Space News Update

— August 15, 2017 —

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1. SpaceX Launches Cargo Capsule Full of Science Experiments

Credit: SpaceX

A SpaceX Falcon 9 rocket climbed into space Monday from NASA's Kennedy Space Center atop a column of gleaming exhaust, shooting a commercial resupply vessel toward the International Space Station with research projects looking into cosmic rays, the origin of Parkinson's disease, the utility of small satellites and an experimental radiation-tolerant supercomputer.

Crammed with more than 6,400 pounds (2,900 kilograms) of supplies, the Dragon capsule bolted on top of the Falcon 9 rocket also carried computer and camera gear, components to maintain the station's life support system and medical equipment, and provisions for the station's six-person crew, including clothing, fresh food and ice cream.

In a maneuver now common during SpaceX launches, the first stage flipped around with guided pulses of cold nitrogen gas to point tail first, then reignited three of its Merlin engines to boost itself back forward Cape Canaveral.

"From what I've heard, it's right on the bullseye and (had a) very soft touchdown, so it's a great pre-flown booster ready to go for the next time," said Hans Koenigsmann, SpaceX's vice president of flight reliability.

SpaceX has reused two of its recovered first stage boosters to date, and engineers are prepping another previously-flown rocket for a mission with an SES communications satellite this fall.

The supply ship's power-generating solar arrays extended shortly after it arrived in space, while the Falcon 9's second stage reignited for a de-orbit maneuver to avoid the creation of space junk.

The automated cargo freighter will reach its destination Wednesday, when astronaut Jack Fischer will take command of the space station's Canadian-built robotic arm to capture the commercial spaceship around 7 a.m. EDT (1100 GMT). The robotic arm will install Dragon on the space station's Harmony module for a planned 32-day stay.

While astronauts inside the station will unpack cargo inside Dragon's internal cabin, the Canadian and Japanese robotic arms will transfer a NASA-funded cosmic ray sensor to a mounting post outside the Kibo laboratory.

Derived from an instrument carried aloft on high-altitude balloons, the Cosmic Ray Energetics and Mass, or CREAM, payload will spend at least three years sampling particles sent speeding through the universe by cataclysmic supernova explosions, and perhaps other exotic phenomena like dark matter.

Scientists think the subatomic particles could hold the key to unlocking mysteries about the universe.

One experiment stowed inside the capsule's pressurized section will investigate the origins of Parkinson's disease in a bid to find a therapy that could slow or halt its development, and another will study the affects of spaceflight on the development of bioengineered lung tissue, potentially helping scientists lessen the chance of organ rejection in transplant patients.

A supercomputer developed by Hewlett Packard Enterprise will spend at least a year on the space station, helping engineers gauge the ruggedness of commercial computer components in the harsh conditions of space.

Most computers sent into space are physically hardened to withstand radiation, cosmic rays, and other rigors of spaceflight. Hewlett Packard said its "spaceborne computer" experiment was hardened with software, reducing the time, money and weight of the supercomputer.

The experimental computer passed at least 146 safety tests and certifications to win NASA approval for the trip to the space station. If it works, Hewlett Packard officials said it could help future space missions, including a human expedition to Mars, have the latest computer technology.

Four small satellites inside the Dragon capsule will be moved inside the space station for deployment later this year.

The biggest of the bunch, named Kestrel Eye 2M, is a pathfinder for a potential constellation of Earth-imaging spacecraft for the U.S. military. About the size of a dorm room refrigerator, the Kestrel Eye 2M satellite was developed by the Army's Space and Missile Defense Command over the last five years.

Three CubeSats sponsored by NASA will test technologies for compact telescopes that could help astronomers observe stars and search for exoplanets, demonstrate a more reliable small satellite design, and study space weather.

Monday's Falcon 9 flight was the first of three launches scheduled from Cape Canaveral in the next 11 days.

Source: SpaceflightNow.com Return to Contents

2. TRAPPIST-1 is Older Than Our Solar System

This illustration shows what the TRAPPIST-1 system might look like from a vantage point near planet TRAPPIST-1f (at right). Credits: NASA/JPL-Caltech

If we want to know more about whether life could survive on a planet outside our solar system, it's important to know the age of its star. Young stars have frequent releases of high-energy radiation called flares that can zap their planets' surfaces. If the planets are newly formed, their orbits may also be unstable. On the other hand, planets orbiting older stars have survived the spate of youthful flares, but have also been exposed to the ravages of stellar radiation for a longer period of time.

