Space News Update – May 2020

By Pat Williams

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

UK'S FIRST COMPLETE GROUND ROCKET TEST IN 50 YEARS TAKES PLACE IN SCOTLAND

The Skyrora Skylark-L rocket undergoes its first vertical static fire test in the Scottish Highlands (Credit: Skyrora)

Skyrora makes history as it completes UK's largest rocket fire test in 50 years. A full-size rocket has successfully carried out all actions needed to reach space, in the first vertical static fire test of its magnitude in the UK for 50 years. Scottish firm Skyrora said the Skylark-L rocket, the first of its kind since the Black Arrow programme, could be ready to launch from British soil as early as spring 2021, although the required spaceport infrastructure is not expected to be ready by then. "We see this as being the first significant step towards reaching

space from our own soil and are very proud to have taken that step as part of the UK's space ambitions," said Skyrora CEO Volodymyr Levykin. "We are now in a full state of readiness for launch. It is this milestone that is the start of the UK's new space revolution, a fantastic example of the potential of what the UK space holds for the future."

Remarkably, the team built a mobile launch complex and completed the full static fire test in just five days. Kildemorie Estate in the Scottish Highlands hosted the test, in which the launch vehicle performed all actions of a launch while restrained to the ground to prevent take-off. The Skylark-L is a bi-liquid propellant launch vehicle. It is Skyrora's first sub-orbital flight vehicle, ready to reach a height of approximately 100km, just on the border of space, known as the Kármán line and carry a payload of up to 60kg. The rocket uses a propellent combination of hydrogen peroxide and kerosene, which are pressure fed into a Skyrora 30kN engine. Building up to the static fire test, the rocket engine itself went through three hot fire tests before integration into the vehicle. When commercially viable, the company plans to use its own 'Ecosene', a kerosene equivalent made from un-recyclable plastic waste. The full static firing test let the team fully check the design and in-house manufacture, making sure it is ready for launch. "It is very hard to oversell what we have achieved here," said Dr Jack-James Marlow. "The rocket engine successfully burned, with all vehicle systems showing nominal operation. The test did not only validate the vehicle, it also tested our mobile launch complex's ground equipment and performed many cold flow and fuel/ defuel tests. In all, there were over 100 unique operations and the team has gained vital experience. "This collection of tests, combined with the 25 other engine tests this year, allow us to take another step along our technology roadmap to orbital launch." Levykin said: "As the launch aspect of the UK's new space industry starts to emerge, there will be many events that have never happened here previously, and this is one of them. This was a mammoth effort in very trying circumstances, so it is quite an achievement to be proud of. "The operation was carried out while having to adhere to very strict social distancing measures, and in an extremely remote location, providing additional challenges, all of which were handled expertly by all the team." He added: "With the expertise in place and all the necessary hardware at the ready, we are poised to take the next steps in making the UK a serious leader in the space business once again." Plans are under way to build the UK's first spaceport in Sutherland, on Scotland's north coast. Construction was expected to take about 15 months, but the project has reportedly been hit by delays during the coronavirus lockdown. During the test, the Skylark-L was supported by Skyrora's transporter-erector that was fixed to the trailer. The mobile complex was made up of several modules including a command centre, oxidiser and fuel handling containers, and a compressed gas container. The company is pioneering the use of 3D printing for engine manufacture. (Skyrora)
UK's first complete ground rocket test in 50 years takes place in Scotland (20 May 2020)

