Space News Update – April 2020

By Pat Williams

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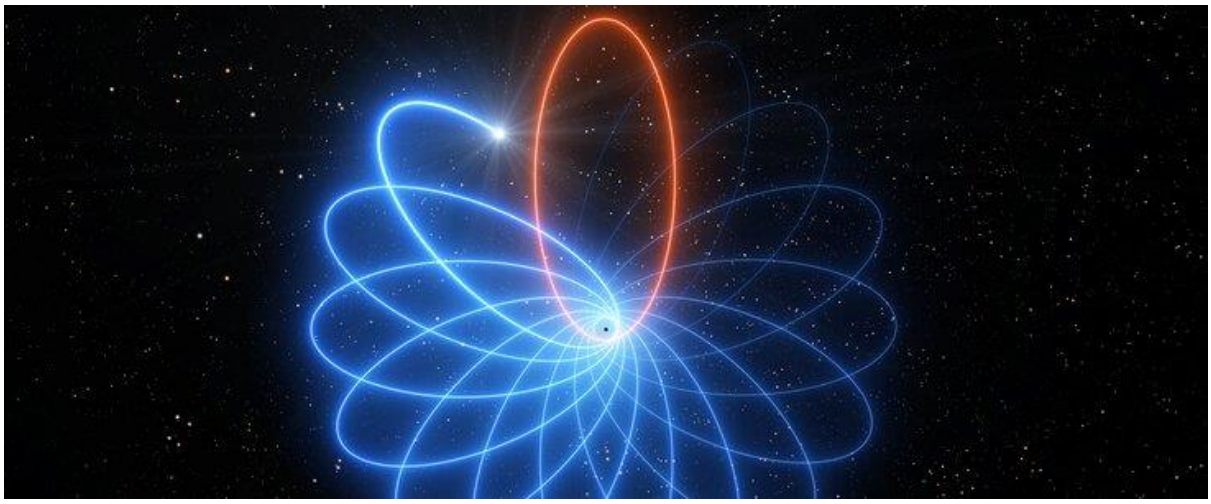
Disclaimer - I claim no authorship for the printed material; except where noted (PW).

ESO TELESCOPE SEES STAR DANCE AROUND SUPERMASSIVE BLACK HOLE, PROVES EINSTEIN RIGHT



Credit: ESO

Observations made with ESO's Very Large Telescope (VLT) have revealed for the first time that a star orbiting the supermassive black hole at the centre of the Milky Way moves just as predicted by Einstein's general theory of relativity. Its orbit is shaped like a rosette and not like an ellipse as predicted by Newton's theory of gravity. This long-sought-after result was made possible by increasingly precise measurements over nearly 30 years, which have enabled scientists to unlock the mysteries of the behemoth lurking at the heart of our galaxy. Einstein's General Relativity predicts that bound orbits of one object around another are not closed, as in Newtonian Gravity, but precess forwards in the plane of motion. This famous effect, first seen in the orbit of the planet Mercury around the Sun, was the first evidence in favour of General Relativity. One hundred years later we have now detected the same effect in the motion of a star orbiting the compact radio source Sagittarius A* at the centre of the

Milky Way. This observational breakthrough strengthens the evidence that Sagittarius A* must be a supermassive black hole of 4 million times the mass of the Sun. Located 26 000 light-years from the Sun, Sagittarius A* and the dense cluster of stars around it provide a unique laboratory for testing physics in an otherwise unexplored and extreme regime of gravity. One of these stars, S2, sweeps in towards the supermassive black hole to a closest distance less than 20 billion kilometres (one hundred and twenty times the distance between the Sun and Earth), making it one of the closest stars ever found in orbit around the massive giant. At its closest approach to the black hole, S2 is hurtling through space at almost three percent of the speed of light, completing an orbit once every 16 years. After following the star in its orbit for over two and a half decades, exquisite measurements robustly detect S2's Schwarzschild precession in its path around Sagittarius A*. Most stars and planets have a non-circular orbit and therefore move closer to and further away from the object they are rotating around. S2's orbit precesses, meaning that the location of its closest point to the supermassive black hole changes with each turn, such that the next orbit is rotated with regard to the previous one, creating a rosette shape. General Relativity provides a precise prediction of how much its orbit changes and the latest measurements from this research exactly match the theory. This effect, known as Schwarzschild precession, had never before been measured for a star around a supermassive black hole. The study with ESO's VLT also helps scientists learn more about the vicinity of the supermassive black hole at the centre of our galaxy. Because the S2 measurements follow General Relativity so well, we can set stringent limits on how much invisible material, such as distributed dark matter or possible smaller black holes, is present around Sagittarius A*. This is of great interest for understanding the formation and evolution of supermassive black holes. This result is the culmination of 27 years of observations of the S2 star using, for the best part of this time, a fleet of instruments at ESO's VLT, located in the Atacama Desert in Chile. The number of data points marking the star's position and velocity attests to the thoroughness and accuracy of the new research: the team made over 330 measurements in total, using the GRAVITY, SINFONI and NACO instruments. Because S2 takes years to orbit the supermassive black hole, it was crucial to follow the star for close to three decades, to unravel the intricacies of its orbital movement. The research was conducted by an international team led by Frank Eisenhauer of the MPE with collaborators from France, Portugal, Germany and ESO. The team make up the GRAVITY collaboration, named after the instrument, they developed for the VLT Interferometer, which combines the light of all four 8-metre VLT telescopes into a super-telescope (with a resolution equivalent to that of a telescope 130 metres in diameter). The same team reported in 2018 another effect predicted by General Relativity: they saw the light received from S2 being stretched to longer wavelengths as the star passed close to Sagittarius A*. A previous result has shown that the light emitted from the star experiences General Relativity. Now we have shown that the star itself senses the effects of General Relativity. With ESO's upcoming Extremely Large Telescope, the team believes that they would be able to see much fainter stars orbiting even closer to the supermassive black hole. If they are lucky, they might capture stars close enough that they actually feel the rotation, the spin, of the black hole. This would mean astronomers would be able to measure the two quantities, spin and mass, that characterise Sagittarius A* and define space and time around it. That would be again a completely different level of testing relativity. (ESO)
ESO telescope sees star dance around supermassive black hole, proves Einstein right
(16 April 2020)

