Space News Update

— July 27, 2018 —

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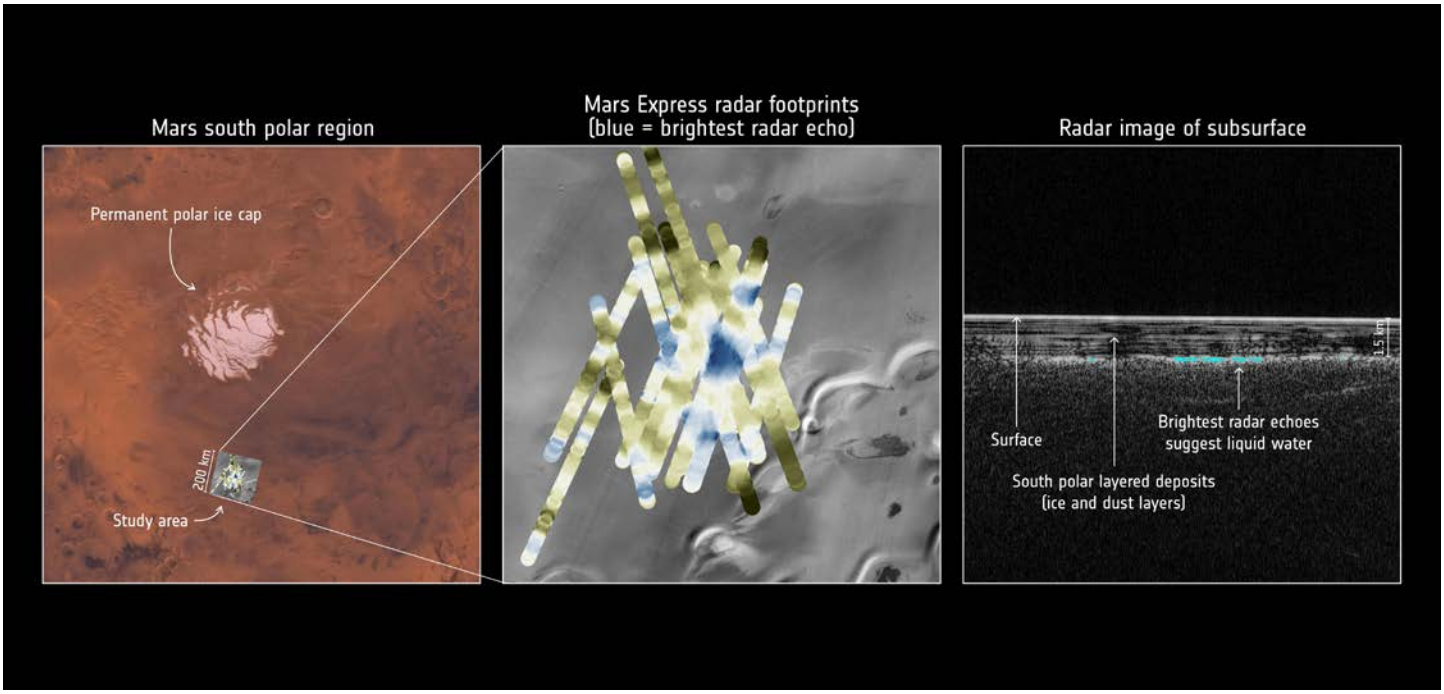
1. Mars Express Detects Liquid Water Hidden under Planet's South Pole



Radar data collected by ESA's Mars Express point to a pond of liquid water buried under layers of ice and dust in the south polar region of Mars.

Evidence for the Red Planet's watery past is prevalent across its surface in the form of vast dried-out river valley networks and gigantic outflow channels clearly imaged by orbiting spacecraft. Orbiters, together with landers and rovers exploring the martian surface, also discovered minerals that can only form in the presence of liquid water.

But the climate has changed significantly over the course of the planet's 4.6 billion year history and liquid water cannot exist on the surface today, so scientists are looking underground. Early results from the 15-year old Mars Express spacecraft already found that water-ice exists at the planet's poles and is also buried in layers interspersed with dust.

The presence of liquid water at the base of the polar ice caps has long been suspected; after all, from studies on Earth, it is well known that the melting point of water decreases under the pressure of an overlying glacier. Moreover, the presence of salts on Mars could further reduce the melting point of water and keep the water liquid even at below-freezing temperatures.

But until now evidence from the Mars Advanced Radar for Subsurface and Ionosphere Sounding instrument, MARSIS, the first radar sounder ever to orbit another planet, remained inconclusive.

It has taken the persistence of scientists working with this subsurface-probing instrument to develop new techniques in order to collect as much high-resolution data as possible to confirm their exciting conclusion.

