetosphere—plasma carried by the planet's strong magnetic field. Charged particles from the magnetosphere at times strike the atmosphere of the planet, causing light shows similar to the ones we see on here on Earth. But they have something ours do not—footprints from the planet's moons. These footprints, the researchers explain, are disturbances in an aurora caused by the presence of a moon—in this case, by Io or Ganymede.

The researchers found evidence of the footprints when studying data sent back to Earth by NASA's Juno space probe. They found that when Io passed close to Jupiter, it caused a double trail of squiggles to appear in a small section of an aurora. The researchers describe it as similar to a Von Kármán vortex—one that streams for hundreds of kilometers. The footprint disappears as the moon moves farther away from the planet.

The group also found a footprint created by Ganymede, a spot in an aurora that, upon closer view, turned out to be two spots—the footprint was split in half. The researchers were not able to find a reason for the split, but note that Ganymede is the only moon orbiting Jupiter that has its own magnetic field. This, they suggest, means that the footprint created by the moon represents the interaction of two magnetospheres.

The researchers suggest that learning more about the footprints caused by Jupiter's moons will help to understand how the moons interact with the planet and how strong magnetic forces in a natural environment interact. They also note that neither footprint was in the location that had been predicted, which indicates that models built to describe such events will need to be adjusted.

Explore further: Old data, new tricks: Fresh results from NASA's Galileo spacecraft 20 years on

More information: A. Mura et al. Juno observations of spot structures and a split tail in Io-induced aurorae on Jupiter, *Science* (2018). DOI: 10.1126/science.aat1450

Source: Phys.org

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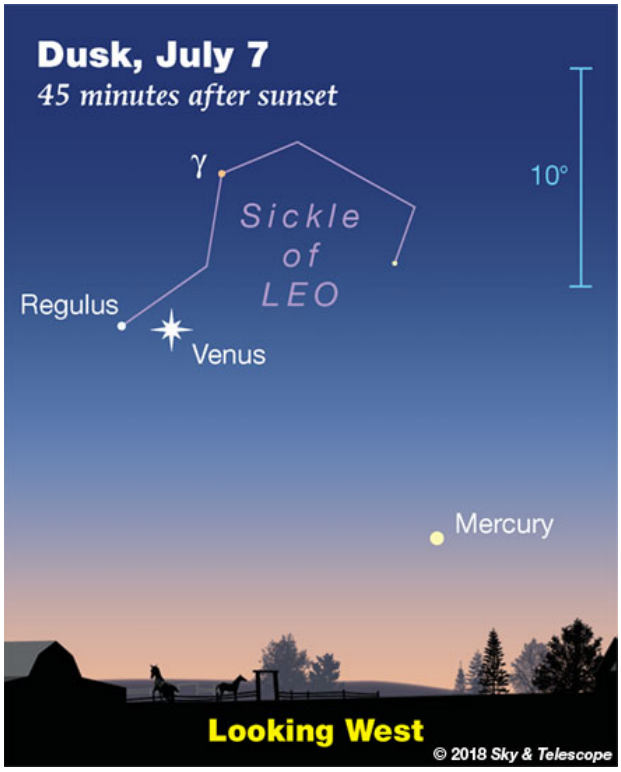
The Night Sky

Friday, July 6

• As twilight fades, watch for Regulus coming into view 3½° to the left of Venus, as shown here.



• After dark the central stars of the constellation Lyra, forming a small triangle and parallelogram, dangle to the lower right from bright Vega high in the east. The two brightest stars of the pattern, after Vega, are the two forming the bottom of the parallelogram: Beta and Gamma Lyrae, Sheliak and Sulafat. They're currently lined up vertically. Beta is the one on top.

• Earth is at the aphelion of its orbit today, its farthest from the Sun for the year: 3% farther than at perihelion in January.

Saturday, July 7

• After dark, Altair shines in the east-southeast. It's the second-brightest star in the eastern sky, after Vega high to its upper left. Above Altair by a finger-width at arm's length is little orange Tarazed. A bit more than a fist-width lower left of Altair is little Delphinus, the Dolphin, leaping leftward.

Sunday, July 8

• The Big Dipper, high in the northwest after dark, is beginning to turn around to "scoop up water" through the evenings of summer and early fall.

Monday, July 9

• Venus and Regulus are in conjunction, 1° apart in the western twilight. Watch for Regulus coming into view just to Venus's lower left.

• Last occultation of Aldebaran. Early Tuesday morning, the thin waning crescent Moon will occult 1st-magnitude Aldebaran for parts of Canada and the uppermost Midwest. The line of grazing occultation crosses Wisconsin and the Straits of Mackinac on to Labrador. The rest of North America sees a near miss. Local timetables.