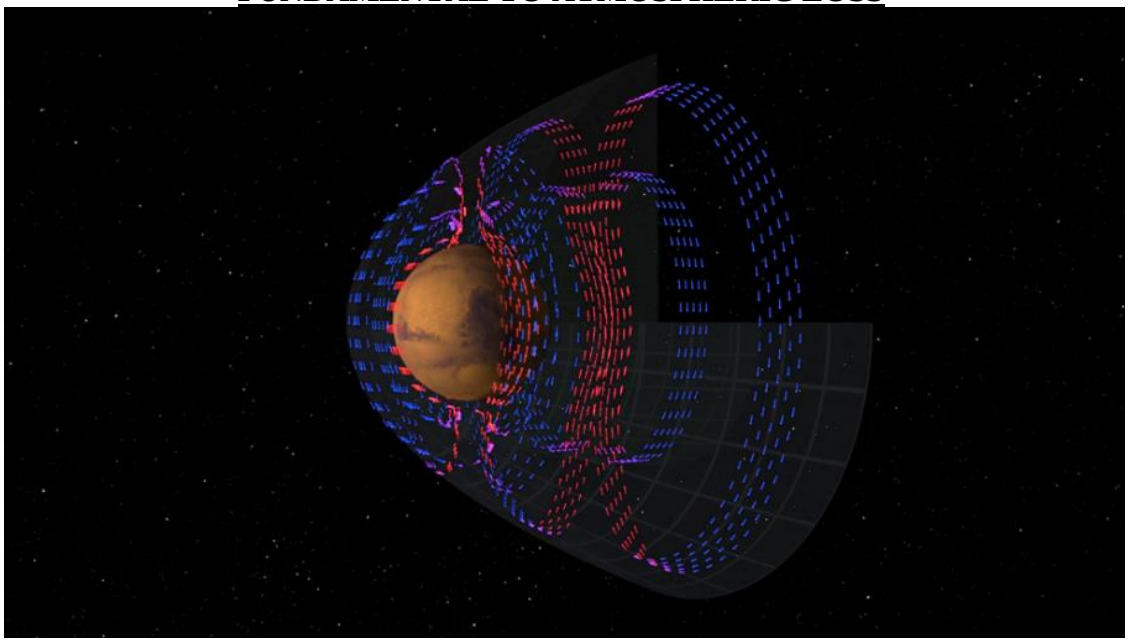
INTERNATIONAL SPACE STATION WELCOMES FIRST SPACEX CREW DRAGON WITH NASA ASTRONAUTS

The Expedition 63 crew has expanded to five members with the arrival of the SpaceX Crew Dragon. (From left) Anatoly Ivanishin, Ivan Vagner, Chris Cassidy, Bob Behnken and Doug Hurley. (NASA photograph)

NASA astronauts Robert Behnken and Douglas Hurley arrived at the International Space Station on Sunday aboard the first commercially built and operated American spacecraft to carry humans to orbit, opening a new era in human spaceflight. The pair of astronauts docked to the space station's Harmony module at 10:16 a.m. EDT Sunday as the microgravity laboratory flew 262 miles above the border northern China and Mongolia. Behnken and Hurley, the first astronauts to fly to SpaceX's Crew Dragon to the station, were welcomed as crew members of Expedition 63 by fellow NASA astronaut Chris Cassidy and two Russian cosmonauts Anatoly Ivanishin and Ivan Vagner. NASA is not going to purchase, own and operate rockets and capsules the way they used to; they're going to partner with commercial industry. When they go to the Moon they're going to land on the surface of the Moon with commercial landers. All of this is leading up to an amazing day where we have humans living and working for long periods of time on the surface of the Moon and doing it with a purpose. And that purpose, of course, is to go to Mars. The crew will remain busy as they continue to test and demonstrate the capabilities of Dragon Endeavour while it is docked to the space station. The Crew Dragon being used for this flight test can stay in orbit about 110 days, and the specific mission duration will be determined once on station based on the readiness of the next commercial crew launch. The operational Crew Dragon spacecraft will be capable of staying in orbit for at least 210 days as a NASA requirement. At the end of the mission, Behnken and Hurley will board the spacecraft, which will autonomously undock, depart the space station and returns to Earth through a parachute-assisted splashdown in the Atlantic Ocean, where the SpaceX recovery ship crew will pick up the crew and return them to Cape Canaveral. (NASA)

International Space Station Welcomes First SpaceX Crew Dragon with NASA Astronauts (31 May 2020)

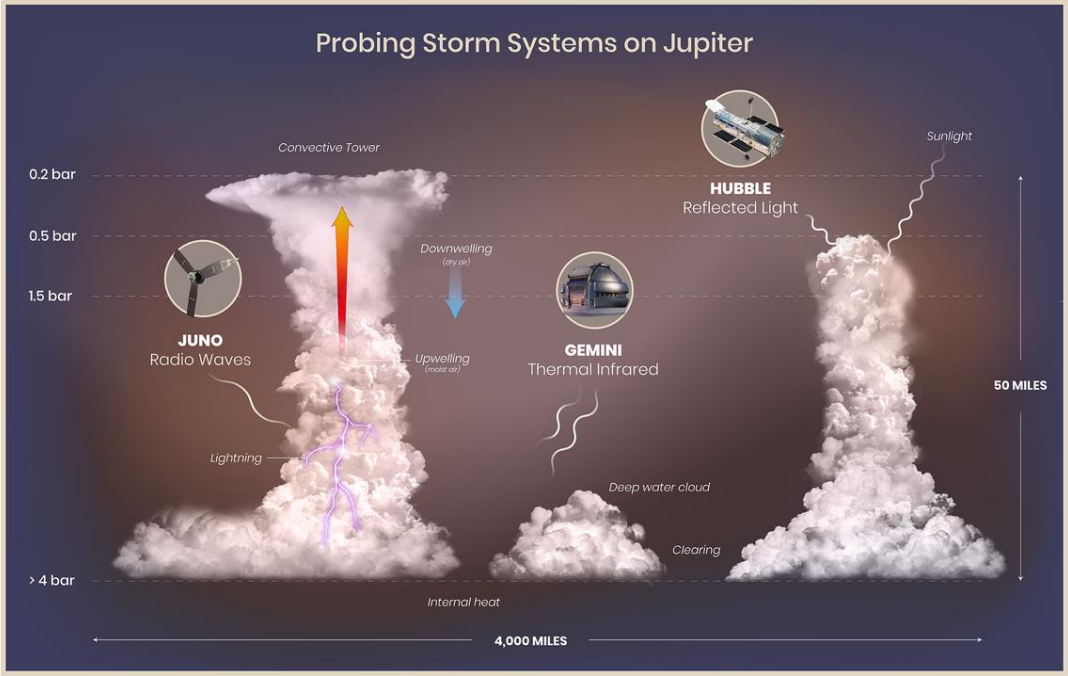
MAVEN MAPS ELECTRIC CURRENTS AROUND MARS THAT ARE FUNDAMENTAL TO ATMOSPHERIC LOSS