Ground-penetrating radar uses the method of sending radar pulses towards the surface and timing how long it takes for them to be reflected back to the spacecraft, and with what strength. The properties of the material that lies between influences the returned signal, which can be used to map the subsurface topography.

The radar investigation shows that south polar region of Mars is made of many layers of ice and dust down to a depth of about 1.5 km in the 200 km-wide area analysed in this study. A particularly bright radar reflection underneath the layered deposits is identified within a 20 km-wide zone.

Analysing the properties of the reflected radar signals and considering the composition of the layered deposits and expected temperature profile below the surface, the scientists interpret the bright feature as an interface between the ice and a stable body of liquid water, which could be laden with salty, saturated sediments. For MARSIS to be able to detect such a patch of water, it would need to be at least several tens of centimetres thick.

"This subsurface anomaly on Mars has radar properties matching water or water-rich sediments," says Roberto Orosei, principal investigator of the MARSIS experiment and lead author of the paper published in the journal *Science* today.

"This is just one small study area; it is an exciting prospect to think there could be more of these underground pockets of water elsewhere, yet to be discovered."

"We'd seen hints of interesting subsurface features for years but we couldn't reproduce the result from orbit to orbit, because the sampling rates and resolution of our data was previously too low," adds Andrea Cicchetti, MARSIS operations manager and a co-author on the new paper.

"We had to come up with a new operating mode to bypass some onboard processing and trigger a higher sampling rate and thus improve the resolution of the footprint of our dataset: now we see things that simply were not possible before."

The finding is somewhat reminiscent of Lake Vostok, discovered some 4 km below the ice in Antarctica on Earth. Some forms of microbial life are known to thrive in Earth's subglacial environments, but could underground pockets of salty, sediment-rich liquid water on Mars also provide a suitable habitat, either now or in the past? Whether life has ever existed on Mars remains an open question, and is one that Mars missions, including the current European-Russian ExoMars orbiter and future rover, will continue to explore.

"The long duration of Mars Express, and the exhausting effort made by the radar team to overcome many analytical challenges, enabled this much-awaited result, demonstrating that the mission and its payload still have a great science potential," says Dmitri Titov, ESA's Mars Express project scientist.

"This thrilling discovery is a highlight for planetary science and will contribute to our understanding of the evolution of Mars, the history of water on our neighbour planet and its habitability."

Mars Express launched 2 June 2003 and celebrates 15 years in orbit on 25 December this year.

Source: ESA Return to Contents

2. Local Winds Play Key Role in Some Megafires

Although drought and overgrown forests are often blamed for major fires in the western United States, new research using unique NASA before-and-after data from a megafire site indicates that highly localized winds sometimes play a much larger role -- creating large, destructive fires even when regional winds are weak.

The study was led by the National Center for Atmospheric Research (NCAR) in Boulder, Colorado. It focused on the 2014 King Fire, using data from airborne instruments managed by NASA's Jet Propulsion Laboratory in Pasadena, California, with advanced computer simulations from NCAR. The King Fire occurred in the Sierra Nevada mountain range during California's severe multi-year drought and burned more than 97,000 acres (39,000 hectares).

The study team found that winds -- both very localized winds related to topography and winds created by the searing heat of the flames -- were the reason the fire suddenly ran 15 miles (24 kilometers) up a steep canyon one afternoon. Winds like these, sometimes only a few hundred yards (meters) across, often go undetected by weather stations that may be several miles away. In fact, for several days before the fire, nearby weather stations measured only weak winds.

"This brings into question several widely held and largely unquestioned assumptions, such as very large fires being caused by the accumulation of vegetation, persistent dry conditions, or requiring extreme conditions," said NCAR scientist Janice Coen, the lead author of the study. In the King Fire, she pointed out, "Small-scale winds and winds generated by the fire had a much greater impact on this fire, and potentially others like it, than any of the other factors."

JPL scientist Natasha Stavros, a coauthor on the study, said, "The NASA airborne measurements were unique in that we observed the forest's vertical structure before and after a fire. These observations let us better identify the type of fuel -- grass, shrubs, or trees. That improved the model simulations, particularly of how

the fire spread in areas where previous fires had burned or timber had been as harvested, and in areas where the burn severity was greatest."

Experimenting with a Megafire

Large and destructive megafires are becoming more frequent in the western United States. Experts have attributed this to a changing climate, which is causing hotter and sometimes drier conditions, or to a century of fire suppression policies that have left forests with more vegetation to fuel the flames than in the past. Scientists cannot experiment with large and destructive wildfires, so they have fallen back on examining statistical correlations to try to tease out the key factors associated with megafires.