Writes David Dunham, organizer of the International Occultation Timing Association,

"The brightest star (other than the Sun) that can be occulted by the Moon will be occulted one last time during the current series, for observers in the western Great Lakes region. It will be a good event, with the crescent Moon only 11% sunlit, so those with clear skies might see the reappearance [of Aldebaran on the Moon's dark limb] even without optical aid. But the Moon will be low; you will need an unobstructed horizon in the east-northeast where the Moon will rise."

Special webpage for this event, with detailed maps.

Not until 2033 will we get another good Aldebaran occultation. Continues Dunham, "The 19-year period between series of occultations of the same star [including the Sun] is called a Meton cycle; the series of occultations of Aldebaran last about 4 years. Four Meton cycles ago, the last accessible Aldebaran graze of that series occurred on March 12, 1962. That was the first grazing occultation I tried to predict, using printed tables of trig functions and a clunky Marchant calculator.... I got close enough [to the graze line] to see Aldebaran's angular size when it reappeared, appearing like a drop of water coming out of a faucet. That sparked my lifelong interest in pursuing these events, precipitating the start of a worldwide effort to observe them."

Source: Sky & Telescope Return to Contents

ISS Sighting Opportunities

For Denver:

Date	Visible	Max Height	Appears	Disappears
Sat Jul 7, 3:38 AM	2 min	51°	45° above WNW	26° above NNE
Sat Jul 7, 5:14 AM	< 1 min	10°	10° above NW	10° above NW
Sun Jul 8, 2:48 AM	2 min	36°	36° above ENE	13° above NE
Sun Jul 8, 4:21 AM	4 min	18°	10° above WNW	14° above N
Mon Jul 9, 1:57 AM	< 1 min	12°	12° above ENE	12° above ENE
Mon Jul 9, 3:30 AM	2 min	25°	22° above NW	21° above N
Mon Jul 9, 5:08 AM	2 min	11°	10° above NNW	10° above N

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

NASA-TV Highlights

(all times Eastern Daylight Time)

Monday, July 9

7 a.m., ISS Expedition 56 In-Flight Event with the Wimbledon Tennis Channel and ISS Commander Drew Feustel of NASA (starts at 7:15 a.m.) (all channels)

5:30 p.m., Coverage of the Launch of the ISS Progress 70 Cargo Craft from the Baikonur Cosmodrome in Kazakhstan (Launch scheduled at 5:51 p.m. EDT) (all channels)

9 p.m., Coverage of the Docking of the ISS Progress 70 Cargo Craft to the ISS (Docking scheduled at 9:39 p.m. EDT) (all channels)

Tuesday, July 10

10:30 a.m., ISS Expedition 56 In-Flight Educational Event with the Glenn Research Center in Cleveland, Ohio and Flight Engineer Serena Aunon-Chancellor of NASA (all channels)

2 p.m., ISS Expedition 56 In-Flight Educational Event with the Langley Research Center in Langley, Virginia and Flight Engineer Alexander Gerst of the European Space Agency (starts at 2:10 p.m.) (all channels)