CIMON-2 MAKES ITS DEBUT ON THE ISS

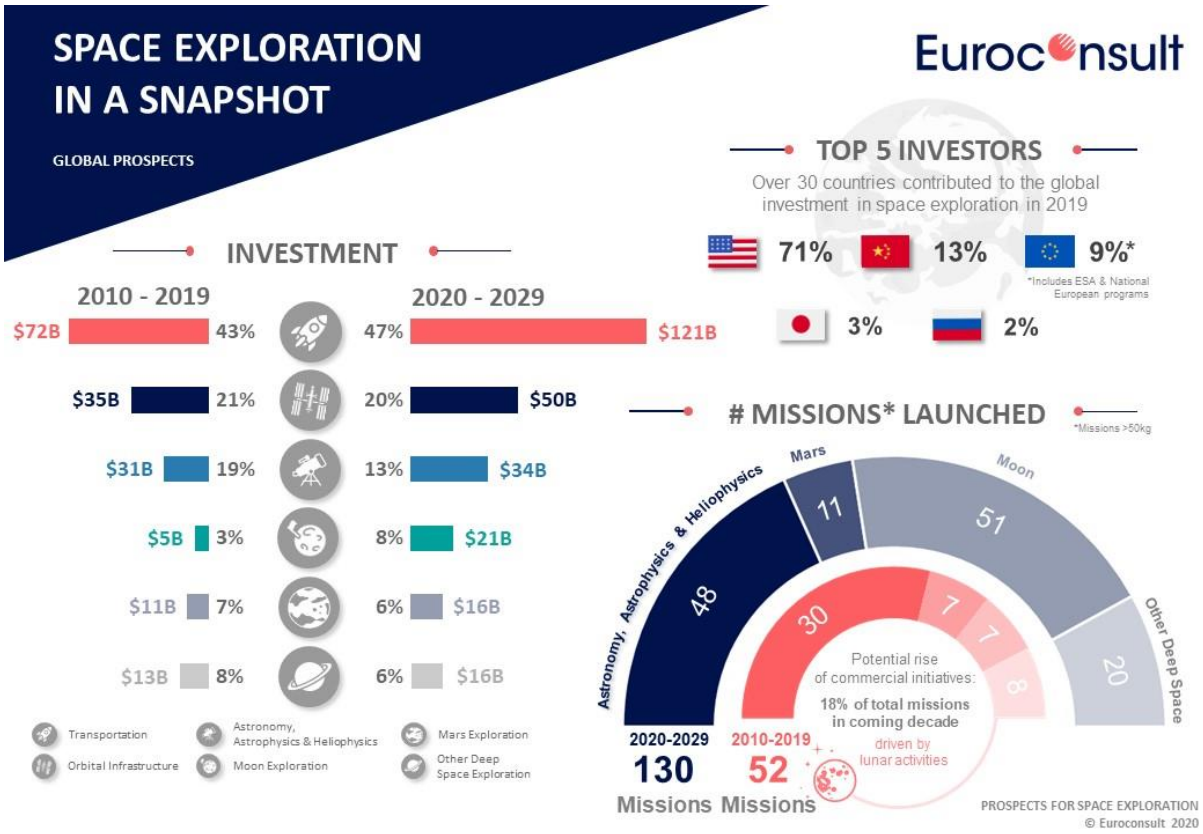
Copyright: NASA/ESA

Developed and built in Germany, CIMON is a technology experiment to support astronauts and increase the efficiency of their work. CIMON is able to show and explain information and instructions for scientific experiments and repairs. The voice-controlled access to documents and media is an advantage, as the astronauts can keep both hands free. It can also be used as a mobile camera to save astronaut crew time. In particular, CIMON could be used to perform routine tasks, such as documenting experiments, searching for objects and taking inventory. CIMON can also see, hear, understand and speak. CIMON can orientate itself using its 'eyes' – a stereo camera and a high-resolution camera that it uses for facial recognition – as well as two other cameras fitted to its sides that it uses for photos and video documentation. Ultrasound sensors measure distances to prevent potential collisions. Its 'ears' consist of eight microphones to identify directions, and an additional directional microphone to improve voice recognition. Its 'mouth' is a loudspeaker that it can use to speak or play music. At the heart of the AI for language understanding is IBM Watson AI technology from IBM Cloud. CIMON has not been equipped with self-learning capabilities and requires active human instruction. The AI used for autonomous navigation was provided by Airbus and is designed for movement planning and object recognition. Twelve internal rotors allow CIMON to move and rotate freely in all directions. This means it can turn towards the astronaut when addressed, nod and shake its head, and follow the astronaut – either autonomously or on command.

CIMON-2, the updated version of the CIMON astronaut assistant has now demonstrated its capabilities during initial tests on the International Space Station (ISS). The free-flying, spherical technology demonstrator with artificial intelligence (AI) showed off a number of its features during interactions with ESA astronaut Luca Parmitano. It is scheduled to stay on the ISS for up to three years. Just shy of two months after the successful first use of CIMON-2, the project team has now received the analysis. A number of tests have now been carried out on CIMON-2, for example on its autonomous flight capabilities, voice-controlled navigation, and its ability to understand and complete various tasks. It also managed to fly to a specific

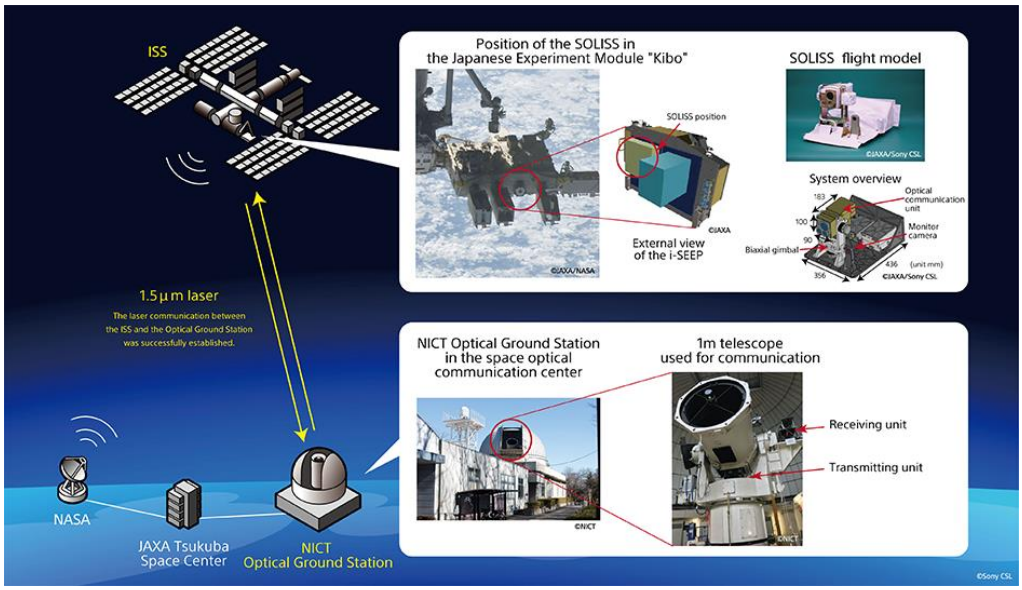
point in the ISS Columbus module for the first time. Thanks to absolute navigation capabilities, CIMON-2 was able to follow verbal commands to move to a particular location, regardless of where it was to begin with. For example, while starting up its new hardware and software, ESA´s Astronaut Luca Parmitano asked CIMON-2 to fly to the Biological Experiment Laboratory (Biolab) inside the Columbus module. It was also given the task of taking photos and videos in the European ISS module on request – and then showing these to the astronaut. Using these capabilities, CIMON-2 will be able to help with future scientific experiments on the ISS. The microphones of the current version of the technology demonstrator are more sensitive than its predecessor's (CIMON), and it has a more advanced sense of direction. Its AI capabilities and the stability of its complex software applications have also been significantly improved. The degree of autonomy of the battery-powered assistant has been increased by around 30%. Astronauts can also activate a feature on CIMON-2 that allows it to analyse emotion in language and show empathy when interacting with the astronauts. In addition, the project aims to research whether intelligent assistants such as CIMON could help reduce stress. As a partner and assistant, CIMON could support astronauts with their high workload of experiments and maintenance and repair work, thereby reducing their exposure to stress. CIMON lays the foundations for social assistance systems that could reduce stress resulting from isolation or group dynamics during long-term missions. Such systems could also possibly help to minimise similar problems back on Earth as well. This continued success of the CIMON project is yet another pioneering achievement in the use of AI in human space flight. (Airbus)
[CIMON-2 makes its debut on the ISS](#) (15 April 2020)