The area consumed by the King Fire, however, had been previously mapped by JPL's Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) and MODIS/ASTER Airborne Simulator (MASTER) instruments in visible and thermal infrared wavelengths, as well as by a U.S. Forest Service lidar instrument, resulting in an extensive database about the forest structure and vegetation types. In addition, the authors had access to airborne thermal imagery collected during the fire. The detailed data gave them a rare opportunity to recreate an actual wildfire within a sophisticated NCAR computer model that combines weather prediction and fire behavior, testing the importance of different factors.

Simulations of the King Fire under more extreme drought conditions did not change the ultimate extent of the fire or greatly alter its expansion, and simulations with half of the actual fuel load (as might exist in a less overgrown forest) unfolded in about the same way as the real fire did.

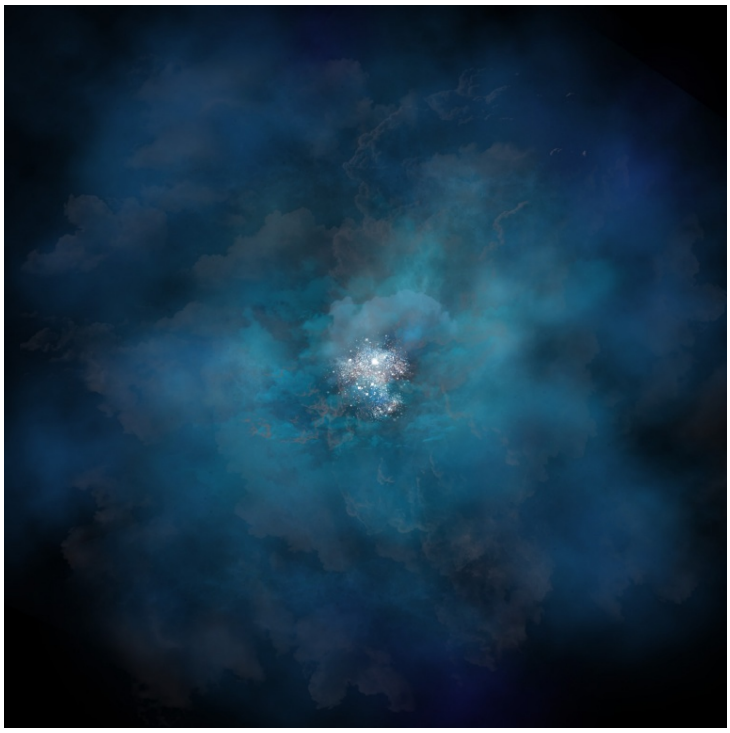
The scientists concluded that the fire became stronger in the canyon because of the inclined slopes. Drought conditions or increased vegetation did help the fire to generate the strong updraft that drew flames up the canyon slope. These factors had little impact while the fire was on flatter ground.

"This is just one case, but it illustrates how the causes of a megafire have sometimes been misunderstood," Coen said.

The study, titled "Deconstructing the King Megafire," was published in the journal Ecological Applications. The research was funded by NASA.

Source: JPL Return to Contents

3. Young Galaxy's Halo Offers Clues to Its Growth and Evolution



A team of astronomers has discovered a new way to unlock the mysteries of how the first galaxies formed and evolved.

In a study published today in the Astrophysical Journal Letters, lead author Dawn Erb of the University of Wisconsin-Milwaukee and her team -- for the very first time -- used new capabilities at W. M. Keck Observatory on Maunakea, Hawaii, to examine Q2343-BX418, a small, young galaxy located about 10 billion light-years away from Earth.

This distant galaxy is an analog for younger galaxies that are too faint to study in detail, making it an ideal candidate for learning more about what galaxies looked like shortly after the birth of the universe.

BX418 is also attracting astronomers' attention because its gas halo is giving off a special type of light.

"In the last several years, we've learned that the gaseous halos surrounding galaxies glow with a particular ultraviolet wavelength called Lyman alpha emission. There are a lot of different theories about what produces this Lyman alpha emission in the halos of galaxies, but at least some of it is probably due to light that is originally produced by star formation in the galaxy being absorbed and re-emitted by gas in the halo," said Erb.

Erb's team, which includes Charles Steidel and Yuguang Chen of Caltech, used one of the observatory's newest instruments, the Keck Cosmic Web Imager (KCWI), to perform a detailed spectral analysis of BX418's gas halo; its properties could offer clues about the stars forming within the galaxy.

"Most of the ordinary matter in the universe isn't in the form of a star or a planet, but gas. And most of that gas exists not in galaxies, but around and between them," said Erb.

The halo is where gas enters and exits the system. The gas surrounding galaxies can fuel them; gas from within a galaxy can also escape into the halo. This inflow and outflow of gas influences the fate of stars.