This image is from a scientific visualization of the electric currents around Mars. Electric currents (blue and red arrows) envelop Mars in a nested, double-loop structure that wraps continuously around the planet from its day side to its night side. These current loops distort the solar wind magnetic field (not pictured), which drapes around Mars to create an induced magnetosphere around the planet. In the process, the currents electrically connect Mars' upper atmosphere and the induced magnetosphere to the solar wind, transferring electric and magnetic energy generated at the boundary of the induced magnetosphere (faint inner paraboloid) and at the solar wind bow shock (faint outer paraboloid).
Credits: NASA/Goddard/MAVEN/CU Boulder/SVS/Cindy Starr

Mars does not generate a magnetic field on its own, outside of relatively small patches of magnetized crust. Something different from what we observe on Earth must be happening on the Red Planet. The solar wind, made up largely of electrically charged electrons and protons, blows constantly from the Sun at around a million miles per hour. It flows around and interacts with the objects in our solar system. The solar wind is also magnetized, and this magnetic field cannot easily penetrate the upper atmosphere of non-magnetized planets like Mars. Instead, currents that it induces in the planet's ionosphere cause a pile-up and strengthening of the magnetic field, creating a so-called induced magnetosphere. How the solar wind powers this induced magnetosphere at Mars has not been well understood until now. As solar wind ions and electrons smash into this stronger induced magnetic field near Mars, they are forced to flow apart due to their opposite electric charge. Some ions flow in one direction, some electrons in the other direction, forming electric currents that drape around from the dayside to the nightside of the planet. At the same time, solar x-rays and ultraviolet radiation constantly ionize some of the upper atmosphere on Mars, turning it into a combination of electrons and electrically charged ions that can conduct electricity. Without a global magnetic field surrounding Mars, the currents induced in the solar wind can form a direct electrical connection to the Martian upper atmosphere. The currents transform the energy of the solar wind into magnetic and electric fields that accelerate charged atmospheric particles into space, driving atmospheric escape to space. The new results reveal several unexpected features particular to MAVEN's goal to understand atmospheric escape: the energy that drives escape appears to be drawn from a much larger volume than was often assumed. (NASA Goddard)
MAVEN maps electric currents around Mars that are fundamental to atmospheric loss
(25 May 2020)

TELESCOPES AND SPACECRAFT JOIN FORCES TO PROBE DEEP INTO JUPITER'S ATMOSPHERE



Credit: NASA

NASA's Hubble Space Telescope and the ground-based Gemini Observatory in Hawaii have teamed up with the Juno spacecraft to probe the mightiest storms in the solar system, taking place more than 500 million miles away on the giant planet Jupiter. With thunderheads that tower forty miles high and stretch half the width of a continent, hurricane-force winds in enormous storms that rage for centuries, and lightning three times as powerful as Earth's strongest super-bolts, Jupiter, king of the planets, has proven itself a more-than-worthy namesake to the supreme Roman god of sky and thunder. Every 53 days, Juno races low over the storm systems detecting radio signals known as "sferics" and "whistlers," which can then be used to map lightning even on the day side of the planet or from deep clouds where flashes are not otherwise visible. Coinciding with each pass, Hubble and Gemini watch from afar, capturing high-resolution global views of the planet that are key to interpreting Juno's close-up observations. Juno's microwave radiometer probes deep into the planet's atmosphere by detecting high-frequency radio waves that can penetrate through the thick cloud layers. The data from Hubble and Gemini can tell us how thick the clouds are and how deep we are seeing into the clouds. By mapping lightning flashes detected by Juno onto optical images captured of the planet by Hubble and thermal infrared images captured at the same time by Gemini, the research team has been able to show that lightning outbreaks are associated with a three-way combination of cloud structures: deep clouds made of water, large convective towers caused by upwelling of moist air, essentially Jovian thunderheads and clear regions presumably caused by downwelling of drier air outside the convective towers. The Hubble data show the height of the thick clouds in the convective towers, as well as the depth of deep water clouds. The Gemini data clearly reveal the clearings in the high-level clouds where it is possible to get a glimpse down to the deep water clouds. (STScI)