Scientists now have a good estimate for the age of one of the most intriguing planetary systems discovered to date -- TRAPPIST-1, a system of seven Earth-size worlds orbiting an ultra-cool dwarf star about 40 light-years away. Researchers say in a new study that the TRAPPIST-1 star is quite old: between 5.4 and 9.8 billion years. This is up to twice as old as our own solar system, which formed some 4.5 billion years ago.

The seven wonders of TRAPPIST-1 were revealed earlier this year in a NASA news conference, using a combination of results from the Transiting Planets and Planetesimals Small Telescope (TRAPPIST) in Chile, NASA's Spitzer Space Telescope, and other ground-based telescopes. Three of the TRAPPIST-1 planets reside in the star's "habitable zone," the orbital distance where a rocky planet with an atmosphere could have liquid water on its surface. All seven planets are likely tidally locked to their star, each with a perpetual dayside and nightside.

At the time of its discovery, scientists believed the TRAPPIST-1 system had to be at least 500 million years old, since it takes stars of TRAPPIST-1's low mass (roughly 8 percent that of the Sun) roughly that long to contract to its minimum size, just a bit larger than the planet Jupiter. However, even this lower age limit was uncertain; in theory, the star could be almost as old as the universe itself. Are the orbits of this compact system of planets stable? Might life have enough time to evolve on any of these worlds?

"Our results really help constrain the evolution of the TRAPPIST-1 system, because the system has to have persisted for billions of years. This means the planets had to evolve together, otherwise the system would have fallen apart long ago," said Adam Burgasser, an astronomer at the University of California, San Diego, and the paper's first author. Burgasser teamed up with Eric Mamajek, deputy program scientist for NASA's

Exoplanet Exploration Program based at NASA's Jet Propulsion Laboratory, Pasadena, California, to calculate TRAPPIST-1's age. Their results will be published in The Astrophysical Journal.

It is unclear what this older age means for the planets' habitability. On the one hand, older stars flare less than younger stars, and Burgasser and Mamajek confirmed that TRAPPIST-1 is relatively quiet compared to other ultra-cool dwarf stars. On the other hand, since the planets are so close to the star, they have soaked up billions of years of high-energy radiation, which could have boiled off atmospheres and large amounts of water. In fact, the equivalent of an Earth ocean may have evaporated from each TRAPPIST-1 planet except for the two most distant from the host star: planets g and h. In our own solar system, Mars is an example of a planet that likely had liquid water on its surface in the past, but lost most of its water and atmosphere to the Sun’s high-energy radiation over billions of years.

However, old age does not necessarily mean that a planet's atmosphere has been eroded. Given that the TRAPPIST-1 planets have lower densities than Earth, it is possible that large reservoirs of volatile molecules such as water could produce thick atmospheres that would shield the planetary surfaces from harmful radiation. A thick atmosphere could also help redistribute heat to the dark sides of these tidally locked planets, increasing habitable real estate. But this could also backfire in a "runaway greenhouse" process, in which the atmosphere becomes so thick the planet surface overheats – as on Venus.

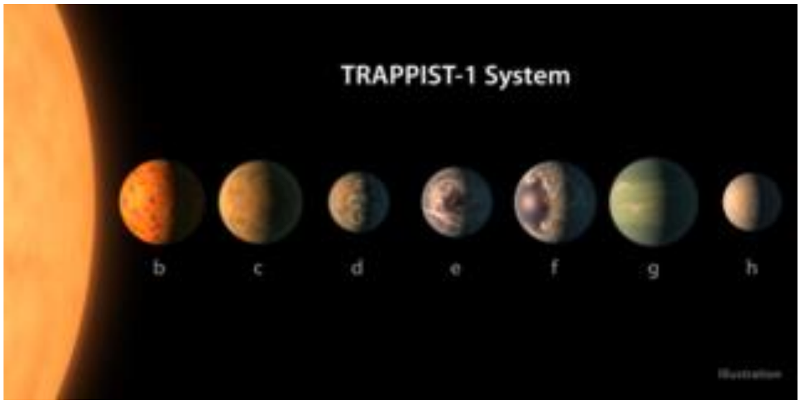
"If there is life on these planets, I would speculate that it has to be hardy life, because it has to be able to survive some potentially dire scenarios for billions of years," Burgasser said.

Fortunately, low-mass stars like TRAPPIST-1 have temperatures and brightnesses that remain relatively constant over trillions of years, punctuated by occasional magnetic flaring events. The lifetimes of tiny stars like TRAPPIST-1 are predicted to be much, much longer than the 13.7 billion-year age of the universe (the Sun, by comparison, has an expected lifetime of about 10 billion years).