"The inflow of new gas accreting into a galaxy provides fuel for new star formation, while outflows of gas limit a galaxy's ability to form stars by removing gas," says Erb. "So, understanding the complex interactions happening in this gaseous halo is key to finding out how galaxies form stars and evolve."

This study is part of a large ongoing survey that Steidel has been leading for many years. Previously, Steidel's team studied BX418 using other instruments at Keck Observatory.

This most recent study using KCWI adds detail and clarity to the image of the galaxy and its gas halo that was not possible before; the instrument is specifically engineered to study wispy currents of faint gas that connect galaxies, known as the cosmic web.

"Our study was really enabled by the design and sensitivity of this new instrument. It's not just an ordinary spectrograph -- it's an integral field spectrograph, which means that it's a sort of combination camera and spectrograph, where you get a spectrum of every pixel in the image," said Erb.

The power of KCWI, combined with the Keck telescopes' location on Maunakea where viewing conditions are among the most pristine on Earth, provides some of the most detailed glimpses of the cosmos.

Erb's team used KCWI to take spectra of the Lyman alpha emission of BX418's halo. This allowed them to trace the gas, plot its velocity and spatial extent, then create a 3-D map showing the structure of the gas and its behavior.

The team's data suggests that the galaxy is surrounded by a roughly spherical outflow of gas and that there are significant variations in the density and velocity range of this gas.

Erb says this analysis is the first of its kind. Because it has only been tested on one galaxy, other galaxies need to be studied to see if these results are typical.

Now that the team has discovered a new way to learn about the properties of the gaseous halo, the hope is that further analysis of the data they collected and computer simulations modeling the processes will yield additional insights into the characteristics of the first galaxies in our universe.

"As we work to complete more detailed modeling, we will be able to test how the properties of Lyman alpha emission in the gas halo are related to the properties of the galaxies themselves, which will then tell us something about how the star formation in the galaxy influences the gas in the halo," Erb said.

Source: SpaceRef.com Return to Contents

The Night Sky

Friday, July 27
• Full Moon (exact at 4:20 p.m. EDT). Full Moon is opposition Moon, so it shines with brilliant Mars, which is just a day past *its* opposition.

Mars right now is 143 times farther from us than the Moon (and it's twice as large). Its surface is covered with rusty dark brown dust compared to the Moon's very dark gray dust. So why do they look orange and white in our night sky? Because they're illuminated brilliantly, by direct sunlight, while the rest of the nighttime scenery around us (to which our eyes adapt) is much dimmer.

• **Total eclipse of the Moon, but not for North America!** (or Hawai`i). The best views will be from Europe, Africa, and much of Asia. This is the *longest* total lunar eclipse of the 21st century, with totality lasting 1 hour 43 minutes. Next to reddish Mars, the Moon will turn from white to (presumably) *very* red, then back to white.

The basic timetable: Partial eclipse begins at 18:24 UT, total eclipse begins 19:30 UT, total eclipse ends 21:13 UT, partial eclipse ends 22:19 UT July 27. Totality happens in twilight or evening for Europe, eastern Brazil, and West Africa; late at night from the Middle East through India; and around dawn for Southeast Asia and much of China, Indonesia, and Australia.

A livestream of the lunar eclipse will be aired on Slooh beginning at 1 p.m. EDT (17:00 UT).

Saturday, July 28
• This evening the Moon shines farther left of Mars after they rise.

Sunday, July 29
• The Big Dipper hangs diagonally in the northwest at nightfall. From its midpoint, look three fists at arm's length to the right to find Polaris (not very bright) glimmering due north as always.

Polaris is the handle-end of the Little Dipper. The only other parts of the Little Dipper that are even modestly bright are the two stars forming the outer end of its bowl. On August evenings you'll find them to Polaris's upper left (by about a fist and a half at arm's length). They're called the Guardians of the Pole, since they circle endlessly around Polaris throughout the night and throughout the year.

Monday, July 30
• The tail of Scorpius is low due south right after dark, well to the lower right of Saturn. *How* low it is depends on how far north or south you live: the farther south, the higher.

Look for the two stars especially close together in the tail. These are Lambda and fainter Upsilon Scorpii, known as the Cat's Eyes. They're canted at an angle; the cat is tilting his head and winking.

The Cat's Eyes point west (right) by nearly a fist-width toward Mu Scorpii, a much tighter pair known as the Little Cat's Eyes. They're oriented almost exactly the same way as the big Cat's Eyes. Can you resolve the Mu pair without using binoculars?