Telescopes and spacecraft join forces to probe deep into Jupiter's atmosphere
(7 May 2020)

VIRGIN GALACTIC'S SPACESHIPTWO COMPLETES FIRST FLIGHT FROM SPACEPORT AMERICA

Credit: Virgin Galactic

Virgin Galactic Holdings today announced the successful completion of its first SpaceShipTwo test flight from Spaceport America. This glide flight marks the inaugural solo flight of VSS Unity in New Mexico and as such is an important flight test milestone in preparation for commercial service. On SpaceShipTwo's flight deck were Dave Mackay and CJ Sturckow who, together with the team in Mission Control, executed some of the key elements of a spaceflight profile. These included take-off and landing along with high-altitude release from the mothership, VMS Eve, which was piloted by Michael Masucci and Kelly Latimer. The flight took off from the Spaceport America runway, with VSS Unity attached to the carrier aircraft, VMS Eve. The vehicles climbed to an altitude of 50,000ft before Unity was released, at which point VSS Unity flew freely for the first time in New Mexico airspace. The spaceship achieved a glide speed of Mach 0.70 and completed multiple test-points, before touching back down smoothly for a runway landing at Spaceport America. Preparation for the next flight will now begin, starting with an in depth analysis of today's flight data. (Virgin Galactic)
Virgin Galactic's SpaceShipTwo completes first flight from Spaceport America
(1 May 2020)

LINKS TO OTHER SPACE NEWS PUBLISHED IN MAY 2020

ASTEROIDS

Hayabusa2 reveals more secrets from Ryugu (11 May 2020)
Scientists used Hayabusa2's ONC-W1 and ONC-T imaging instruments to look at dusty matter kicked up by the spacecraft's engines during the touchdowns. They discovered large amounts of very fine grains of dark-red coloured minerals. These were produced by solar heating, suggesting at some point Ryugu must have passed close by the sun. The team investigated the spatial distribution of the dark-red matter around Ryugu as well as its spectra or light signature. The strong presence of the material around specific latitudes corresponded to the areas that would have received the most solar radiation in the asteroid's past; hence, the belief that Ryugu must have passed by the sun. From previous studies we know Ryugu is carbon-rich and contains hydrated minerals and organic molecules. We wanted to know how solar heating chemically changed these molecules. Our theories about solar heating could change what we know of orbital dynamics of asteroids in the solar system. This in turn alters our knowledge of broader solar system history, including factors that may have affected the early Earth. When Hayabusa2 delivers material it collected during both touchdowns, researchers will unlock even more secrets of our solar history. Based on spectral readings and

albedo, or reflectivity, from within the touchdown sites, researchers are confident that both dark-red solar-heated material and grey unheated material were collected by Hayabusa2. (University of Tokyo)

OSIRIS-REx ready for touchdown on asteroid Bennu (20 May 2020)
NASA's first asteroid sample return mission is officially prepared for its long-awaited touchdown on asteroid Bennu's surface. The Origins, Spectral Interpretation, Resource Identification and Security – Regolith Explorer (OSIRIS-REx) mission has targeted Oct. 20 for its first sample collection attempt. During the TAG event, OSIRIS-REx's sampling mechanism will touch Bennu's surface for approximately five seconds, fire a charge of pressurized nitrogen to disturb the surface, and collect a sample before the spacecraft backs away. The mission has resources onboard for three sample collection opportunities. If the spacecraft successfully collects a sufficient sample on Oct. 20, no additional sampling attempts will be made. The spacecraft is scheduled to depart Bennu in mid-2021 and will return the sample to Earth on Sept. 24, 2023. (NASA Goddard)

ASTROPHYSICS

Where high energy neutrinos come from (13 May 2020)
Russian astrophysicists have come close to solving the mystery of where high-energy neutrinos come from in space. The team compared the data on the elusive particles gathered by the Antarctic neutrino observatory IceCube and on long electromagnetic waves measured by radio telescopes. Cosmic neutrinos turned out to be linked to flares at the centres of distant active galaxies, which are believed to host supermassive black holes. As matter falls toward the black hole, some of it is accelerated and ejected into space, giving rise to neutrinos that then coast along through the universe at nearly the speed of light. (MIPT)