"Stars much more massive than the Sun consume their fuel quickly, brightening over millions of years and exploding as supernovae," Mamajek said. "But TRAPPIST-1 is like a slow-burning candle that will shine for about 900 times longer than the current age of the universe."

Some of the clues Burgasser and Mamajek used to measure the age of TRAPPIST-1 included how fast the star is moving in its orbit around the Milky Way (speedier stars tend to be older), its atmosphere’s chemical composition, and how many flares TRAPPIST-1 had during observational periods. These variables all pointed to a star that is substantially older than our Sun.

Future observations with NASA's Hubble Space Telescope and upcoming James Webb Space Telescope may reveal whether these planets have atmospheres, and whether such atmospheres are like Earth's. Also, future observations with Spitzer could help scientists sharpen their estimates of the TRAPPIST-1 planets’ densities, which would inform their understanding of their compositions.



TRAPPIST-1 is an ultra-cool dwarf star in the constellation Aquarius, and its seven planets orbit very close to it. Credits: NASA/JPL-Caltech

Source: NASA

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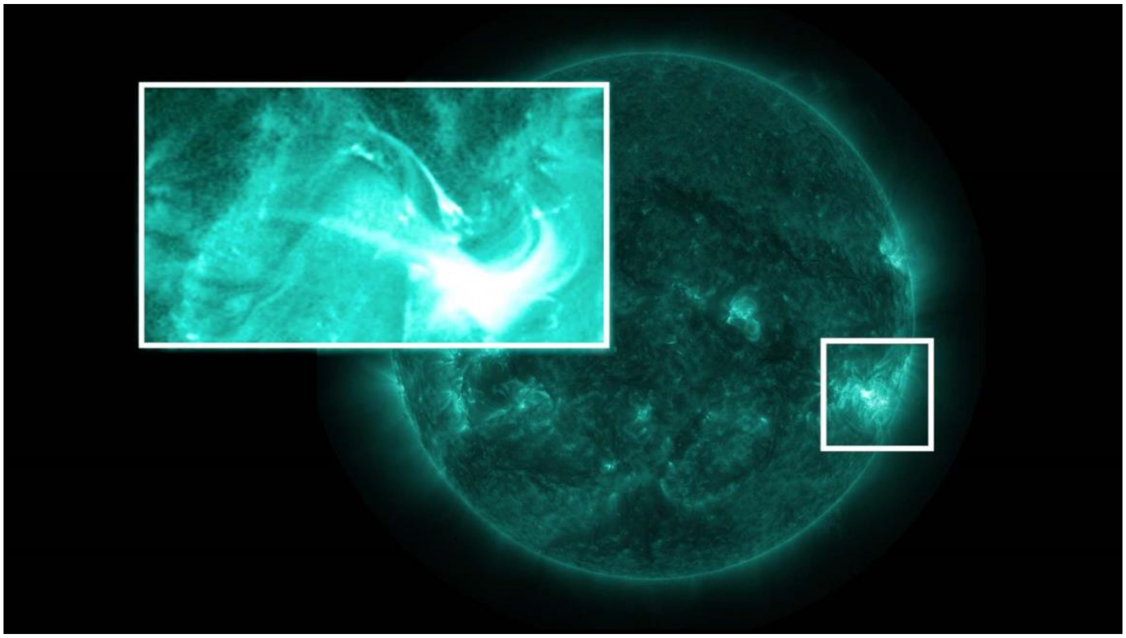
3. NASA Watches the Sun Put a Stop to Its Own Eruption



Credit: NASA's Scientific Visualization Studio

On Sept. 30, 2014, multiple NASA observatories watched what appeared to be the beginnings of a solar eruption. A filament — a serpentine structure consisting of dense solar material and often associated with solar eruptions — rose from the surface, gaining energy and speed as it soared. But instead of erupting from the Sun, the filament collapsed, shredded to pieces by invisible magnetic forces.

Because scientists had so many instruments observing the event, they were able to track the entire event from beginning to end, and explain for the first time how the Sun's magnetic landscape terminated a solar eruption. Their results are summarized in a paper published in The Astrophysical Journal on July 10, 2017.