Tuesday, July 31

• Starry Scorpius is sometimes called "the Orion of Summer" for its brightness and its prominent red supergiant (Antares in the case of Scorpius, Betelgeuse for Orion). But Scorpius passes a lot lower in the south than Orion for those of us at mid-northern latitudes. That means it has only one really good evening month: July. Catch Scorpius due south just after dark, before it starts to tilt lower toward the southwest.

Source: Sky & Telescope Return to Contents

ISS Sighting Opportunities

For Denver:

Date	Visible	Max Height	Appears	Disappears
Fri Jul 27, 00:45 AM	< 1 min	10°	10° above NNW	10° above NNW
Fri Jul 27, 8:41 PM	2 min	16°	16° above NNW	10° above NNE
Fri Jul 27, 10:18 PM	1 min	10°	10° above N	10° above NNE
Fri Jul 27, 11:54 PM	< 1 min	15°	15° above N	15° above N
Sat Jul 28, 9:25 PM	1 min	10°	10° above NNW	10° above N
Sat Jul 28, 11:03 PM	2 min	14°	12° above N	13° above NNE
Sun Jul 29, 10:10 PM	2 min	11°	10° above N	10° above NNE
Mon Jul 30, 9:18 PM	1 min	10°	10° above N	10° above NNE
Mon Jul 30, 10:55 PM	1 min	20°	16° above N	20° above NNE
Tue Jul 31, 10:03 PM	3 min	15°	12° above NNW	12° above NE
Tue Jul 31, 11:38 PM	< 1 min	13°	10° above NW	13° above NW

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

NASA-TV Highlights

(all times Eastern Daylight Time)

July 27, Friday
2:15 p.m. – Live Views of the Total Lunar Eclipse (All Channels)

July 30, Monday
12:05 p.m. – Space Station In-Flight Educational Event with NASA Interns at the Johnson Space Center, Houston and NASA astronaut Ricky Arnold (All Channels)

July 31, Tuesday
1 a.m. – Mars close approach viewing from the Griffith Observatory in Los Angeles (All Channels)
10:55 a.m. - Space Station In-Flight Educational Event with the Las Cruces Museum of Nature and Science in Las Cruces, New Mexico and NASA astronauts Ricky Arnold and Serena Aunon-Chancellor (All Channels)

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

Space Calendar

- Jul 27 -  [Jul 24] Total Lunar Eclipse
- Jul 27 -  [Jul 24] Mars At Opposition
- Jul 27 - Comet C/2018 N1 (NEOWISE) Closest Approach To Earth (0.306 AU)
- Jul 27 - Comet C/2018 N1 (NEOWISE) At Opposition (0.306 AU)
- Jul 27 - Comet P/2007 T2 (Kowalski) Perihelion (0.655 AU)
- Jul 27 - Comet 138P/Shoemaker-Levy At Opposition (1.894 AU)
- Jul 27 - Comet 114P/Wiseman-Skiff At Opposition (3.197 AU)
- Jul 27 - Aten Asteroid 2018 NR1 Near-Earth Flyby (0.044 AU)
- Jul 27 - Atira Asteroid 1998 DK36 Closest Approach To Earth (0.594 AU)
- Jul 27 - Asteroid 6563 Steinheim Closest Approach To Earth (1.424 AU)
- Jul 27 - Asteroid 6433 Enya Closest Approach To Earth (1.424 AU)
- Jul 27 - Asteroid 8129 Michaelbusch Closest Approach To Earth (1.450 AU)
- Jul 27 - Kuiper Belt Object 2017 OF69 At Opposition (42.789 AU)
- Jul 28 - Asteroid 1602 Indiana Closest Approach To Earth (1.446 AU)
- Jul 28 - Asteroid 3784 Chopin Closest Approach To Earth (1.640 AU)
- Jul 28 - Asteroid 15058 Billcooke Closest Approach To Earth (2.143 AU)
- Jul 28 - 45th Anniversary (1973), Skylab-3 Launch
- Jul 28 - Albert Wilson's 100th Birthday (1918)
- Jul 28 - Theodor Wulf's 150th Birthday (1868)
- Jul 29 - South Delta-Aquarids Meteor Shower Peak
- Jul 29 - Comet 200P/Larsen At Opposition (2.821 AU)
- Jul 29 - Apollo Asteroid 439313 (2012 VE82) Near-Earth Flyby (0.068 AU)
- Jul 29 - Asteroid 42487 Angstrom Closest Approach To Earth (1.185 AU)
- Jul 29 - Asteroid 1268 Libya Closest Approach To Earth (3.348 AU)
- Jul 30 - 80th Anniversary (1938), Seth Nicholson's Discovery of Jupiter Moon Carme
- Jul 31 - Comet 3D/Biela Closest Approach To Earth (1.717 AU)
- Jul 31 - Comet 3D/Biela At Opposition (1.717 AU)
- Jul 31 - Comet 76P/West-Kohoutek-Ikemura At Opposition (2.868 AU)
- Jul 31 - Asteroid 10217 Richardcook Closest Approach To Earth (1.210 AU)
- Jul 31 - Asteroid 55 Pandora Closest Approach To Earth (1.588 AU)
- Jul 31 - Asteroid 27500 Mandelbrot Closest Approach To Earth (1.832 AU)
- Jul 31 - Richard Oldham's 160th Birthday (1858)
- Jul 31 - John Canton's 300th Birthday (1718)
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Source: JPL Space Calendar