THE 2020S: THE SPACE EXPLORATION DECADE



According to Euroconsult's latest research, "Prospects for Space Exploration", global government investment in space exploration totalled nearly $20 billion in 2019, a 6% increase year-on-year. Thirty-one countries and space agencies lead this global investment with the U.S. accounting for 71% of spending. Funding for space exploration is forecast to increase to $30 billion by 2029, driven by Moon exploration, transportation, and orbital infrastructure. Approximately 130 missions are expected over the coming decade, compared to 52 missions conducted over the past 10 years. (Euroconsult)
The 2020s: the space exploration decade (14 April 2020)

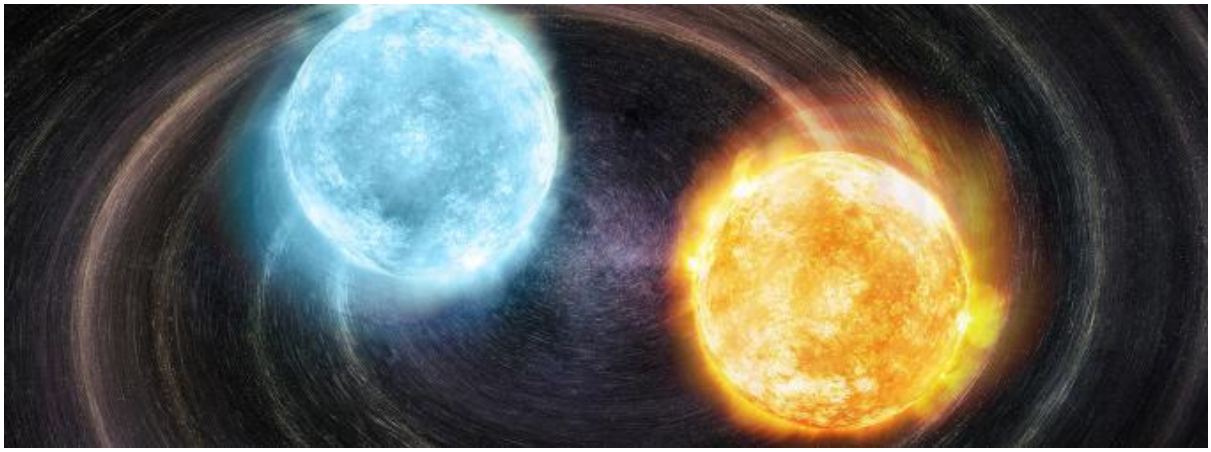
SMALL OPTICAL LINK FOR INTERNATIONAL SPACE STATION (SOLISS) SUCCEEDS IN BIDIRECTIONAL LASER COMMUNICATION BETWEEN SPACE AND GROUND STATION



Credit: JAXA

This marks the first time in the world that bidirectional symmetric Ethernet links have been established by using laser communication devices designed for small satellites. The benefit of laser communication compared to radio wave is the physical ability to scale its bandwidth. The success in bidirectional laser communication demonstration using long-established optical disk technology and the Ethernet standard will likely create a pathway to ultra-high speed (low latency) data communication, and real-time mass-data communication for cross-links between satellites and between a satellite and ground stations in the future. Experimental operation aimed at improving communication stability using SOLISS is planned to continue until early June 2020. The Japanese Experiment Module (JEM) "Kibo" of the International Space Station (ISS) is a permanent experimental facility located in low earth orbit about 400 kilometers above the earth. The maximum utilization of the value of Kibo, which enables long-term verification testing with the support of astronauts, has turned into a meaningful opportunity to expand the use of the ISS for civilian use and technical demonstration, as outlined in the Basic Plan on Space Policy. It is anticipated that this technology will serve as the basis for realizing mass-data communication with orbiting spacecrafts around the earth in future space exploration such as to the Moon and Mars. (JAXA)
Small Optical Link for International Space Station (SOLISS) succeeds in bidirectional laser communication between space and ground station (23 April 2020)

ASTRONOMERS DETECT FIRST DOUBLE HELIUM-CORE WHITE DWARF GRAVITATIONAL WAVE SOURCE



Credit: Harvard & Smithsonian

Scientists at the Center for Astrophysics | Harvard & Smithsonian announced the detection of J2322+0509, a detached binary white dwarf composed of two helium-core stars with a short orbital period. It is the first gravitational wave source of its kind ever detected. The star will be used for verification on the much-anticipated LISA (Laser Interferometer Space Antenna) gravitational wave observatory, planned for launch in 2034. This binary had no light curve. They couldn't detect a photometric signal because there isn't one. Spectroscopic studies, however, shaped the story of a difficult-to-detect yet scientifically important binary system and revealed its orbital motion.
(Center for Astrophysics | Harvard & Smithsonian)
Astronomers detect first double helium-core white dwarf gravitational wave source
(3 April 2020)

LINKS TO OTHER SPACE NEWS PUBLISHED IN FEBRUARY 2020

ASTEROIDS

Rehearsal time for NASA's asteroid sampling spacecraft (9 April 2020)
In August, a robotic spacecraft will make NASA's first-ever attempt to descend to the surface of an asteroid, collect a sample, and ultimately bring it safely back to Earth. In order to achieve this challenging feat, the OSIRIS-REx mission team devised new techniques to operate in asteroid Bennu's microgravity environment – but they still need experience flying the spacecraft in close proximity to the asteroid in order to test them. So, before touching down at sample site Nightingale this summer, OSIRIS-REx will first rehearse the activities leading up to the event. On Apr. 14, the mission will pursue its first practice run – officially known as "Checkpoint" rehearsal – which will also place the spacecraft the closest it's ever been to Bennu. This rehearsal is a chance for the OSIRIS-REx team and spacecraft to test the first steps of the robotic sample collection event. (NASA Goddard)

BLACK HOLES

Something is lurking in the heart of Quasar 3C 279 (7 April 2020)
One year ago, the Event Horizon Telescope (EHT) Collaboration published the first image of

a black hole in the nearby radio galaxy M 87. Now the collaboration has extracted new information from the EHT data on the distant quasar 3C 279: they observed the finest detail ever seen in a jet produced by a supermassive black hole. New analyses enabled the collaboration to trace the jet back to its launch point, close to where violently variable radiation from across the electromagnetic spectrum arises. The newly analyzed data show that the normally straight jet has an unexpected twisted shape at its base. (NRAO)

Star survives close call with a black hole (23 April 2020)
Astronomers may have discovered a new kind of survival story: a star that had a brush with a giant black hole and lived to tell the tale through exclamations of X-rays. Data from NASA's Chandra X-ray Observatory and ESA's XMM-Newton uncovered the account that began with a red giant star wandering too close to a supermassive black hole in a galaxy about 250 million light years from Earth. The black hole, located in a galaxy called GSN 069, has a mass about 400,000 times that of the Sun, putting it on the small end of the scale for supermassive black holes. Once the red giant was captured by the black hole's gravity, the outer layers of the star containing hydrogen were stripped off and careened toward the black hole, leaving the core of the star, known as a white dwarf, behind. "In my interpretation of the X-ray data the white dwarf survived, but it did not escape," said Andrew King of the University of Leicester in the UK, who performed this study. "It is now caught in an elliptical orbit around the black hole, making one trip around about once every nine hours." (NASA)