Watch the video to view the observations and models that enabled scientists to track the failed solar eruption from its onset up through the solar atmosphere — and ultimately understand why it faded away.
https://svs.gsfc.nasa.gov/11797

"Each component of our observations was very important," said Georgios Chintzoglou, lead author of the paper and a solar physicist at Lockheed Martin Solar and Astrophysics Laboratory in Palo Alto, California, and the University Corporation for Atmospheric Research in Boulder, Colorado. "Remove one instrument, and you're basically blind. In solar physics, you need to have good coverage observing multiple temperatures — if you have them all, you can tell a nice story."

The study makes use of a wealth of data captured by NASA's Solar Dynamics Observatory, NASA's Interface Region Imaging Spectrograph, JAXA/NASA's Hinode, and several ground-based telescopes in support of the launch of the NASA-funded VAULT2.0 sounding rocket. Together, these observatories watch the Sun in dozens of different wavelengths of light that reveal the Sun's surface and lower atmosphere, allowing scientists to track the eruption from its onset up through the solar atmosphere — and ultimately understand why it faded away.

The day of the failed eruption, scientists pointed the VAULT2.0 sounding rocket — a sub-orbital rocket that flies for some 20 minutes, collecting data from above Earth's atmosphere for about five of those minutes — at an area of intense, complex magnetic activity on the Sun, called an active region. The team also collaborated with IRIS to focus its observations on the same region.

“We were expecting an eruption; this was the most active region on the Sun that day,” said Angelos Vourlidas, an astrophysicist at the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, principal investigator of the VAULT2.0 project and co-author of the paper. “We saw the filament lifting with IRIS, but we didn’t see it erupt in SDO or in the coronagraphs. That’s how we knew it failed.”

The Sun’s landscape is controlled by magnetic forces, and the scientists deduced the filament must have met some magnetic boundary that prevented the unstable structure from erupting. They used these observations as input for a model of the Sun’s magnetic environment. Much like scientists who use topographical data to study Earth, solar physicists map out the Sun’s magnetic features, or topology, to understand how these forces guide solar activity.

Chintzoglou and his colleagues developed a model that identified locations on the Sun where the magnetic field was especially compressed, since rapid releases of energy — such as those they observed when the filament collapsed — are more likely to occur where magnetic field lines are strongly distorted.

“We computed the Sun’s magnetic environment by tracing millions of magnetic field lines and looking at how neighboring field lines connect and diverge,” said Antonia Savcheva, an astrophysicist at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, and co-author of the paper. “The amount of divergence gives us a measure of the topology.”

Their model shows this topology shapes how solar structures evolve on the Sun’s surface. Typically, when solar structures with opposite magnetic orientations collide, they explosively release magnetic energy, heating the atmosphere with a flare and erupting into space as a coronal mass ejection — a massive cloud of solar material and magnetic fields.

But on the day of the Sept. 2014 near-eruption, the model indicated the filament instead pushed up against a complex magnetic structure, shaped like two igloos smashed against each other. This invisible boundary, called a hyperbolic flux tube, was the result of a collision of two bipolar regions on the sun’s surface — a nexus of four alternating and opposing magnetic fields ripe for magnetic reconnection, a dynamic process that can explosively release great amounts of stored energy.

“The hyperbolic flux tube breaks the filament’s magnetic field lines and reconnects them with those of the ambient Sun, so that the filament’s magnetic energy is stripped away,” Chintzoglou said.

This structure eats away at the filament like a log grinder, spraying chips of solar material and preventing eruption. As the filament waned, the model demonstrates heat and energy were released into the solar atmosphere, matching the initial observations. The simulated reconnection also supports the observations of bright flaring loops where the hyperbolic flux tube and filament met — evidence for magnetic reconnection.

While scientists have speculated such a process exists, it wasn’t until they serendipitously had multiple observations of such an event that they were able to explain how a magnetic boundary on the Sun is capable of halting an eruption, stripping a filament of energy until it’s too weak to erupt.

This study indicates the Sun’s magnetic topology plays an important role in whether or not an eruption can burst from the Sun. These eruptions can create space weather effects around Earth.

“Most research has gone into how topology helps eruptions escape,” Chintzoglou said. “But this tells us that apart from the eruption mechanism, we also need to consider what the nascent structure encounters in the beginning, and how it might be stopped.”

Source: NASA Return to Contents

The Night Sky

Tuesday, August 15

- In early dawn Wednesday morning the 16th, look east for the waning Moon near Aldebaran, as shown here. Below them is Orion, with his three-star belt nearly vertical.

Wednesday, August 16

- The two brightest stars of summer are Vega, overhead soon after dark, and Arcturus, shining in the west. Vega is a white-hot, type-*A* star 25 light-years away. Arcturus is a yellow-orange-hot, type-*K* giant 37 light-years distant. Their color difference is clear to the unaided eye.

