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Space Image of the Week
1. Actual image of a white dwarf feeding on material from a larger red giant 650 light years from Earth

The SPHERE planet-hunting instrument on the European Southern Observatory's Very Large Telescope captured this image of a white dwarf feeding on its companion star, a type of Red Giant called a Mira variable. Most stars exist in binary systems, and they spend an eternity serenely orbiting their common center of gravity. But something almost sinister is going on between these two.

Astronomers at the ESO have been observing the pair for years and have uncovered what they call a "peculiar story." The Red Giant is a Mira variable, meaning it's near the end of its life, and it's pulsing up to 1,000 times as bright as the sun. Each time it pulses, its gaseous envelope expands, and the smaller White Dwarf strips material from the Red Giant.

The binary system is called R Aquarii, and it is, of course, in the constellation Aquarius. It's about 650 light years away from Earth.

If R Aquarii were not a binary system, and was only the red giant, it would still be a dramatic sight. In its death throes, the Mira variable pulses about once every year, and flares up to almost 1,000 times brighter than the sun. As it pulses, it expands and sheds its outer layers into interstellar space, to be taken up in another generation of starbirth, some time in the future. Its core has run out of hydrogen and fusion has ceased there. Instead, fusion takes place in a shell of hydrogen that surrounds the core.

Left on its own, the Mira variable in R Aquarii would shed its outer layers as a planetary nebula, and in a few million years, would become a white dwarf itself. But its companion has something to say about this.
R Aquarii is called a symbiotic star system because of their relationship. As the white dwarf draws in material from the Red Giant, it ejects some of it in weird looping patterns, seen in this Hubble image. Credit: Judy Schmidt, USA – ...more

The Mira variable's companion in this binary system is a white dwarf. It's smaller, denser, and much hotter than the Mira variable. It steals stellar material from the Mira star and sucks it in with its gravity. It then sends jets of material out into space.

As if that wasn't enough for this strange pair, the white dwarf has some fireworks of its own. Sometimes, enough material—mostly hydrogen—from the Mira variable star collects on the surface of the white dwarf, and triggers a thermonuclear nova explosion. The explosion expels more material out into space, adding to the spectacle. The remnants of past nova events can be seen in the tenuous nebula of gas radiating from R Aquarii in this image.

The SPHERE (Spectro-Polarimetric High-contrast Exoplanet Research) instrument that captured the main image is a planet-hunting instrument, with the power to directly image exoplanets. But that's not all it can do. The same power that makes it able to image exoplanets also means it can a wide variety of other astronomical objects, including R Aquarii.

SPHERE wasn't the only instrument looking at the odd binary pair. The Hubble has also been looking at the white dwarf feeding on its companion, several times over the years. Below is a three-part image showing how the 'scopes worked together to understand this system.

This image shows part of the wide-field observation from Hubble compared with the intricate details uncovered by the unparalleled observational capabilities of SPHERE and the VLT. Credit: ESO/Schmid et al./NASA/ESA

Source: Phys.org
NASA's Parker Solar Probe, the first human-made object to fly into the Sun's corona, completed its first solar flyby on November 11, collecting a wealth of unprecedented data about the workings of our magnificent home star. And now, weeks later, that data is arriving home.

It may be a little bit of a wait for scientists to analyse it and start coming through with some papers, but in the meantime, we have a feast for our eyes: Parker has sent back its first photo from its new home orbiting the Sun.

Taken by the spacecraft's WISPR (Wide-field Imager for Solar Probe) instrument, the image shows a coronal streamer, also known as a helmet streamer - a loop of electrically charged coronal gases and plasma connecting two regions of opposite polarity on the Sun, extended by the Solar wind.

Usually pictures we obtain of these streamers look more like this, so, from a distance of just 27.2 million kilometres (16.9 million miles), Parker is already providing a much more detailed perspective of the streamer's structure, with at least two visible rays.

That bright dot you see is actually Mercury, waving from the background. Hi, Mercury! And the black dots are an artefact from background correction.

NASA hasn't told us what temperatures were like at the time Parker snapped this shot, but the probe is equipped with state-of-the-art heat shielding that will protect it up to the temperatures of 1,644 Kelvin (1,370 degrees Celsius or 2,500 degrees Fahrenheit) it's expected to reach.
The next flyby is slated to begin on April 4 next year, but scientists have plenty to sink their teeth into for the time being.

"We don't know what to expect so close to the Sun until we get the data, and we'll probably see some new phenomena," said Parker project scientist Nour Raouafi.

"Parker is an exploration mission - the potential for new discoveries is huge."