Spitzer telescope reveals the precise timing of a black hole dance (28 April 2020)
The OJ 287 galaxy hosts one of the largest black holes ever found, with over 18 billion times the mass of our Sun. Orbiting this behemoth is another black hole with about 150 million times the Sun's mass. Twice every 12 years, the smaller black hole crashes through the enormous disk of gas surrounding its larger companion, creating a flash of light brighter than a trillion stars - brighter, even, than the entire Milky Way galaxy. The light takes 3.5 billion years to reach Earth. (JPL)

BLAZAR

Discovery of a young blazar produced by the merger of two galaxies (14 April 2020)
Astronomers have imaged the formation of a jet from two younger, spiral-shaped galaxies, in the process of merging. In scientific terminology these young spiral galaxies containing jets are called Narrow Line Seyfert 1 gamma ray emitter galaxies (γ-NLSy1). Each merging galaxy shows a supermassive black hole at its centre. The more massive of the two shows a very young jet, with an estimated age less than 15,000 years, whose existence can be attributed to the interaction between the galaxies, which started at least 500 million years ago. Astronomers are seeing the jet face-on so that they have found the precursor of a blazar. As an analogy one could say that if a blazar is an adult, a γ-NLSy1 is a child.
(Isaac Newton Group of Telescopes)

DWARF PLANETS

Astronomers measure wind speed on a brown dwarf (9 April 2020)
Allers, Vos, and Williams, along with Beth Biller of the University of Edinburgh, reported their findings in the journal Science.
The astronomers studied a brown dwarf called 2MASS J10475385+2124234, an object

roughly the same size as Jupiter, but roughly 40 times more massive, about 34 light-years from Earth. Brown dwarfs, sometimes called "failed stars," are more massive than planets, but not massive enough to cause the thermonuclear reactions at their cores that power stars. They noted that the rotation period of Jupiter as determined by radio observations is different from the rotation period determined by observations at visible and infrared wavelengths," Allers said. That difference is because the radio emission is caused by electrons interacting with the planet's magnetic field, which is rooted deep in the planet's interior, while the infrared emission comes from the top of the atmosphere. The atmosphere is rotating more quickly than the interior of the planet, and the corresponding difference in velocities is due to atmospheric winds. Expecting the same mechanisms to be at work in the brown dwarf, they decided to measure its rotation speeds with both radio and infrared telescopes. Just as with Jupiter, they found that the brown dwarf's atmosphere is rotating faster than its interior, with a calculated wind speed of about 1425 miles per hour. This is significantly faster than Jupiter's wind speed, about 230 mph. The astronomers said their technique can be used to measure winds not only on other brown dwarfs, but also on extrasolar planets. (NRAO)

EARTH

New NASA radar looks to monitor volcanoes and earthquakes from space (2 April 2020)
Traditionally, researchers monitor ground deformation with on-the-ground sensors and the Global Positioning System (GPS). InSAR measurements are complementary to ground measurements and can often guide how ground sensors are installed. In orbit, a series of small InSAR satellites could peer down and record changes in ground deformation. Volcanoes will often inflate with magma before they erupt. Although it's difficult to predict how big or how long the eruption will be, they can say, "this volcano started inflating and there's a higher probability of it erupting." (NASA Goddard)

Satellites providing clear picture of greenhouse gases (14 April 2020)
With increasing levels of greenhouse gases causing our climate to change, it is important to understand exactly where these gases come from and how they disperse in the atmosphere. A new dataset, produced by the European Space Agency's Climate Change Initiative, provides a detailed view of carbon dioxide and methane – two of the most important human-made gases driving global warming. (ESA)

GeoOptics launches GeoPRO – innovative radio occultation data processing system
(15 April 2020)
GeoOptics announced today the launch of an original radio occultation data processing system called the GeoOptics Processor for Radio Occultation (GeoPRO) that provide even more accurate and timely weather data from its CICERO constellation of radio occultation (RO) satellites. CICERO nanosatellites are designed to create the most detailed picture ever assembled of the Earth's ionosphere and atmosphere. (GeoOptics)

Airbus will support France and India to monitor climate change with TRISHNA
(20 April 2020)
The French Space Agency (Centre National d'Etudes Spatiales, CNES) has recently signed a contract with Airbus Defence and Space for the development and manufacture of the thermal

infrared instrument for the TRISHNA satellite. TRISHNA (Thermal infraRed Imaging Satellite for High resolution Natural resource Assessment) will be the latest satellite in the joint Franco-Indian satellite fleet dedicated to climate monitoring and operational applications. CNES and ISRO (Indian Space Research Organisation) are partnering on the development of an infrared observation system with high thermal resolution and high revisit capability including a satellite and associated ground segment. TRISHNA observations will enhance our understanding of the water cycle and improve management of the planet's precious water resources, to better define the impacts of climate change, especially at local levels. Measuring surface temperatures provides information on hydric stress; a lack of water and its impact on the vegetative cycle, and this monitoring of water and energy cycles is one of the main objectives of the mission, to be applied particularly in agriculture and hydrology. This mission will also serve numerous other applications: surveillance of continental and coastal waters, follow up of urban heat traps, risk monitoring (fire detection and volcanic activity), study of the cryosphere (glaciers, frozen lakes) and radiation budget assessment. TRISHNA represents a significant step forward, both in terms of resolution and refresh rate. While existing missions are limited in terms of resolution (above 1km) and with revisit only every few weeks, TRISHNA will image the Earth every three days, at 50m resolution, observing a wide temperature range, from approx. -20°C to +30°C, with high precision (0.3°C). (Airbus)

EXOPLANETS

Cheops observes its first exoplanets and is ready for science (16 April 2020)
Cheops, ESA's new exoplanet mission, has successfully completed its almost three months of in-orbit commissioning, exceeding expectations for its performance. The satellite, which will commence routine science operations by the end of April, has already obtained promising observations of known exoplanet-hosting stars, with many exciting discoveries to come. (ESA)

Researchers use 'hot Jupiter' data to mine exoplanet chemistry (23 April 2020)
After spotting a curious pattern in scientific papers, they described exoplanets as being cooler than expected, Cornell astronomers have improved a mathematical model to accurately gauge the temperatures of planets from solar systems hundreds of light-years away. This new model allows scientists to gather data on an exoplanet's molecular chemistry and gain insight on the cosmos' planetary beginnings. (Cornell University)

INTERNATIONAL SPACE STATION

Bartolomeo successfully docks with Columbus laboratory (3 April 2020)
In a several-hour operation of the Canadian robotic arm of the International Space Station ISS, the Bartolomeo platform, developed and built at Airbus in Bremen, was assembled at the European space laboratory Columbus. Thus, an important step has been taken towards the commercial use of the platform for microgravity research. Although the platform is now firmly attached to Columbus, the electrical connection is still missing. This must be provided by an outboard mission of the ISS astronauts. When this action can take place is not yet defined. (Airbus)