Thursday, August 17

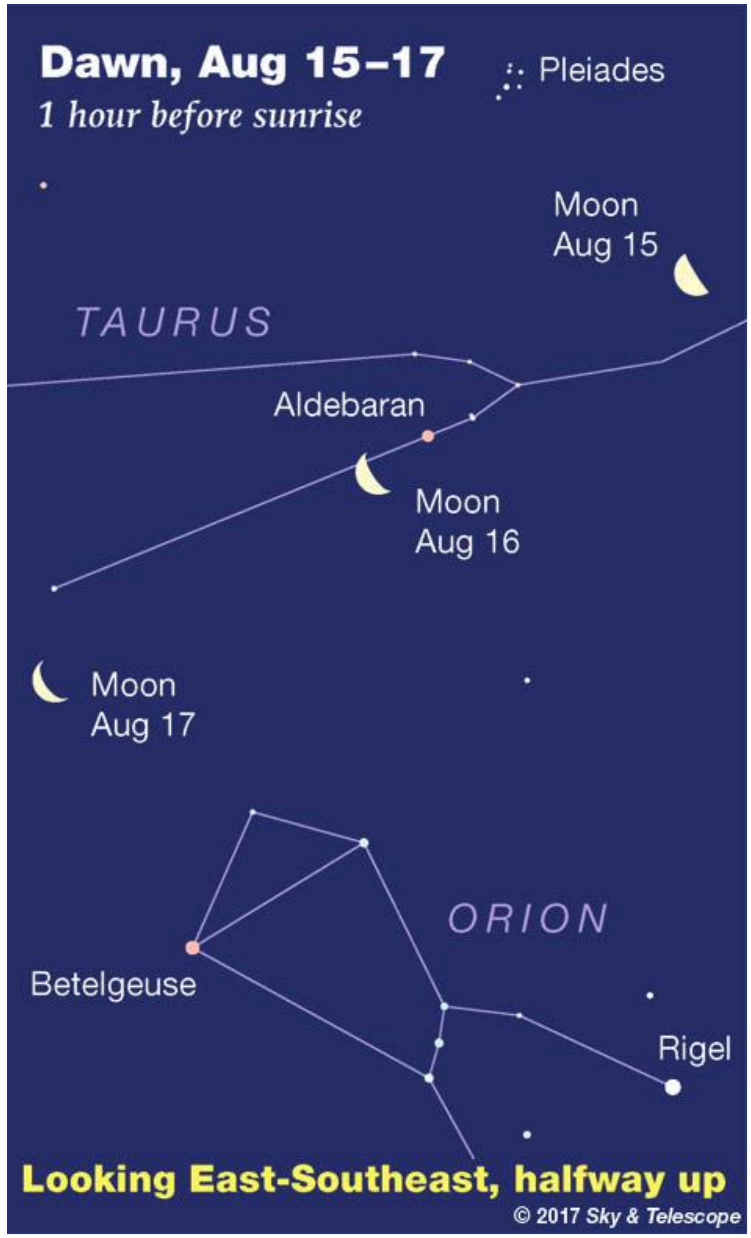
- The W of Cassiopeia, tilting a little, is nicely up in the northeast these evenings. Its upper, right-hand side is the brightest. Watch it rise higher and tilt further through the night and through the next few months.
- In early dawn Friday morning the 18th, the waning crescent Moon hangs in the east with bright Venus to its lower left, as shown here. Look left or upper left of Venus for Pollux and Castor.

Friday, August 18

- In early dawn Saturday morning the 19th, the waning Moon is under Venus low in the east, as shown here. Pollux and Castor are still to Venus's left or upper left.

Saturday, August 19

- August is prime Milky Way time, and the evening sky is now moonless. After dark, the Milky Way runs from Sagittarius in the south, up and left across Aquila and through the big Summer Triangle very high in the east, and on down through Cassiopeia to Perseus rising low in the north-northeast.



On the morning of the 16th, Venus shines with Aldebaran high above Orion.