BLACK HOLES

ESO instrument finds closest black hole to Earth (6 May 2020)
A team of astronomers from the European Southern Observatory (ESO) and other institutes has discovered a black hole lying just 1000 light-years from Earth. The black hole is closer to our Solar System than any other found to date and forms part of a triple system that can be seen with the naked eye. The team found evidence for the invisible object by tracking its two companion stars using the MPG/ESO 2.2-metre telescope at ESO's La Silla Observatory in Chile. They say this system could just be the tip of the iceberg, as many more similar black holes could be found in the future. They were totally surprised to realise that this is the first stellar system with a black hole that can be seen with the unaided eye. Located in the constellation of Telescopium, the system is so close to us that its stars can be viewed from the southern hemisphere on a dark, clear night without binoculars or a telescope. (ESO)

BROWN DWARFS

Astronomers find Jupiter-like cloud bands on closest brown dwarf (5 May 2020)
Brown dwarfs, often called "failed stars," weigh up to 80 times as much as Jupiter, yet their gravity compacts them to about the size of Jupiter in diameter. And like Jupiter, brown dwarfs can have clouds and weather. Astronomers have found evidence that the closest known brown dwarf, Luhman 16A, has Jupiter-like cloud bands. In contrast its companion brown dwarf, Luhman 16B, shows signs of patchy clouds. A team of astronomers has

discovered that the closest known brown dwarf, Luhman 16A, shows signs of cloud bands similar to those seen on Jupiter and Saturn. This is the first time scientists have used the technique of polarimetry to determine the properties of atmospheric clouds outside of the solar system, or exoclouds. Brown dwarfs are objects heavier than planets but lighter than stars, and typically have 13 to 80 times the mass of Jupiter. Luhman 16A is part of a binary system containing a second brown dwarf, Luhman 16B. At a distance of 6.5 light-years, it's the third closest system to our Sun after Alpha Centauri and Barnard's Star. Both brown dwarfs weigh about 30 times as much as Jupiter. Despite the fact that Luhman 16A and 16B have similar masses and temperatures (about 1,900° F or 1,000° C), and presumably formed at the same time, they show markedly different weather. Luhman 16B shows no sign of stationary cloud bands, instead exhibiting evidence of more irregular, patchy clouds. Luhman 16B therefore has noticeable brightness variations as a result of its cloudy features, unlike Luhman 16A. Like Earth and Venus, these objects are twins with very different weather. It can rain things like silicates or ammonia. It's pretty awful weather, actually. The researchers used an instrument on the Very Large Telescope in Chile to study polarized light from the Luhman 16 system. Polarization is a property of light that represents the direction that the light wave oscillates. Polarized sunglasses block out one direction of polarization to reduce glare and improve contrast. Instead of trying to block out that glare, they're trying to measure it. When light is reflected off of particles, such as cloud droplets, it can favour a certain angle of polarization. By measuring the preferred polarization of light from a distant system, astronomers can deduce the presence of clouds without directly resolving either brown dwarf's cloud structure. Even from light-years away, they can use polarization to determine what the light encountered along its path.

COMETS

Solar Orbiter to pass through the tails of Comet ATLAS (29 May 2020)
ESA's Solar Orbiter will cross through the tails of Comet ATLAS during the next few days. Although the recently launched spacecraft was not due to be taking science data at this time, mission experts have worked to ensure that the four most relevant instruments will be switched on during the unique encounter. (ESA)

EARTH

SAR interferometry demonstrated with an 18-day global repeat by ICEYE (6 May 2020)
SAR interferometry is used to detect millimetre-scale surface movements in vertical direction between two or more SAR images. These height differences are analysed using maps called interferograms, which are the basis for creating Digital Elevation Models (DEM). Interferograms are also used for monitoring oil exploration activities, ongoing underground constructions, ensuring the safety of mining activities, and analysing ground deformations after earthquakes, among other uses. With an actively maintained 18-day repeat ground track worldwide, ICEYE has demonstrated a new radar satellite imaging capability from its current radar satellite constellation. ICEYE's interferometric SAR capability is used for change detection measured in millimeters. (ICEYE)

Aeolus goes public (12 May 2020)
Aeolus is one of ESA's Earth Explorer missions, which all set out to demonstrate how new ways of observing Earth can advance our understanding of how the planet works as a system.