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

Space Calendar

- Jul 06 - Earth At Aphelion (1.017 AU From Sun)
- Jul 06 - Comet P/2017 Y3 (Leonard) Closest Approach To Earth (1.492 AU)
- Jul 06 - Comet 101P/Chernykh At Opposition (3.721 AU)
- Jul 06 - Asteroid 584 Semiramis Occults HIP 8544 (6.2 Magnitude Star)
- Jul 06 - Asteroid 3526 Jeffbell Closest Approach To Earth (1.530 AU)
- Jul 06 - 80th Anniversary (1938), Seth Nicholson's Discovery of Jupiter Moon Lysithea
- Jul 07 - Apollo Asteroid 2018 MV6 Near-Earth Flyby (0.065 AU)
- Jul 07 - Asteroid 18499 Showalter Closest Approach To Earth (0.759 AU)
- Jul 07 - Asteroid 2410 Morrison Closest Approach To Earth (1.209 AU)
- Jul 07 - Asteroid 11365 NASA Closest Approach To Earth (1.334 AU)
- Jul 07 - Amor Asteroid 1915 Quetzalcoatl Closest Approach To Earth (2.248 AU)
- Jul 07 - Asteroid 34901 Mauna Loa Closest Approach To Earth (2.843 AU)
- Jul 07 - Lecture: Introduction to Astronomy, Homolovi State Park, Arizona
- Jul 07 - 15th Anniversary (2003), Mars Exploration Rover B (Opportunity) Launch
- Jul 07 - George Graham's 345th Birthday (1673)
- Jul 08 - Kuiper Belt Object 50000 Quaoar Occults UCAC4-374-109194 (14.6 Magnitude Star)
- Jul 08 - Atira Asteroid 418265 (2008 EA32) Closest Approach To Earth (0.589 AU)
- Jul 08 - Atira Asteroid 2010 XB11 Closest Approach To Earth (0.726 AU)
- Jul 08 - Kuiper Belt Object 486958 (2014 MU69) At Opposition (42.237 AU)
- Jul 08 - Kuiper Belt Object 2014 PN70 At Opposition (42.932 AU)
- Jul 09 - Moon Occults Asteroid 87 Sylvia
- Jul 09 - NEW [Jul 02] Comet C/2018 M1 (Catalina) Perihelion (1.315 AU)
- Jul 09 - Comet C/2017 S6 (Catalina) At Opposition (1.354 AU)
- Jul 09 - Comet 94P/Russell Closest Approach To Earth (2.993 AU)
- Jul 09 - Comet P/2008 Y12 (SOHO) At Opposition (3.933 AU)
- Jul 09 - Centaur Object 10199 Chariklo At Opposition (14.922 AU)
- Jul 09 - 60th Anniversary (1958), Thor-Able Launch (Carried Laska the Mouse)
- Jul 09 - James Pollack's 80th Birthday (1938)

George Graham

Source: JPL Space Calendar

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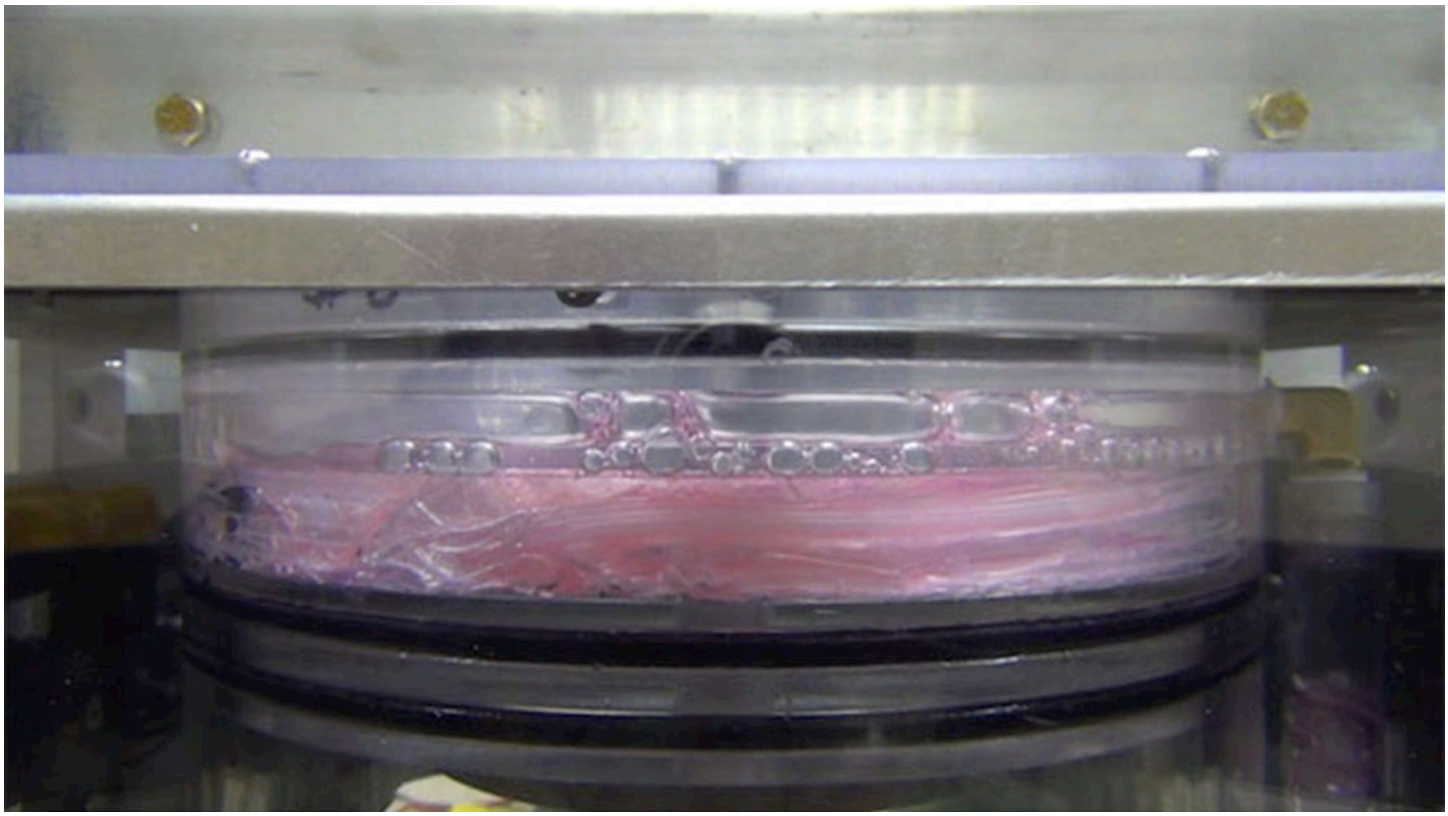
Food for Thought