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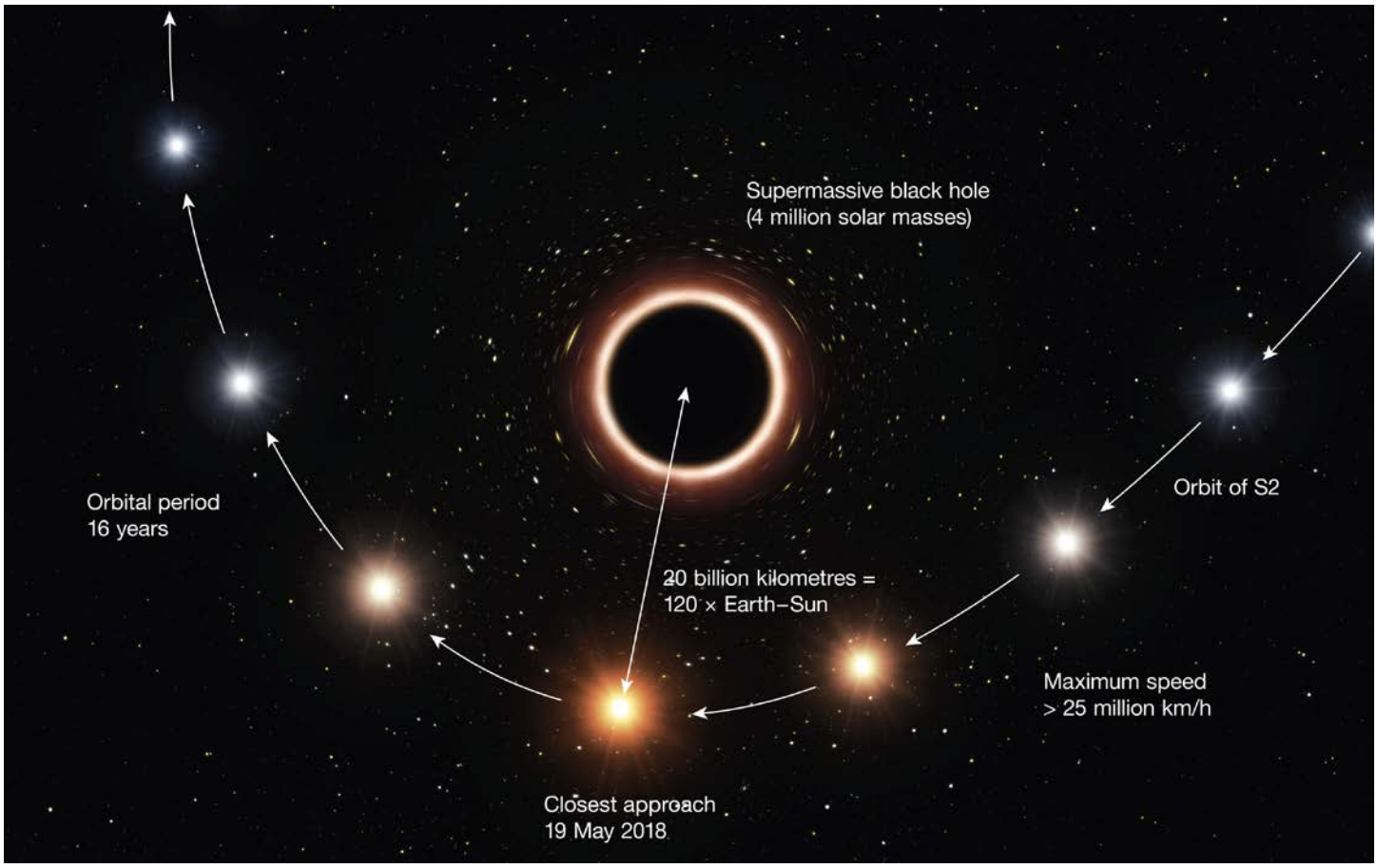
Food for Thought

First successful test of Einstein's general relativity near supermassive black hole



Observations made with ESO's Very Large Telescope have for the first time revealed the effects predicted by Einstein's general relativity on the motion of a star passing through the extreme gravitational field near the supermassive black hole in the centre of the Milky Way. This long-sought result represents the climax of a 26-year-long observation campaign using ESO's telescopes in Chile.