Source: Science Alert

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3. NASA's Juno Mission Halfway to Jupiter Science

On Dec. 21, at 8:49:48 a.m. PST (11:49:48 a.m. EST) NASA's Juno spacecraft will be 3,140 miles (5,053 kilometers) above Jupiter's cloud tops and hurtling by at a healthy clip of 128,802 mph (207,287 kilometers per hour). This will be the 16th science pass of the gas giant and will mark the solar-powered spacecraft's halfway point in data collection during its prime mission.

Juno is in a highly-elliptical 53-day orbit around Jupiter. Each orbit includes a close passage over the planet's cloud deck, where it flies a ground track that extends from Jupiter's north pole to its south pole.

"With our 16th science flyby, we will have complete global coverage of Jupiter, albeit at coarse resolution, with polar passes separated by 22.5 degrees of longitude," said Jack Connerney, Juno deputy principal investigator from the Space Research Corporation in Annapolis, Maryland. "Over the second half of our prime mission - science flybys 17 through 32 - we will split the difference, flying exactly halfway between each previous orbit. This will provide coverage of the planet every 11.25 degrees of longitude, providing a more detailed picture of what makes the whole of Jupiter tick."

Launched on Aug. 5, 2011, from Cape Canaveral, Florida, the spacecraft entered orbit around Jupiter on July 4, 2016. Its science collection began in earnest on the Aug. 27, 2016, flyby. During these flybys, Juno's suite of sensitive science instruments probes beneath the planet's obscuring cloud cover and studies Jupiter's auroras to learn more about the planet's origins, interior structure, atmosphere and magnetosphere.

"We have already rewritten the textbooks on how Jupiter's atmosphere works, and on the complexity and asymmetry of its magnetic field," said Scott Bolton, principal investigator of Juno, from the Southwest Research Institute in San Antonio. "The second half should provide the detail that we can use to refine our understanding of the depth of Jupiter's zonal winds, the generation of its magnetic field, and the structure and evolution of its interior."

Two instruments aboard Juno, the Stellar Reference Unit and JunoCam, have proven to be useful not only for their intended purposes, but also for science data collection. The Stellar Reference Unit (SRU) was designed to collect engineering data used for navigation and attitude determination, so the scientists were pleased to find that it has scientific uses as well.

"We always knew the SRU had a vital engineering job to do for Juno," said Heidi Becker, Juno's radiation monitoring investigation lead at NASA's Jet Propulsion Laboratory in Pasadena, California. "But after making
scientific discoveries in Jupiter's radiation belts and taking a first-of-its-kind image of Jupiter's ring, we realized the added value of the data. There is serious scientific interest in what the SRU can tell us about Jupiter."

The JunoCam imager was conceived as an outreach instrument to bring the excitement and beauty of Jupiter exploration to the public.

"While originally envisioned solely as an outreach instrument to help tell the Juno story, JunoCam has become much more than that," said Candy Hansen, Juno co-investigator at the Planetary Science Institute in Tucson, Arizona. "Our time-lapse sequences of images over the poles allow us to study the dynamics of Jupiter's unique circumpolar cyclones and to image high-altitude hazes. We are also using JunoCam to study the structure of the Great Red Spot and its interaction with its surroundings."

Source: JPL
The Night Sky

**Plan ahead:** Venus will occult a 6th-magnitude star on the morning of December 21st for parts of eastern and central North America. But this observation will be tricky! See December 20th below.

**Friday, December 14**

- Mars shines above the Moon in early evening. Mars is about twice as big as the Moon in physical diameter, but it's currently 425 times farther away that Mars.

Look far below them for Fomalhaut. At a distance of 25 light-years, Fomalhaut is 1.4 million times farther than Mars.

- **Comet 46P/Wirtanen** may or may not be visible in your binoculars, much less to the naked eye, as it sails only 7 million miles by Earth this week. It’s 3rd or 4th magnitude but very spread out, and moonlight is becoming a problem. Try for it tonight or tomorrow while the Moon is still only about first quarter. The comet will appear very large (its coma is at least 1° wide) and ghostly dim, perhaps much dimmer than your light pollution and moonlight. See [Comet 46P/Wirtanen Approaches Earth](#) for more info and a detailed enough finder chart. And keep your expectations low, regardless of uninformed media hype.

**Saturday, December 15**

- First-quarter Moon (exact at 6:49 a.m. on this date). The Moon shines in the south after dusk with Mars about 10° (a fist at arm’s length) to its right, under the Great Square of Pegasus.