New crew arrives safely at Space Station (9 April 2020)
For almost 20 years, humans have lived and worked continuously aboard the International Space Station, advancing scientific knowledge and demonstrating new technologies, making research breakthroughs not possible on Earth. As a global endeavour, 239 people from 19 countries have visited the unique microgravity laboratory that has hosted more than 2,800 research investigations from researchers in 108 countries.
It is the third spaceflight for Cassidy and Ivanishin and the first for Vagner, who are scheduled to return to Earth in October after a mission of more than six months during which they will conduct about 160 science investigations in fields such as, biology, Earth science, human research, physical sciences, and technology development. Work on the unique microgravity laboratory advances scientific knowledge and demonstrates new technologies, making research breakthroughs that will enable long-duration human and robotic exploration of the Moon and Mars. (NASA)

Astronauts Meir, Morgan and Skripochka return from Space Station (17 April 2020)
Among the research experiments to which the Expedition 62 crew contributed was the Droplet Formation Study, which evaluates water droplet formation, water flow and, indirectly, the perceived pressure of current shower head technology as compared to the industry-standard use of jet nozzles. The study examines droplet size and speed and how they affect the feeling of increased pressure for the end user. Another experiment to which the crew contributed was Mochii, a miniature scanning electron microscope used to conduct real-time, on-site imaging and composition measurements of particles. Analysis of small and microscopic particles is a critical need for human space exploration beyond low-Earth orbit when samples cannot be returned to Earth immediately for analysis. (NASA)

JUPITER AND MOONS

Jupiter probe JUICE: Final integration in full swing (23 April 2020)
JUICE, the JUpiter ICy moons Explorer mission, has reached its next milestone. Until the end of 2020 it will be kitted out with its final components including harness, power electronics, onboard computer, communication systems, navigation sensors, thermal hardware and its scientific instruments. Next stop: Noordwijk, the Netherlands, where the probe has to undergo its thermal vacuum environmental test campaign to prove it is ready for its journey via Venus and Mars to Jupiter and its mission in the Jovian system. The 5.2-ton JUICE spacecraft will set off in May 2022 on its near 600 million-kilometre-long journey to Jupiter with a planned arrival date of October 2029. The spacecraft will carry 10 state-of-the-art scientific instruments, including cameras, spectrometers, an ice-penetrating radar, an altimeter, radio-science experiment, and sensors to monitor the magnetic fields and charged particles in the Jovian system. JUICE will complete a unique tour of the Jupiter system that will include in-depth studies of three potentially ocean-bearing moons, Ganymede, Europa and Callisto. JUICE will spend more than three years in the Jupiter system, collecting data to provide answers on the conditions for planet formation and the emergence of life. It will spend nine months orbiting the icy moon Ganymede analyzing its nature and evolution, and its potential habitability. (Electro Optic Systems)

LAUNCH SERVICES

Rocket Lab successfully completes electron mid-air recovery test (8 April 2020)
Rocket Lab, a space systems company and the global leader in dedicated small satellite launch, has successfully completed a mid-air recovery test – a manoeuvre that involves snagging an Electron test stage from the sky with a helicopter. The successful test is a major step forward in Rocket Lab's plans to reuse the first stage of its Electron launch vehicle for multiple missions. The test took place in early March, before 'Safer at Home' orders were issued and before New Zealand entered Alert Level 4 in response to the COVID-19 situation. https://youtu.be/N3CWGDhkmbs (Rocket Lab)

Progress MS-14 cargo spacecraft and launch vehicle final assembly (21 April 2020)
On April 21, 2020 Roscosmos specialists completed the general assembly of the Soyuz-2.1a carrier rocket with the Progress MS-14 cargo spacecraft. To do so, the upper stage with the spacecraft was docked to the third stage of the booster, after that the assembly was docked to the unit consisting of the first and second stages. Later the Technical Management and State Commission on Crewed Space Complex Flight Tests gave clearance to transport and install the Soyuz-2.1a carrier rocket at the site No. 31 launchpad. The rollout is scheduled for the morning of April 22, 2020. The launch of the Soyuz-2.1a carrier rocket with Progress MS-14 spacecraft is scheduled for April 25, 2020. The spacecraft is to deliver to the ISS propellant, water and other cargoes needed to support further crewed operation of the space station. The spacecraft docking to the Zvezda module of the Russian ISS segment is to occur in several hours after the lift-off, according to the so-called 'superfast' two-orbit scheme – at 05:12:23 UTC +/- 3 minutes. (Roscosmos)

MARS

Penn Engineers' 'nanocardboard' flyers could serve as Martian atmospheric probes
(20 April 2020)
This summer, NASA plans to launch its next Mars rover, Perseverance, which will carry with it the first aircraft to ever fly on another planet, the Mars Helicopter. As the first of its kind, the Mars Helicopter will carry no instruments and collect no data. NASA describes merely flying it all as "high-risk, high-reward" research. With the risks of extraterrestrial flight in mind, Penn Engineers are suggesting a different approach to exploring the skies of other worlds: a fleet of tiny aircraft that each weigh about as much as a fruit fly and have no moving parts. These flyers are plates of "nanocardboard," which levitate when bright light is shone on them. As one side of the plate heats up, the temperature differential gets air circulating through its hollow structure and shooting out of the corrugated channels that give it its name, thrusting it off the ground. A recently published study demonstrates nanocardboard's flying and payload-carrying abilities in an environment similar to that of Mars. The thinner atmosphere there would give the flyers a boost, enabling them to carry payloads ten times as massive as they are. The weaker Martian gravity would further enhance their capabilities. (Penn Engineering)

Promising signs for Perseverance rover in its quest for past Martian life (23 April 2020)
Scientists have speculated that the Jezero crater on Mars, the site of the next NASA rover mission to the Red Planet, could be a good place to look for markers of life. A new analysis of satellite imagery supports that hypothesis. By modelling the length of time it took to form

the layers of sediment in a delta deposited by an ancient river as it poured into the crater, researchers have concluded that if life once existed near the Martian surface, traces of it could have been captured within the delta layers. There probably was water for a significant duration on Mars and that environment was most certainly habitable, even if it may have been arid. They showed that sediments were deposited rapidly and that if there were organics, they would have been buried rapidly, which means that they would likely have been preserved and protected. Jezero crater was selected for NASA's next rover mission partly because the site contains a river delta, which on Earth are known to effectively preserve organic molecules associated with life. But without an understanding of the rates and durations of delta-building events, the analogy remained speculative. The new research, published online on April 23 in AGU Advances, offers guidance for sample recovery in order to better understand the ancient Martian climate and duration of the delta formation for NASA's Perseverance Rover to Mars, which is expected to launch in July 2020 as part of the first Mars sample return mission. Findings from Jezero crater could aid our understanding of how life evolved on Earth. If life once existed there, it likely didn't evolve beyond the single-cell stage, scientists say. That's because Jezero crater formed over 3.5 billion years ago, long before organisms on Earth became multicellular. If life once existed at the surface, its evolution was stalled by some unknown event that sterilized the planet. That means the Martian crater could serve as a kind of time capsule preserving signs of life as it might once have existed on Earth.
(Stanford University)