Obscured by thick clouds of absorbing dust, the closest supermassive black hole to the Earth lies 26 000 light-years away at the centre of the Milky Way. This gravitational monster, which has a mass four million times that of the Sun, is surrounded by a small group of stars orbiting around it at high speed. This extreme environment—the strongest gravitational field in our galaxy—makes it the perfect place to explore gravitational physics, and particularly to test Einstein's general theory of relativity.

New infrared observations from the exquisitely sensitive GRAVITY, SINFONI and NACO instruments on ESO's Very Large Telescope (VLT) have now allowed astronomers to follow one of these stars, called S2, as it passed very close to the black hole during May 2018. At the closest point this star was at a distance of less than 20 billion kilometres from the black hole and moving at a speed in excess of 25 million kilometres per hour—almost three percent of the speed of light.

The team compared the position and velocity measurements from GRAVITY and SINFONI respectively, along with previous observations of S2 using other instruments, with the predictions of Newtonian gravity, general relativity and other theories of gravity. The new results are inconsistent with Newtonian predictions and in excellent agreement with the predictions of general relativity.

These extremely precise measurements were made by an international team led by Reinhard Genzel of the Max Planck Institute for Extraterrestrial Physics (MPE) in Garching, Germany, in conjunction with collaborators around the world, at the Paris Observatory–PSL, the Université Grenoble Alpes, CNRS, the Max Planck Institute for Astronomy, the University of Cologne, the Portuguese CENTRA – Centro de Astrofisica e Gravitação and ESO. The observations are the culmination of a 26-year series of ever-more-precise observations of the centre of the Milky Way using ESO instruments.

"This is the second time that we have observed the close passage of S2 around the black hole in our galactic centre. But this time, because of much improved instrumentation, we were able to observe the star with unprecedented resolution," explains Genzel. "We have been preparing intensely for this event over several years, as we wanted to make the most of this unique opportunity to observe general relativistic effects."

The new measurements clearly reveal an effect called gravitational redshift. Light from the star is stretched to longer wavelengths by the very strong gravitational field of the black hole. And the change in the wavelength of light from S2 agrees precisely with that predicted by Einstein's theory of general relativity. This is the first time that this deviation from the predictions of the simpler Newtonian theory of gravity has been observed in the motion of a star around a supermassive black hole.

The team used SINFONI to measure the velocity of S2 towards and away from Earth and the GRAVITY instrument in the VLT Interferometer (VLTI) to make extraordinarily precise measurements of the changing position of S2 in order to define the shape of its orbit. GRAVITY creates such sharp images that it can reveal the motion of the star from night to night as it passes close to the black hole—26 000 light-years from Earth.

"Our first observations of S2 with GRAVITY, about two years ago, already showed that we would have the ideal black hole laboratory," adds Frank Eisenhauer (MPE), Principal Investigator of GRAVITY and the SINFONI spectrograph. "During the close passage, we could even detect the faint glow around the black hole on most of the images, which allowed us to precisely follow the star on its orbit, ultimately leading to the detection of the gravitational redshift in the spectrum of S2."

More than one hundred years after he published his paper setting out the equations of general relativity, Einstein has been proved right once more—in a much more extreme laboratory than he could have possibly imagined!