Carrying one of the most sophisticated instruments ever to be put into orbit, Aeolus is the first satellite mission to directly profile Earth's winds from space. It works by emitting short, powerful pulses of ultraviolet light from a laser and measures the Doppler shift from the very small amount of light that is scattered back to the instrument from molecules and particles to deliver vertical profiles that show the horizontal speed of the world's winds in the lowermost 26 km of the atmosphere. (ESA)

Swarm probes weakening of Earth's magnetic field (20 May 2020)
In an area stretching from Africa to South America, Earth's magnetic field is gradually weakening. This strange behaviour has geophysicists puzzled and is causing technical disturbances in satellites orbiting Earth. Scientists are using data from ESA's Swarm constellation to improve our understanding of this area known as the 'South Atlantic Anomaly.' At surface level, the South Atlantic Anomaly presents no cause for alarm. However, satellites and other spacecraft flying through the area are more likely to experience technical malfunctions as the magnetic field is weaker in this region, so charged particles can penetrate the altitudes of low-Earth orbit satellites. (ESA)

EXOPLANETS

ESO telescope sees signs of planet birth (20 May 2020)
Observations made with the European Southern Observatory's Very Large Telescope (ESO's VLT) have revealed the tell-tale signs of a star system being born. Around the young star AB Aurigae lies a dense disc of dust and gas in which astronomers have spotted a prominent spiral structure with a 'twist' that marks the site where a planet may be forming. The observed feature could be the first direct evidence of a baby planet coming into existence. (ESO)

Astronomers create cloud atlas for hot, Jupiter-like exoplanets (26 May 2020)
Giant planets in our solar system and circling other stars have exotic clouds unlike anything on Earth, and the gas giants orbiting close to their stars, so-called hot Jupiters, boast the most extreme. A team of astronomers from the United States, Canada and the United Kingdom have now come up with a model that predicts which of the many types of proposed clouds, from sapphire to smoggy methane haze, to expect on hot Jupiters of different temperatures, up to thousands of degrees Kelvin. Surprisingly, the most common type of cloud, expected over a large range of temperatures, should consist of liquid or solid droplets of silicon and oxygen, like melted quartz or molten sand. On cooler hot Jupiters, below about 950 Kelvin (1,250 degrees Fahrenheit), skies are dominated by a hydrocarbon haze, essentially smog. (UC Berkeley)

ESPRESSO confirms the presence of an Earth around the nearest star (28 May 2020)
The existence of a planet the size of Earth around the closest star in the solar system, Proxima Centauri, has been confirmed by an international team of scientists including researchers from the University of Geneva (UNIGE). The results reveal that the planet in question, Proxima b, has a mass of 1.17 earth masses and is located in the habitable zone of its star, which it orbits in 11.2 days. This breakthrough has been possible thanks to radial velocity measurements of unprecedented precision using ESPRESSO, the Swiss-manufactured spectrograph, the most accurate currently in operation, which is installed on the Very Large Telescope in Chile. Proxima b was first detected four years ago by means of an older

spectrograph, HARPS, also developed by the Geneva-based team, which measured a low disturbance in the star's speed, suggesting the presence of a companion.
(University of Geneva)

FAST RADIO BURSTS

Astronomers discover new class of cosmic explosions (26 May 2020)
Fast Blue Optical Transients (FBOTs), represent a type of stellar explosion significantly different from others. FBOTs probably begin the same way as certain supernovae and gamma-ray bursts when a star much more massive than the Sun explodes at the end of its "normal" atomic fusion-powered life. The differences show up in the aftermath of the initial explosion. In the "ordinary" supernova of this type, called a core-collapse supernova, the explosion sends a spherical blast wave of material into interstellar space. If, in addition to this, a rotating disk of material briefly forms around the neutron star or black hole left after the explosion and propels narrow jets of material at nearly the speed of light outward in opposite directions, these jets can produce narrow beams of gamma rays, causing a gamma-ray burst. The rotating disk, called an accretion disk, and the jets it produces, are called an "engine" by astronomers. FBOTs, the astronomers concluded, also have such an engine. In their case, unlike in gamma-ray bursts, it is enshrouded by thick material. That material probably was shed by the star just before it exploded and may have been pulled from it by a binary companion. When the thick material near the star is struck by the blast wave, it causes the bright visible-light burst soon after the explosion that initially made these objects appear so unusual. That bright burst also is why astronomers call these blasts "fast blue optical transients." This is one of the characteristics that distinguished them from ordinary supernovae. As the blastwave from the explosion collides with the material around the star as it travels outwards, it produces radio emission. This very bright emission was the important clue that proved that the explosion was powered by an engine. The shroud of dense material means that the progenitor star is different from those leading to gamma-ray bursts. Using the W.M. Keck Observatory, the astronomers found that both CSS 161010 and ZTF18abvkwla are in small, dwarf galaxies. Although a common element of the FBOTs is that all three have a 'central engine,' the astronomers caution that the engine also could be the result of stars being shredded by black holes, though they consider supernova-type explosions to be the more likely candidate. (NRAO)