- Orion is in good view in the south after dinnertime now. Gemini is to its left (as seen from the world's mid-northern latitudes). The head stars of the Gemini twins, Castor and Pollux, are at the left end of the Gemini constellation — one over the other, with Castor on top.

High above Orion is Aldebaran, at one tip of the V-shaped asterism made by the brightest stars of the Hyades cluster.

And high above Aldebaran and the Hyades are the Pleiades, a smaller but brighter cluster. The Pleiades are about as big as your fingertip at arm’s length. The Hyades are 150 light-years distant and the Pleiades are about 440, which is the only reason why the Pleiades appear smaller.

Far to their left shines bright Capella, magnitude zero.

**Sunday, December 16**
• Have you ever watched a Sirius-rise? Find an open view right down to the east-southeast horizon, and watch for Sirius to come up about two fists at arm's length below Orion's vertical belt. Sirius rises sometime around 8 p.m. this week, depending on the date and your location.

When a star is very low, it tends to twinkle quite slowly and often in vivid colors. Sirius is bright enough to show these effects well, especially with binoculars.

**Monday, December 17**

• The Summer Triangle is sinking lower in the west after dusk, and Altair is the first of its stars to go (for mid-northern observers). Start by spotting bright, zero-magnitude Vega in the northwest right after dark. The brightest star above Vega is Deneb. Altair, the Triangle's third star, is farther to Vega's left or lower left. How late into the evening, and into the advancing season, can you keep Altair in view?

**Tuesday, December 18**

• For the next few days the asteroid 6 Hebe, magnitude 8.6, is passing just south of the dim Rosette Nebula in Monoceros with its central star group NGC 2244. They're high in late evening. See the article and finder chart in the December *Sky & Telescope*, page 50.

Source:  *Sky & Telescope* 

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ISS Sighting Opportunities

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

NASA-TV Highlights
(all times Eastern Daylight Time)

December 14, Friday
12 p.m. – SpaceCast Weekly (All Channels)
2 p.m. - NASA in Silicon Valley Live - Exploring Space with the World’s Largest Flying Telescope (Public Channel)
4 p.m., 8 p.m. – Replay of SpaceCast Weekly (All Channels)
10 p.m. - Replay of SpaceCast Weekly (Public Channel)

December 18, Tuesday
10:50 a.m. - Canadian Space Agency hosts in-flight event with astronaut David Saint-Jacques (Media Channel only in native language)
4:40 p.m. - International Space Station Change of Command Ceremony (All Channels)