Emirates Mars Mission: Hope probe ready for launch from Japan's Tanegashima Space Centre (29 April 2020)
UAE Regional Mars probe was transferred to the launch site on Tanegashima Island in Japan. They aim to launch in July. The Hope Probe will be the first probe to provide a complete picture of the Martian atmosphere and its layers when it reaches the red planet's orbit in 2021. It will help answer key questions about the global Martian atmosphere and the loss of hydrogen and oxygen gases into space over the span of one Martian year.
(UAE Space Agency, Mohammed Bin Rashid Space Center)

MOON

Intuitive Machines selects launch date and landing site for 2021 moon mission
(13 April 2020)
Intuitive Machines (IM) engineers selected an area in Oceanus Procellarum near Vallis Schröteri as the landing site for its upcoming IM-1 lunar mission with an anticipated launch date in October 2021. Vallis Schröteri, also known as Schröter's Valley, is the largest valley on the Moon (comparable in size to the Grand Canyon) and is surrounded by Oceanus Procellarum, the largest lunar maria on the Moon. Oceanus Procellarum, also called the Ocean of Storms, covers over 10 percent of the entire Moon and has a diverse array of geological features. NASA considered a site near Vallis Schröteri for Apollo 18; now, IM is taking up the baton to conduct the initial survey. Nova-C, the first lander wholly developed by a private company, will deliver commercial cargo and five NASA-provided payloads to the lunar surface. These payloads will conduct scientific research and technology demonstrations as part of NASA's Commercial Lunar Payload Services (CLPS) program, in preparation for sending astronauts back to the Moon in 2024. (Intuitive Machines)

When the moon dust settles, it won't settle in VIPER's wheels (7 April 2020)
Moon dust is a formidable adversary – the grains are as fine as powder and as sharp as tiny

shards of glass. During the Apollo 17 mission to the Moon, the astronauts lamented how the dust found its way into everything, coating their spacesuits and jamming the shoulder joints, getting inside their lunar habitat and even causing symptoms of a temporary "lunar dust hay fever" in astronaut Harrison Schmitt. Those symptoms fortunately went away quickly – but the problem of Moon dust remains for future missions. NASA's new Moon rover, the Volatiles Investigating Polar Exploration Rover, has been running tests to ensure its wheel module components are dust-proof in advance of going to the Moon in 2023. VIPER's job is to hunt for water resources at the Moon's South Pole, creating the first resource maps for human space exploration before astronauts arrive under NASA's Artemis program in 2024. (NASA Ames)

Masten Space Systems will deliver NASA and commercial payloads to the lunar surface in 2022 (8 April 2020)
Today, NASA and Masten Space Systems announced that the Commercial Lunar Payload Services (CLPS) Project Office has selected Masten to deliver a suite of NASA-sponsored scientific instruments to the lunar surface by December 2022. In addition to commercial payloads, Masten's XL-1 lunar lander will deliver nine science and technology demonstration experiments to the lunar south pole. As part of the Artemis program, the purpose of these experiments is to collate localized, concurrent data sets from the lunar polar region in advance of human missions to the Moon. (Masten Space Systems, NASA)

USGS releases first-ever comprehensive geologic map of the Moon (20 April 2020)
Have you ever wondered what kind of rocks make up those bright and dark splotches on the moon? Well, the USGS has just released a new authoritative map to help explain the 4.5-billion-year-old history of our nearest neighbor in space. For the first time, the entire lunar surface has been completely mapped and uniformly classified by scientists from the USGS Astrogeology Science Center, in collaboration with NASA and the Lunar Planetary Institute. The lunar map, called the "Unified Geologic Map of the Moon," will serve as the definitive blueprint of the moon's surface geology for future human missions and will be invaluable for the international scientific community, educators and the public-at-large. The digital map is available online now and shows the moon's geology in incredible detail (1:5,000,000 scale). (USGS)

NASA CubeSat will shine a laser light on the Moon's darkest craters (27 April 2020)
Over the course of two months, Lunar Flashlight will swoop low over the Moon's South Pole to shine its lasers into permanently shadowed regions and probe for surface ice. Found near the North and South Poles, these dark craters are thought to be "cold traps" that accumulate molecules of different ices, including water ice. The molecules may have come from comet and asteroid material impacting the lunar surface and from solar wind interactions with the lunar soil. Because these craters are so cold, these molecules never receive enough energy to escape, so they become trapped and accumulate over billions of years. Lunar Flashlight's four-laser reflectometer will use near-infrared wavelengths that are readily absorbed by water to identify any accumulations of ice on the surface. Should the lasers hit bare rock as they shine into the South Pole's permanently shadowed regions, their light will reflect back to the spacecraft, signaling a lack of ice. But if the light is absorbed, it would mean these dark pockets do indeed contain ice. The greater the absorption, the more widespread ice may be at the surface. While the CubeSat can provide information only about the presence of ice on the

surface, and not below it, Lunar Flashlight seeks to fill a critical gap in our understanding of how much water ice these regions possess. (JPL)

NASA names companies to develop human landers for Artemis Moon missions (30 April 2020)
NASA has selected three U.S. companies to design and develop human landing systems (HLS) for the agency's Artemis program, one of which will land the first woman and next man on the surface of the Moon by 2024. NASA is on track for sustainable human exploration of the Moon for the first time in history. The human landing system awards under the Next Space Technologies for Exploration Partnerships (NextSTEP-2) Appendix H Broad Agency Announcement (BAA) are firm-fixed price, milestone-based contracts. The total combined value for all awarded contracts is $967 million for the 10-month base period.
The following companies were selected to design and build human landing systems:
•Blue Origin of Kent, Washington, is developing the Integrated Lander Vehicle (ILV) a three-stage lander to be launched on its own New Glenn Rocket System and ULA Vulcan launch system.
•Dynetics (a Leidos company) of Huntsville, Alabama, is developing the Dynetics Human Landing System (DHLS) a single structure providing the ascent and descent capabilities that will launch on the ULA Vulcan launch system.
•SpaceX of Hawthorne, California, is developing the Starship – a fully integrated lander that will use the SpaceX Super Heavy rocket.
With these contract awards, America is moving forward with the final step needed to land astronauts on the Moon by 2024, including the incredible moment when we will see the first woman set foot on the lunar surface. This is the first time since the Apollo era that NASA has direct funding for a human landing system. (NASA)

Research reveals possibly active tectonic system on the Moon (30 April 2020)
Researchers have discovered a system of ridges spread across the nearside of the Moon topped with freshly exposed boulders. The ridges could be evidence of active lunar tectonic processes, the researchers say, possibly the echo of a long-ago impact that nearly tore the Moon apart. Exposed blocks on the surface have a relatively short lifetime because the regolith build up is happening constantly. When we see them, there needs to be some explanation for how and why they were exposed in certain locations. In 2014, NASA's GRAIL mission found a network of ancient cracks in the Moon's crust. Those cracks became channels through which magma flowed to the Moon's surface to form deep intrusions. The blocky ridges seemed to line up just about perfectly with the deep intrusions revealed by GRAIL. The ridges above these ancient intrusions are still heaving upward. The upward movement breaks the surface and enables regolith to drain into cracks and voids, leaving the blocks exposed. Because bare spots on the Moon get covered over fairly quickly, this cracking must be quite recent, possibly even ongoing today. They refer to what they've found as ANTS, for Active Nearside Tectonic System. The researchers believe that the ANTS was actually set in motion billions of years ago with a giant impact on the Moon's far side. In previous studies they proposed this impact, which formed the 1500-mile South Pole Aitken Basin, shattered the interior on the opposite side, the nearside facing the Earth. Magma then filled these cracks and controlled the pattern of dikes detected in the GRAIL mission. The blocky ridges comprising the ANTS now trace the continuing adjustments along these ancient weaknesses. (Brown University)