GALAXIES

New observations show that massive disk galaxies formed exceptionally early in cosmic history (20 May 2020)
In our 13.8 billion-year-old universe, most disk galaxies like our Milky Way were thought to form gradually, reaching their large mass relatively late. But now astronomers using the ALMA observatory, have found a massive rotating disk galaxy, seen when the universe was only ten percent of its current age. The observation shows that some disk galaxies must have formed much more quickly. This supports earlier computer simulations that had indicated the role of a quick, "cold" mode of galaxy formation. (Max-Planck-Gesellschaft)

INTERNATIONAL SPACE STATION

Airbus and Xenesis sign payload contract for new Bartolomeo platform on the International Space Station(5 May 2020)
Aerospace company Airbus has signed a payload slot contract with laser communications start-up Xenesis for Bartolomeo platform on the International Space Station (ISS). Xenesis is planning to demonstrate its Xen-Hub optical communication space terminal aboard the Airbus-built platform on ISS. The optical communications terminal has been developed to expand the bandwidth of satellite communications and was built following a technology transfer from the Nasa Jet Propulsion Laboratory. The Bartolomeo platform was launched from the Kennedy Space Center in Florida and installed on the ISS Columbus module on 1 April. The platform serves as an affordable alternative to small satellites and CubeSats. It can provide direct views of Earth from altitudes of around 240 miles. (Airbus)

Last of NASA's versatile science 'EXPRESS Racks' heads to space station (18 May 2020)
When the Japanese HTV-9 Kounotori cargo ship lifts off to deliver supplies and science equipment to the International Space Station, a landmark chapter in the station's story will draw to a close and a new chapter, helping to chart a course for Artemis-generation voyages into the solar system, will begin. Among the manifested cargo aboard the spacecraft will be the final NASA "EXpedite the PRocessing of Experiments to the Space Station" multipurpose payload shelving unit. Better known as EXPRESS Racks, these permanent fixtures on the station support a variety of research experiments, providing power, protective storage, cooling and heating, command and data communications and easy transport for up to 10 small payloads each. Once the new rack is installed, 11 total racks will be on the station, the eight original EXPRESS Racks and three Basic EXPRESS Racks, more streamlined and versatile modern versions. Each is about the size of a refrigerator and comes equipped with up to eight configurable lockers and two drawers to house payloads. Experiments can be conducted, removed independently and returned to Earth, depending on varying time requirements. The first EXPRESS rack was successfully tested aboard the space shuttle in 1997. The first two completed racks were delivered to the space station on STS-100 in 2001 and have been in continuous operation ever since, as have all the subsequent added racks. The new rack is expected to be installed on the station and operational by fall 2020. (NASA Marshall)

New European Drawer Rack set for Space Station(18 May 2020)
When the Japanese HTV-9 cargo vehicle launches to the International Space Station on 20 May it will carry a part of Europe in its pressurised module. The second iteration of the European Drawer Rack (EDR-2) is destined for the European Columbus laboratory and will provide even greater opportunities for science in space. Columbus has been flying 400 km above our heads as part of the International Space Station for 12 years. Its collection of facilities enables European scientists to run experiments across scientific disciplines including biology, metallurgy and physics, as well as research in radiation and testing new technology in microgravity. (ESA)

NASA astronauts launch from America in test flight of SpaceX Crew Dragon (30 May 2020)
For the first time in history, NASA astronauts have launched from American soil in a commercially built and operated American crew spacecraft on its way to the International Space Station. The SpaceX Crew Dragon spacecraft carrying NASA astronauts Robert Behnken and Douglas Hurley lifted off at 3:22 p.m. EDT Saturday on the company's Falcon 9 rocket from Launch Complex 39A at NASA's Kennedy Space Center in Florida. Known as NASA's SpaceX Demo-2, the mission is an end-to-end test flight to validate the SpaceX crew transportation system, including launch, in-orbit, docking and landing operations. This

is SpaceX's second spaceflight test of its Crew Dragon and its first test with astronauts aboard, which will pave the way for its certification for regular crew flights to the station as part of NASA's Commercial Crew Program. (NASA)