NASA Seeks New Ways to Handle Trash for Deep Space Missions



Life aboard the International Space Station requires extreme measures in efficiency to preserve resources, reduce waste, repurpose materials, and recycle water and breathable air. Regular cargo resupply missions deliver approximately 12 metric tons of supplies each year, which can lead to significant storage challenges aboard the orbiting laboratory. When trash accumulates, astronauts manually squeeze it into trash bags, temporarily storing almost two metric tons of it for relatively short durations, and then send it away in a departing commercial supply vehicle, which either returns it to Earth or incinerates it during reentry through the atmosphere.

Future spacecraft, much farther from Earth, likely will not have the regular cadence of visiting commercial ships that can remove trash, so NASA is turning to U.S. industry to advance concepts for trash compaction and processing systems. The agency has issued a call for prototypes, and eventually, flight demonstrations to fly on the space station. The solicitation was issued through Next Space Technologies for Exploration Partnerships (NextSTEP) Broad Agency Announcement, Appendix F: Logistics Reduction in Space by Trash Compaction and Processing System.

Storing trash inside a spacecraft not only consumes precious volume, but also can create physical and biological hazards for the crew. Storage also removes the option to extract valuable leftover resources that could be recycled or repurposed. The solicitation seeks solutions that compact trash, remove biological and physical safety concerns, and recover trapped resources for potential reuse or repurposing. Proposing companies won't have to start from ground zero, however. NASA has been developing waste management systems since the 1980s, including recent developments such as the Heat Melt Compactor and "trash to gas" technologies.

The development will occur in two phases. In Phase A, selected companies will create a concept trash compaction and processing system, conduct design reviews with NASA, and validate concepts through

prototype ground demonstrations. Throughout this phase, the companies may request use of NASA facilities to conduct subsystem tests. In Phase B, a flight unit will be developed to demonstrate a system aboard the space station as early as 2022.

Inherent with the NextSTEP partnership model, private companies must contribute their own corporate resources toward the development of their trash compaction and processing systems. In this case, responders are required to show a minimum of 20 percent contribution toward the overall development cost, or 10 percent for small businesses. Proposals are due August 22, 2018. NASA plans to host an industry day on July 24, to share details about the solicitation, describe available NASA facilities, and answer questions from potential respondents.

NASA's Exploration Campaign will usher in a new era of human exploration, taking humans farther in space than ever before. Operations aboard the Gatewayin lunar orbit, as well as on the surface of the Moon, will require innovative approaches to live and work more independently from Earth. Logistical efficiencies afforded by new innovations like trash compaction and processing systems will make human exploration safer and more sustainable.

Source: NASA Return to Contents

Space Image of the Week

Dawn's Early Light, Rocket's Red Glare

Explanation If you saw the dawn's early light from Cape Canaveral Air Force Station last Friday, June 29, then you could have seen this rocket's red glare. The single 277-second long exposure, made from the roof of NASA's Vehicle Assembly building, shows a predawn Falcon 9 launch, the rocket streaking eastward into the sky about 45 minutes before sunrise. At high altitude, its stage separation plume is brightly lit by the Sun still below the eastern horizon. The Falcon 9 rocket's first stage had been launched before, lofting the Transiting Exoplanet Survey Satellite (TESS) into orbit on April 18, only 72 days earlier. For this launch of SpaceX Commercial Resupply Service mission 15 (CRS-15) it carried an also previously flown Dragon capsule. But no further reuse of this Falcon 9 was planned so no dramatic first stage landing followed the launch. The Dragon capsule arrived at the International Space Station on July 2.

Image Credit & Copyright: Michael Seeley

Source: APOD

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