PLUTO AND KUIPER BELT

The birth of a "Snowman" at the edge of the solar system (22 April 2020)
Simple high-speed collision between two random objects in the Kuiper Belt would shatter them, as they are likely to predominantly made of soft ice. If the two bodies orbited each other on a circular orbit (similar to the moon orbiting the Earth), and then slowly in-spiralled to more gently approach each other and make contact, Arrokoth's rotation speed would have been extremely high, while the measured speed was actually quite low in respect to such expectations. Arrokoth's full rotation, 'a day,' takes 15.92 hours. In addition, its angle of inclination (relative to the plane of its orbit around the Sun) is very large at 98 degrees and so it almost lies on the side relative to its orbit, a peculiar feature in itself. According to the model, these two bodies revolve around each other, but because they revolve together around the Sun, they basically constitute a triple system. The dynamics of such triple systems are complex and notoriously known as the three-body problem. The dynamics of gravitating triple systems is known to be very chaotic. In the study, they showed that the system did not move in a simple and orderly manner, but also did not behave in a totally chaotic way. It evolved from having a wide, relatively circular orbit, into a highly eccentric, elliptic orbit through a slow (secular) evolution, much slower compared to the orbital period of Arrokoth around the Sun. We could show that such trajectories eventually lead to a collision, which on the one hand will be slow, and not smash the objects, but on the other hand, produce a slowly-rotating, highly inclined object, consistent with Arrokoth properties. The detailed simulations confirmed this picture, and produced models closely resembling Arrokoth's snowman appearance, rotation and inclination. The researchers also studied how robust and probable such processes are and found them to potentially be quite common with as many as 20% of all Kuiper Belt wide binaries, and potentially evolving in similar ways. Until now it was not possible to explain the unique features of Arrokoth. It is a counter intuitive result, but the likelihood of collision in such configurations actually increases as the initial binary is more widely separated (but still bound) and the initial tilt angle is closer to 90 degrees. The model explains both the high likelihood of collision as well as the unique data of the unified system today, and in fact predict that many more objects in the Kuiper Belt. In fact, even Pluto's and Charon's system might have formed through a similar process, and they appear to play an important role in the evolution of binary and moon systems in the solar system. (Technion)

SATELLITES

Oita partners with Virgin Orbit to establish first horizontal spaceport in Asia (2 April 2020)
Virgin Orbit, the California-based small satellite launch company, has announced a new partnership with Oita Prefecture to bring horizontal launch to Japan. With the support of regional partners ANA Holdings Inc. and the Space Port Japan Association, Virgin Orbit has identified Oita Airport as its preferred pilot launch site — yet another addition to the company's growing global network of horizontal launch sites — in pursuit of a mission to space from Japan as early as 2022. (Virgin Orbit)

Intelsat 901 satellite returns to service using Northrop Grumman's Mission Extension Vehicle (17 April 2020)
A satellite may be healthy and fully operational, but it can still be retired if its fuel supply has

depleted. Once fuel runs dry, that's it: The satellite is done, unusable. Enter the Mission Extension Vehicle (MEV). On average, there are about 20 satellites each year that reach this condition and are retired. Since the number of potentially unusable satellites is so vast, Northrop Grumman is leading the way in developing satellite servicing plans and technology. MEV has solved this issue: It is a vehicle designed to dock with geostationary satellites whose fuel is nearly depleted. Once connected to its client satellite, MEV will use its own thrusters and fuel supply to extend the satellite's lifespan by performing station-keeping manoeuvres. Then, when the customer no longer needs MEV's service, it will undock and move on to the next client satellite. (Northrop Grumman)

SBIRS GEO-5 space vehicle enters critical thermal vacuum testing (24 April 2020)
SBIRS GEO-5 is a high-priority U.S. Space Force program that provides worldwide missile warning capability for the U.S. military. SMC's Production Corps and its industry partner Lockheed Martin Space work in close collaboration to achieve this major milestone for the program. SBIRS uses infrared surveillance to provide missile warning for national defence. The system consists of a constellation of satellites in both Geosynchronous Earth Orbit (GEO) and Highly Elliptical Orbit (HEO). The newest SBIRS satellites, GEO-5 and GEO-6, are based upon Lockheed Martin Space's modernized LM 2100 spacecraft, an update that improves overall system resiliency to provide mission assurance to the war fighter. (SMC)

NASA's new solar sail system to be tested on-board NanoAvionics' satellite (29 April 2020)
The aim of the ACS3 mission is to replace conventional rocket propellants by developing and testing solar sails using sunlight beams to thrust the nanosatellite. These solar sail propulsion systems are designed for future small interplanetary spacecrafts destined for low-cost deep-space and science missions requiring long-duration, low-thrust propulsion. The benefit of nanosatellites with solar sails is a continuous thrust without using expending propellants, enabling orbits that are not possible with conventional propulsion systems. Mission for these spacecrafts include comet rendezvous, solar system and interstellar scouts, polar orbits around the sun and planets, and asteroid mining. However, until the arrival of dedicated launchers for smallsats likely deep-space missions for nanosatellites are piggy-back rides where the main spacecraft would carry one or more nanosatellite like a Russian doll and fulfill their mission or a stand-alone system executing its own mission. NanoAvionics buses use multiple standard-sized units of 10x10x10cm. The size of the resulting spacecraft is measured by the number of units, e.g. 3U, 6U or 12U. The bus is the infrastructure of the spacecraft including components such as propulsion and communications systems; together with the payload ('mission') it comprises the satellite. A nanosatellite is class of smallsats typically with a mass, including propellant, between 1 and 10 kg (2.2 and 22.0 lbs.). (NanoAvionics)

SATURN AND MOONS

Data from NASA's Cassini may explain Saturn's atmospheric mystery (6 April 2020)
The upper layers in the atmospheres of gas giants - Saturn, Jupiter, Uranus and Neptune - are hot, just like Earth's. But unlike Earth, the Sun is too far from these outer planets to account for the high temperatures. Their heat source has been one of the great mysteries of planetary science. New analysis of data from NASA's Cassini spacecraft finds a viable explanation for what's keeping the upper layers of Saturn, and possibly the other gas giants, so hot: auroras at the planet's north and south poles. Electric currents, triggered by interactions between solar winds and charged particles from Saturn's moons, spark the auroras and heat the upper

atmosphere. (As with Earth's northern lights, studying auroras tells scientists what's going on in the planet's atmosphere.) The work, published April 6 in Nature Astronomy, is the most complete mapping yet of both temperature and density of a gas giant's upper atmosphere - a region that has, in general, been poorly understood. (JPL)