Source: [Sky and Telescope]

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ISS Sighting Opportunities (from Denver)

No ISS sightings are possible from Friday Aug 11, 2017 through Sunday Aug 27, 2017

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

NASA-TV Highlights (all times Eastern Time Zone)

Tuesday, August 15

- 10:30 a.m. - ISS Expedition 52 In-Flight Media Event with Hearst Magazines/Women's Day and NASA Flight Engineer Peggy Whitson (Starts at 10:45 a.m.) (all channels)

Wednesday, August 16

- 5:30 a.m. - Coverage of the Rendezvous and Grapple of the SpaceX/Dragon Cargo Craft at the ISS (Grapple scheduled at approximately 7 a.m. ET) (NTV-1 (Public))
- 6 a.m. - Live Interviews on the 2017 Historic Solar Eclipse – It's Only Days Away (NTV-3 (Media))
- 8:30 a.m. - Coverage of the Installation of the SpaceX/Dragon CRS-12 Cargo Craft to the Harmony Module of the ISS (all channels)
- 3 p.m. - Live Interviews on the 2017 Historic Solar Eclipse – It's Only Days Away (NTV-3 (Media))

Thursday, August 17

- 9 a.m. - TDRS-M Prelaunch News Conference (all channels)
- 10 a.m. - Coverage of ISS Expedition 52 Russian Spacewalk #43 (Yurchikhin and Ryazanskiy; spacewalk begins at 10:45 a.m. ET) (all channels)
- 2 p.m. - TDRS-M NASA Social (NTV-3 (Media))

Friday, August 18

- 7:30 a.m. - TDRS-M Launch Commentary (all channels)
- 10 a.m. - ISS Expedition 52 In-Flight Interview with the ZDF Network, Germany for the European Space Agency and ESA Flight Engineer Paolo Nespoli (In native language) (starts at 10:15 a.m.) (NTV-3 (Media))

Watch NASA TV online by going to the NASA website. Return to Contents

Space Calendar

- Aug 15 - Comet 116P/Wild At Opposition (2.882 AU)
- Aug 15 - Comet P/2010 B2 (WISE) At Opposition (3.450 AU)
- Aug 15 - Comet P/2009 WX51 (Catalina) At Opposition (4.198 AU)
- Aug 15 - Comet 95P/Chiron Occults 2UCAC 32806659 (14.3 Magnitude Star)
- Aug 15 - Apollo Asteroid 414990 (2011 EM51) Near-Earth Flyby (0.078 AU)
- Aug 15 - Apollo Asteroid 1566 Icarus Closest Approach To Earth (1.109 AU)
- Aug 15 - Asteroid 3933 Portugal Closest Approach To Earth (1.966 AU)
- Aug 15 - Regional Meeting of the International Academy of Astronautics, Pasadena, California
- Aug 15 - Lecture: Venus - The Forgotten, Mysterious Planet, Washington DC
- Aug 15-17 - Low-Cost Planetary Missions Conference (LCPM-12), Pasadena, California
- Aug 15-18 - Conference: Accretion - Building New Worlds, Houston, Texas
- **Aug 16 - Zhangheng 1 (CSES 1)/ NuSat 4 (Aleph-1 4)/NuSat 5 (Aleph-1 5)/ GOMX 4A (Ulloriaq)/GOMX 4B/ Fengmaniu 1/ Shaonian Xing CZ-2D Launch**
- Aug 16 - Moon Occults Aldebaran
- Aug 16 - Comet 77P/Longmore At Opposition (2.601 AU)
- Aug 16 - Comet 3D/Biela At Opposition (2.887 AU)
- Aug 16 - Apollo Asteroid 2017 PD25 Near-Earth Flyby (0.025 AU)
- Aug 16 - Apollo Asteroid 2017 HV3 Near-Earth Flyby (0.099 AU)
- Aug 16 - Asteroid 37582 Faraday Closest Approach To Earth (0.952 AU)
- Aug 16 - Asteroid 2713 Luxemburg Closest Approach To Earth (1.798 AU)
- **Aug 17 - Blagovest 1 Proton-M Briz-M Launch**
- Aug 17 - Asteroid 5335 Damocles (Burnt Out Comet) At Opposition (19.684 AU)
- Aug 17 - Comet 69P/Taylor At Opposition (3.139 AU)
- Aug 17 - Comet C/2015 H2 (PANSTARRS) At Opposition (4.644 AU)
- Aug 17 - Apollo Asteroid 2002 CY58 Near-Earth Flyby (0.068 AU)
- Aug 17 - Apollo Asteroid 2016 CD137 Near-Earth Flyby (0.099 AU)
- Aug 17 - Asteroid 5107 Laurenbacall Closest Approach To Earth (2.271 AU)
- Aug 17-18 - Chrusciel-Fest Symposium: A Panorama of GR, Vienna, Austria
- Aug 17-19 - Workshop: eXtreme Matter Meets eXtreme Gravity, Bozeman, Montana
- **Aug 18 - TDRS M Atlas 5 Launch**
- Aug 18 - Comet P/2010 P4 (WISE) Perihelion (1.861 AU)
- Aug 18 - Comet 164P/Christensen Closest Approach To Earth (2.026 AU)
- Aug 18 - Apollo Asteroid 2012 BD14 Near-Earth Flyby (0.067 AU)
- Aug 18 - Atira Asteroid 2015 ME131 Closest Approach To Earth (0.424 AU)
- Aug 18 - Asteroid 13208 Fraschetti Closest Approach To Earth (0.964 AU)
- Aug 18 - Lunar and Planetary Laboratory Conference, Tucson, Arizona