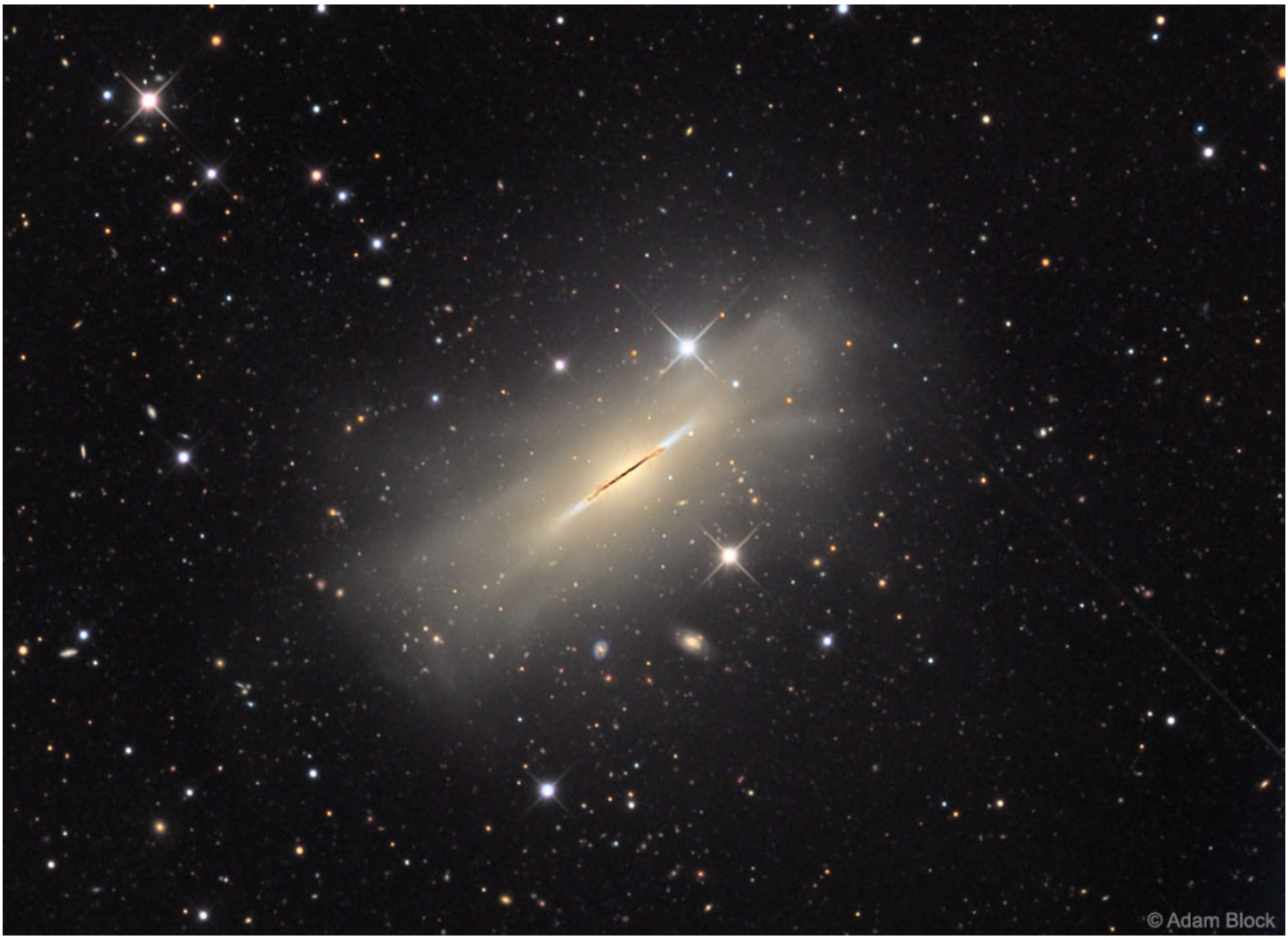
Françoise Delplancke, head of the System Engineering Department at ESO, explains the significance of the observations: "Here in the Solar System we can only test the laws of physics now and under certain circumstances. So it's very important in astronomy to also check that those laws are still valid where the gravitational fields are very much stronger."

Continuing observations are expected to reveal another relativistic effect very soon—a small rotation of the star's orbit, known as Schwarzschild precession—as S2 moves away from the black hole.

Xavier Barcons, ESO's Director General, concludes: "ESO has worked with Reinhard Genzel and his team and collaborators in the ESO Member States for over a quarter of a century. It was a huge challenge to develop the uniquely powerful instruments needed to make these very delicate measurements and to deploy them at the VLT in Paranal. The discovery announced today is the very exciting result of a remarkable partnership."

Source: Phys.org Return to Contents

Space Image of the Week



The Edge-On Spindle Galaxy
Image Credit & Copyright: Adam Block, Mt. Lemmon SkyCenter, U. Arizona

Explanation: What kind of celestial object is this? A relatively normal galaxy -- but seen from its edge. Many disk galaxies are actually just as thin as NGC 5866, pictured here, but are not seen edge-on from our vantage point. A perhaps more familiar galaxy seen edge-on is our own Milky Way Galaxy. Cataloged as M102 and NGC 5866, the Spindle galaxy has numerous and complex dust lanes appearing dark and red, while many of the bright stars in the disk give it a more blue underlying hue. The blue disk of young stars can be seen extending past the dust in the extremely thin galactic plane. There is evidence that the Spindle galaxy has cannibalized smaller galaxies over the past billion years or so, including multiple streams of faint stars, dark dust that extends away from the main galactic plane, and a surrounding group of galaxies (not shown). In general, many disk galaxies become thin because the gas that forms them collides with itself as it rotates about the gravitational center. The Spindle galaxy lies about 50 million light years distant toward the constellation of the Dragon (Draco).

Source: APOD

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