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

- Dec 14 - 5th Anniversary (2013), Chang'e 3, Moon Landing (China)
- Dec 14 - Comet 137P/Shoemaker-Levy Perihelion (1.929 AU)
- Dec 14 - Comet 198P/ODAS Perihelion (2.006 AU)
- Dec 14 - Comet C/2018 V4 (Africano) Closest Approach To Earth (2.383 AU)
- Dec 14 - Comet C/2018 F1 (Grauer) Perihelion (2.993 AU)
- Dec 14 - Comet P/2012 G1 (PANSTARRS) At Opposition (3.714 AU)
- Dec 14 - Comet 73P-BM/Schwassmann-Wachmann At Opposition (3.959 AU)
- Dec 14 - Comet 73P-BA/Schwassmann-Wachmann At Opposition (3.960 AU)
- Dec 14 - Comet 73P-BH/Schwassmann-Wachmann At Opposition (3.960 AU)
- Dec 14 - Comet 73P-BI/Schwassmann-Wachmann At Opposition (3.960 AU)
- Dec 14 - Comet 73P-BE/Schwassmann-Wachmann At Opposition (3.962 AU)
- Dec 14 - Comet 73P-V/Schwassmann-Wachmann At Opposition (3.973 AU)
- Dec 14 - Apollo Asteroid 2018 XE2 Near-Earth Flyby (0.027 AU)
- Dec 14 - Amor Asteroid 2018 VS9 Near-Earth Flyby (0.083 AU)
- Dec 14 - Asteroid 289586 Shackleton Closest Approach To Earth (1.394 AU)
- Dec 14 - Asteroid 15614 Pillinger Closest Approach To Earth (2.147 AU)
- Dec 14 - Plutino 84922 (2003 VS2) At Opposition (35.694 AU)
- Dec 14 - Plutino 307463 (2002 VU130) At Opposition (38.981 AU)
- Dec 14 - 15th Anniversary (2003), Nozomi, Mars Flyby
- Dec 14 - Laura Ingalls’ 125th Birthday (1893)
- Dec 15 - VCLS 1/ CeREs/ ALBus/ CHOMPTT/ Da Vinci/ ISX (CP 11)/ NMTSat/ RSat-P/ Shields 1/ STF 1/ CubeSail 1 & 2/ TOMSat EagleScout (AeroCube 11A) & TOMSat R3 (AeroCube 11B)/ SHFT 1 Electron Launch
- Dec 15 - Ziyuan 2D/BNU-1/Tianyi MV-1 CZ-4B Launch
- Dec 15 - Mercury At Its Greatest Western Elongation (21 Degrees)
- Dec 15 - Asteroid 433 Eros Occults TYC 3731-303-1 (10.5 Magnitude Star)
- Dec 15 - Apollo Asteroid 2018 VO9 Near-Earth Flyby (0.007 AU)
- Dec 15 - Apollo Asteroid 2018 XH1 Near-Earth Flyby (0.030 AU)
- Dec 15 - Asteroid 2247 Hiroshima Closest Approach To Earth (1.280 AU)
- Dec 15 - Asteroid 2710 Veverka Closest Approach To Earth (1.457 AU)
- Dec 15 - Asteroid 5203 Pavarotti Closest Approach To Earth (1.541 AU)
- Dec 15 - Asteroid 2161 Grissom Closest Approach To Earth (1.565 AU)
- Dec 15 - Asteroid 5661 Hildebrand Closest Approach To Earth (3.417 AU)
- Dec 15 - 40th Anniversary (1978), Nuevo Mercurio Meteorite Shower (Hit Houses in Mexico)
- Dec 15-17 - SpaceLand Forum, Mauritius
- Dec 16 - Comet 232P/Hill At Opposition (2.079 AU)
- Dec 16 - Comet 340P/Boattini At Opposition (3.493 AU)
- Dec 16 - Comet 73P-AA/Schwassmann-Wachmann At Opposition (3.966 AU)
- Dec 16 - Comet C/2015 X5 (PANSTARRS) At Opposition (6.485 AU)
- Dec 16 - Asteroid 433 Eros Occults TYC 3731-1111-1 (11.4 Magnitude Star)
- Dec 16 - Apollo Asteroid 2018 WM2 Near-Earth Flyby (0.055 AU)
- Dec 16 - Asteroid 9997 COBE Closest Approach To Earth (1.288 AU)
- Dec 16 - Asteroid 4150 Starr Closest Approach To Earth (1.436 AU)
- Dec 16 - Asteroid 4147 Lennon Closest Approach To Earth (1.540 AU)
- Dec 16 - Asteroid 1604 Tombaugh Closest Approach To Earth (2.066 AU)
- Dec 16 - 80th Anniversary (1938), Meteorite Fall in Ivuna, Tanzania
- Dec 16 - Alexander Clarke's 190th Birthday (1828)
Dec 17 - Comet 46P/Wirtanen Near-Earth Flyby (0.078 AU)
Dec 17 - Comet 38P/Stephan-Oterma Closest Approach To Earth (0.766 AU)
Dec 17 - Comet 87P/Bus At Opposition (2.703 AU)
Dec 17 - Apollo Asteroid 6239 Minos Closest Approach To Earth (0.956 AU)
Dec 17 - Asteroid 16425 Chuckyeager Closest Approach To Earth (1.515 AU)
Dec 17 - Kuiper Belt Object 19521 Chaos At Opposition (40.318 AU)
Dec 17 - 60th Anniversary (1958), Project Mercury Created
Dec 17 - 115th Anniversary (1903), Wright Brothers’ First Airplane Flight
Dec 17 - Josep Comas Sola’s 150th Birthday (1868)
Dec 17 - [Dec 14] KH-11 17 (Crystal 17, NROL-71) Delta 4H Launch
Dec 17 - CSO 1 Soyuz 2-1b (Soyuz ST-B) Launch
Dec 17 - GPS 3-01 Falcon 9 Launch
Dec 18 - Comet 159P/LONEOS Closest Approach To Earth (2.868 AU)
Dec 18 - Comet 297P/Beshore At Opposition (3.195 AU)
Dec 18 - [Dec 13] Amor Asteroid 2018 XK2 Near-Earth Flyby (0.082 AU)
Dec 18 - [Dec 12] Apollo Asteroid 2018 XG1 Near-Earth Flyby (0.089 AU)
Dec 18 - Asteroid 5676 Voltaire Closest Approach To Earth (1.514 AU)
Dec 18 - Asteroid 3351 Smith Closest Approach To Earth (1.832 AU)

Source: JPL Space Calendar
Food for Thought

Branson looks ahead to beginning commercial SpaceShipTwo flights

With a first flight to the edge of space under the company’s belt, Virgin Galactic founder Richard Branson believes commercial flights of SpaceShipTwo could begin some time next year.