Source: JPL Space Calendar

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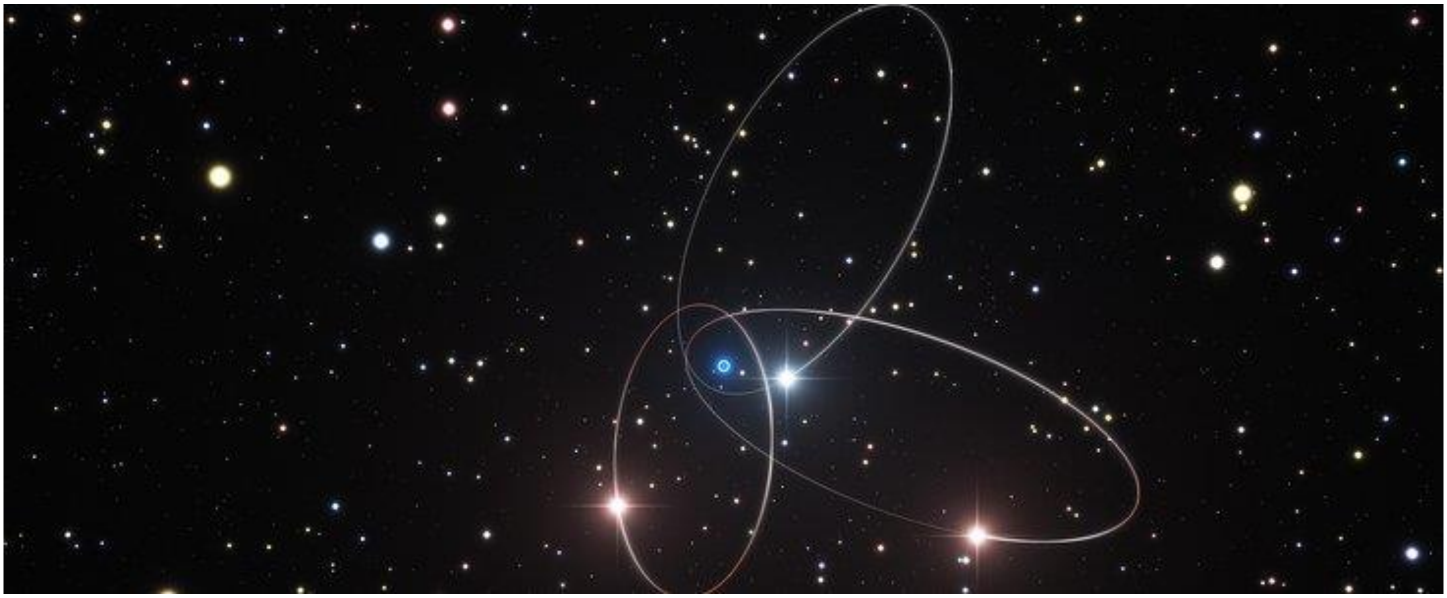
Food for Thought

Hint of Relativity Effects in Stars Orbiting Supermassive Black Hole at Center of Galaxy



Artist's impression of the orbits of stars close to the Galactic Centre

A new analysis of data from ESO's Very Large Telescope and other telescopes suggests that the orbits of stars around the supermassive black hole at the center of the Milky Way may show the subtle effects predicted by Einstein's general theory of relativity. There are hints that the orbit of the star S2 is deviating slightly from the path calculated using classical physics. This tantalizing result is a prelude to much more precise measurements and tests of relativity that will be made using the GRAVITY instrument as star S2 passes very close to the black hole in 2018.

At the center of the Milky Way, 26 000 light-years from Earth, lies the closest supermassive black hole, which has a mass four million times that of the Sun. This monster is surrounded by a small group of stars orbiting at high speed in the black hole's very strong gravitational field. It is a perfect environment in which to test gravitational physics, and particularly Einstein's general theory of relativity.