SPACE WEATHER

NASA awards NOAA's Space Weather Follow-On Lagrange 1 Magnetometer (15 April 2020)
On behalf of the National Oceanic and Atmospheric Administration (NOAA), NASA has awarded the Space Weather Follow-On Lagrange 1 (SWFO-L1) Magnetometer contract to Southwest Research Institute (SwRI) based in San Antonio, Texas. The SWFO-L1 satellite, which is planned to launch in 2024 as a rideshare on the NASA IMAP, will collect upstream solar wind data and coronal imagery to support NOAA's mission to monitor and forecast space weather events. SwRI will design, analyse, develop, fabricate, integrate, test, calibrate and evaluate the magnetometer instrument that consists of two three-axis magnetometers and associated electronics that will be used to measure the vector interplanetary magnetic field. SwRI will also support launch and on-orbit check-out of the instrument, supply and maintain the instrument Ground Support Equipment and support the Mission Operations Center through mission hand-over to NOAA. (NASA Goddard)

SUN

New insight into Parker Solar Probe's early observations (29 April 2020)
New analysis provides a possible explanation for the origin of switchbacks, the sudden reversals in the magnetic field of the solar wind, first observed by Parker Solar Probe during its November 2018 solar flyby. A new paper suggests the origin of switchbacks are related to the way the Sun maintains and moves magnetic field lines that stretch out into the solar system, tied to a theory first proposed more than two decades ago. The Sun's complex magnetic field is mostly made up of closed loops of magnetic field with both ends anchored in the Sun. The Sun's less-common open field lines migrate between the Sun's north and south poles over the course of the approximately 11-year solar cycle, during which the overall magnetic field reverses in polarity. A theory first published by Fisk and colleagues more than two decades ago explains the process behind this field line migration, and its predictions line up with the switchbacks observed by Parker Solar Probe. The switchbacks, essentially S-shaped kinks in the magnetic field lines streaming from the Sun, seem to arise from a reconfiguration of open and looped magnetic field lines already in the Sun's atmosphere. When an open magnetic field line encounters a closed magnetic loop, they can undergo a process called interchange reconnection. This allows the open magnetic field line to snap into the loop and allows one side of the formerly closed magnetic loop to connect to solar magnetic field extending outwards into the solar system. This process would create an outward-flowing S-shaped kink in the newly formed open magnetic field line, a shape that tracks with the switchbacks measured by Parker Solar Probe. This interchange reconnection also drags the open magnetic field line across the solar surface, meaning that the Sun's magnetic field can move east to west faster than solar rotation alone explains. This aligns with observations made during Parker Solar Probe's first solar encounters: the larger than

expected “sideways” motion of solar wind near the Sun. This, the authors suggest, is the expression of the plasma’s and magnetic field’s flow pattern deeper in the solar corona. This theory, first proposed in 1996 based on data from the ESA/NASA Ulysses mission, could unify these two aspects Parker Solar Probe's early observations. The mission's future solar encounters, progressively closer to the Sun, will help scientists further investigate the switchbacks' origins and test the predictions of this theory. (NASA Goddard)

Sun is less active than similar stars (30 April 2020)
The Sun is an ever-changing star: at times, numerous dark sunspots cover its visible surface; at others, the surface is completely "empty". However, by cosmic standards the Sun is extraordinarily monotonous. For the first time, the scientists compared the Sun with hundreds of other stars with similar rotation periods and other fundamental properties. Most of them displayed much stronger variations. This raises the question of whether the Sun’s feebleness is a basic trait or whether our star has merely been going through an unusually quiet phase for several millennia. A star’s rotation contributes to the creation of its magnetic field in a dynamo process in its interior. The magnetic field is the driving force responsible for all fluctuations in activity. The state of the magnetic field determines how often the Sun emits energetic radiation and hurls particles at high speeds into space in violent eruptions, how numerous dark sunspots and bright regions on its surface are and thus also how brightly the Sun shines. For the last decade, the Sun has been showing itself to be rather weakly active, even by its own low standards. Predictions of activity for the next eleven years indicate that this will not change soon. (Max Planck Institute for Solar System Research)

TECHNOLOGY

Using augmented reality to prepare Orion hardware for Artemis II crewed mission
(1 April 2020)
The goggle technology provides a unique function for understanding the dynamic work environment of assembling complex hardware, such as a spacecraft that will fly humans to deep space. Instead of interpreting the work procedure from text or models on a 2-D screen, the instructions appear overlaid in 3-dimensional space onto the physical spacecraft while wearing the goggles. “For something we are used to doing in at least a week’s time, or eight to 12 shifts, we were able to complete in one shift.” Lakaszcyck said looking through the goggles and seeing exactly where to place items on the spacecraft, what orientation to place them, and the reference number that accompanies them, makes the process more efficient than ever. (NASA Kennedy)

UNIVERSE

Universe expansion may not be uniform (8 April 2020)
Astronomers have assumed for decades that the Universe is expanding at the same rate in all directions. A new study based on data from ESA’s XMM-Newton, NASA’s Chandra and the German-led ROSAT X-ray observatories suggests this key premise of cosmology might be wrong. (ESA)

VENUS

MESSENGER data upends long-held idea about Venus' atmosphere (20 April 2020)
Nitrogen concentration through Venus' atmosphere. New analysis of MESSENGER data, as it did a flyby of Venus, shows an uptick in nitrogen concentration around Venus' upper cloud deck roughly 30 miles (50 kilometers) up, upending a long-held idea that nitrogen is distributed equally throughout. (JHU APL)

Atmospheric tidal waves maintain Venus' super-rotation (24 April 2020)
An international research team led by Takeshi Horinouchi of Hokkaido University has revealed that this 'super-rotation' is maintained near the equator by atmospheric tidal waves formed from solar heating on the planet's dayside and cooling on its nightside. Closer to the poles, however, atmospheric turbulence and other kinds of waves have a more pronounced effect. Venus rotates very slowly, taking 243 Earth days to rotate once around its axis. Despite this very slow rotation, Venus' atmosphere rotates westward 60 times faster than its planetary rotation. This super-rotation increases with altitude, taking only four Earth days to circulate around the entire planet towards the top of the cloud cover. The fast-moving atmosphere transports heat from the planet's dayside to nightside, reducing the temperature differences between the two hemispheres. The team developed a new, highly precise method to track clouds and derive wind velocities from images provided by ultraviolet and infrared cameras on the Akatsuki spacecraft, which began its orbit of Venus in December 2015. This allowed them to estimate the contributions of atmospheric waves and turbulence to the super-rotation. The group first noticed that atmospheric temperature differences between low and high latitudes are as small as it cannot be explained without a circulation across latitudes. Since such circulation should alter the wind distribution and weaken the super-rotation peak, it also implies there is another mechanism which reinforces and maintains the observed wind distribution. Further analyses revealed that the maintenance is sustained by the thermal tide, an atmospheric wave excited by the solar heating contrast between the dayside and the nightside, which provides the acceleration at low latitudes. Earlier studies proposed that atmospheric turbulence and the waves other than the thermal tide may provide the acceleration. However, the current study showed that they work oppositely to weakly decelerate the super-rotation at low latitude, even though they play an important role at mid- to high latitudes. Their findings uncovered the factors that maintain the super-rotation while suggesting a dual circulation system that effectively transports heat across the globe: the meridional circulation that slowly transports heat towards the poles and the super-rotation that rapidly transports heat towards the planet's nightside. The study could help better understand atmospheric systems on tidally locked exo-planets whose one side always facing the central stars, which is similar to Venus having a very long solar day.
(Hokkaido University)

Pat Williams April 2020