An exuberant Branson took the stage at the Mojave Air and Space Port here to congratulate the company and its employees for a successful test flight Dec. 13 of the SpaceShipTwo vehicle named VSS Unity, which reached a peak altitude of 82.7 kilometers. The flight was the first by the vehicle to cross the boundary of 50 miles, or approximately 80 kilometers, that U.S. government agencies use to award astronaut wings.

“How on Earth do I describe the feeling?” he said on stage, referring to his emotions from watching the successful test flight. “Joy? Definitely. Relief? Emphatically. Exhilaration? Absolutely.”

Offstage, a more subdued Branson, huddling with a group of reporters, said he shed “tears of relief” after the successful flight. “When you are in the test flight program of a space company, you can never be completely, 100 percent sure, because that’s what a test flight program is,” he said. “The spaceship was tested to its limits today and she performed just as we wished and we just couldn’t be happier.”

This flight does not mark the end of the test flight program for SpaceShipTwo. “We will now push on with the remaining portion of our flight test program, which will see the rocket motor burn for longer, and VSS Unity fly still faster and higher,” he said onstage.

On the Dec. 13 test flight, SpaceShipTwo’s hybrid rocket motor burned for 60 seconds, several seconds longer than the high end of estimates of the burn time company officials gave at a briefing the day before. George Whitesides, chief executive of Virgin Galactic, said after this flight that a full-duration burn would last approximately five seconds longer.
Branson was optimistic that the next test flight could take place in the near future after a review of data from this flight. “If nothing shows up that needs to be changed, then the next test flight could be quite soon,” he told reporters, suggesting that could happen in roughly a month.

He also stated that, if all goes well, only a few more test flights would be needed before Virgin Galactic would be ready to shift operations to Spaceport America in New Mexico, where the company plans to perform commercial flights. “Ideally, we want to do three more flights before we go to New Mexico.”

Whitesides said upcoming test flights would include flying company employees in the vehicle along with pilots in order to test operational procedures for future flights that will carry spaceflight participants. “Once we’ve gotten through that, we could start thinking about doing commercial flights,” he said, not giving a specific number of test flights planned beyond “not a huge number.”

Branson confirmed that he still planned to be on the first commercial flight of SpaceShipTwo from Spaceport America. “Sometime next year, once the testing is finished, then I’ll do my flight,” he said.

The company plans to grow the fleet of vehicles supporting commercial operations. Besides VSS Unity, two more SpaceShipTwo vehicles are currently under construction, with the first of them expected to be completed in about a year. Branson said the company would “soon” start building two more SpaceShipTwo vehicles as well as a second WhiteKnightTwo carrier aircraft.

Virgin Galactic has about 700 customers who have either paid the full price of a ticket or a deposit. “We stopped for the last four years taking new reservations,” he said, but will start taking reservations again soon.

Those new customers might be paying more than the $250,000 price previously offered by the company. “What will happen in the short term is that the price will go up a bit,” he said. “And then, in the next most likely three years, it will start coming down.” He didn’t specify the size of the increase or by how much the price would later decrease.

“Space is not cheap,” he said. “I’ve personally invested about a billion dollars into this project.” He said that the total investment was about $1.3 to 1.5 billion, a total Whitesides said later included not just Virgin Galactic but also spacecraft manufacturer The Spaceship Company and small launch vehicle firm Virgin Orbit.

Branson suggested that he may be looking for additional investors into the company. Virgin Group announced an agreement with the Public Investment Fund of Saudi Arabia in October 2017 that would have resulted in a $1 billion investment in Virgin’s space companies. However, Branson said in October that he had terminated the deal in reaction to the murder of journalist Jamal Khashoggi by the Saudi government.

“We said no to the Saudi money because of the Khashoggi incident,” he said. “By being successful today, I suspect we’ll bring in other investors to help us take it on to the next stage.”

Source: [Space News](http://www.spacenews.com)

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Space Image of the Week

Mars InSight Lander Seen in First Images from Space

NASA's InSight spacecraft (left), its heat shield (middle) and its parachute (right) were imaged on Dec. 6 and 11 by the HiRISE camera onboard NASA's Mars Reconnaissance Orbiter.

In images released Dec. 13, the three new features on the Martian landscape appear teal. That's not their actual color: Light reflected off their surfaces cause the color to be saturated. The ground around the lander is dark, blasted by its retorockets during descent. Look carefully for a butterfly shape, and you can make out the lander's solar panels on either side.

Source:  JPL