A team of German and Czech astronomers have now applied new analysis techniques to existing observations of the stars orbiting the black hole, accumulated using ESO's Very Large Telescope (VLT) in Chile and others over the last twenty years. They compare the measured star orbits to predictions made using classical Newtonian gravity as well as predictions from general relativity.

The team found suggestions of a small change in the motion of one of the stars, known as S2 that is consistent with the predictions of general relativity. The change due to relativistic effects amounts to only a few percent in the shape of the orbit, as well as only about one sixth of a degree in the orientation of the orbit. If confirmed, this would be the first time that a measurement of the strength of the general relativistic effects has been achieved for stars orbiting a supermassive black hole.

Marzieh Parsa, PhD student at the University of Cologne, Germany and lead author of the paper, is delighted: "The Galactic Centre really is the best laboratory to study the motion of stars in a relativistic environment. I was amazed how well we could apply the methods we developed with simulated stars to the high-precision data for the innermost high-velocity stars close to the supermassive black hole."

The high accuracy of the positional measurements, made possible by the VLT's near-infrared adaptive optics instruments, was essential for the study. These were vital not only during the star's close approach to the black hole, but particularly during the time when S2 was further away from the black hole. The latter data allowed an accurate determination of the shape of the orbit.

"During the course of our analysis we realized that to determine relativistic effects for S2 one definitely needs to know the full orbit to very high precision," comments Andreas Eckart, team leader at the University of Cologne.

As well as more precise information about the orbit of the star S2, the new analysis also gives the mass of the black hole and its distance from Earth to a higher degree of accuracy.

Co-author Vladimir Karas from the Academy of Sciences in Prague, the Czech Republic, is excited about the future: "This opens up an avenue for more theory and experiments in this sector of science."

This analysis is a prelude to an exciting period for observations of the Galactic Centre by astronomers around the world. During 2018 the star S2 will make a very close approach to the supermassive black hole. This time the GRAVITY instrument, developed by a large international consortium led by the Max-Planck-Institut für extraterrestrische Physik in Garching, Germany, and installed on the VLT Interferometer, will be available to help measure the orbit much more precisely than is currently possible. Not only is GRAVITY, which is already making high-precision measurements of the Galactic Centre, expected to reveal the general relativistic effects very clearly, but also it will allow astronomers to look for deviations from general relativity that might reveal new physics.

This research was presented in a paper entitled "Investigating the Relativistic Motion of the Stars Near the Black Hole in the Galactic Center", by M. Parsa et al., to be published in the Astrophysical Journal.

Notes

- S2 is a 15-solar-mass star on an elliptical orbit around the supermassive black hole. It has a period of about 15.6 years and gets as close as 17 light-hours to the black hole — or just 120 times the distance between the Sun and the Earth.
- A similar, but much smaller, effect is seen in the changing orbit of the planet Mercury in the Solar System. That measurement was one of the best early pieces of evidence in the late nineteenth century suggesting that Newton's view of gravity was not the whole story and that a new approach and new insights were needed to understand gravity in the strong-field case. This ultimately led to Einstein publishing his general theory of relativity, based on curved spacetime, in 1915.
- When the orbits of stars or planets are calculated using general relativity, rather than Newtonian gravity, they evolve differently. Predictions of the small changes to the shape and orientation of orbits with time are different in the two theories and can be compared to measurements to test the validity of general relativity.

Source: European Southern Observatory Return to Contents

Space Image of the Week

Spiral Galaxy NGC 1512: The Inner Ring

Image Credit: NASA, ESA, Hubble Space Telescope

Explanation: Most galaxies don't have any rings -- why does this galaxy have two? To begin, the bright band near NGC 1512's center is a nuclear ring, a ring that surrounds the galaxy center and glows brightly with recently formed stars. Most stars and accompanying gas and dust, however, orbit the galactic center in a ring much further out -- here seen near the image edge. This ring is called, counter-intuitively, the inner ring. If you look closely, you will see this the inner ring connects ends of a diffuse central bar that runs horizontally across the galaxy. These ring structures are thought to be caused by NGC 1512's own asymmetries in a drawn-out process called secular evolution. The gravity of these galaxy asymmetries, including the bar of stars, cause gas and dust to fall from the inner ring to the nuclear ring, enhancing this ring's rate of star formation. Some spiral galaxies also have a third ring -- an outer ring that circles the galaxy even further out.

Source: NASA APOD Return to Contents