LAUNCH SERVICES

Rocket Crafters concludes Comet testing (12 May 2020)
Rocket Crafters, the first space launch company to use additive manufacturing to 3D print rocket fuel, announces the conclusion of testing for the Comet engine, a large-scale proof of concept test model of its STAR-3DTM hybrid rocket engine. The tests were designed to show that the patent-pending hybrid rocket engines could scale from the laboratory to a size more commercially relevant. With 49 successful laboratory tests under their belt ranging from 250 to 500 pounds of thrust, Rocket Crafters initiated testing of the Comet 5000-pound thrust engine in February of this year. (Rocket Crafters)

MARS

ExoMars rover upgrades and parachute tests (15 May 2020)
The second ExoMars mission, scheduled for launch to the Red Planet in 2022, is taking advantage of the extra time to upgrade some of the rover's instruments and get ready for the next parachute high-altitude drop tests. (ESA)

Planetary exploration rover avoids sand traps with "rear rotator pedalling"(13 May 2020)
Built with wheeled appendages that can be lifted and wheels able to "wiggle," a new robot known as the "Mini Rover" has developed and tested complex locomotion techniques robust enough to help it climb hills covered with such granular material and avoid the risk of getting ignominiously stuck on some remote planet or moon. (Georgia Tech)

Lava-like mud flows on Mars (18 May 2020)
Scientists have long suspected that the 'fire-breathing' volcanoes that spread large quantities of flowing lava over Mars were not the only kind. The numerous mountain cones in the northern hemisphere of the Red Planet may be the result of mud volcanoes. However, until now, researchers have lacked knowledge about the behaviour of water-rich mud on the surface of Mars. An unusual laboratory experiment involving the German Aerospace Centre has now been able to show how mud flows at very low temperatures and under reduced atmospheric pressure. It behaves in a similar way to very specific lava flows on Earth. The results, which have now been published in the journal Nature Geoscience, add important details to the existing knowledge of Mars and its history, which has been shaped by volcanic activity. We have long been aware that in the early history of Mars, several billion years ago, large amounts of water were released over a short period of time, eroding very large valleys in the landscape, which have long since dried up. Extensively eroded masses of fragmented rock were transported through these outflow channels and into the northern lowlands of the planet, where they were quickly deposited. Later, these rocky masses were covered by younger sediments and volcanic rocks. Some Mars researchers had previously suspected that these underground, water-rich sediments could have become liquefied under certain circumstances and been pushed back up to the surface under pressure. In reference to the similar rise of magma, this process, which is well documented in many sedimentary basins on Earth, is referred to as sedimentary volcanism or mud volcanism. Laboratory experiments show that at very low temperatures and under very low atmospheric pressure, mud behaves

similar to flowing lava on Earth. Results suggest that tens of thousands of conical hills on Mars, often with a small crater at their summit, could be the result of mud volcanism. (DLR)

4-billion-year-old nitrogen-containing organic molecules discovered in Martian meteorites (29 May 2020)
Using advanced techniques, scientists have detected organic compounds containing nitrogen in Martian meteorites which were ejected from Mars' surface ~ 15 million years ago, proving that evidence for early life can be preserved and detected today. (Tokyo Tech)

MISCELLANEOUS

Space-based early warning sensor design passes critical milestone (27 May 2020)
Raytheon Intelligence & Space's competitive sensor payload design passed its Preliminary Design Review for the U.S. Space Force's Next Generation Overhead Persistent Infrared Block 0 GEO missile warning satellites being designed and built by spacecraft prime contractor Lockheed Martin Space. Detecting missile launches early starts in space. Each layer, or orbit, provides a necessary and unique view of the Earth to initially detect and then track a missile. Passing the Preliminary Design Review shows that our approach meets mission requirements, putting this 'Go Fast' program one step closer to launch. (Raytheon Intelligence and Space)

MOON

NASA commits to future Artemis missions with more SLS rocket engines (1 May 2020)
NASA has awarded a contract to Aerojet Rocketdyne of Sacramento, California, to manufacture 18 additional Space Launch System (SLS) RS-25 rocket engines to support Artemis missions to the Moon. The Artemis program is the next step in human space exploration. It's part of America's broader Moon to Mars exploration approach, in which astronauts will explore the Moon and experience gained there to enable humanity's next giant leap, sending humans to Mars. (NASA)

Astronaut urine for building a Moon base (8 May 2020)
Thanks to future lunar inhabitants, the 1.5 litres of liquid waste a person generates each day could become a promising by-product for space exploration. Using only materials available on site, an approach known in the space arena as In-Situ Resource Utilisation, or ISRU, will reduce the need of launching huge volumes of supplies from Earth to build on the Moon. The main ingredient would be a powdery soil found everywhere on the surface of the Moon, known as lunar regolith. The superplasticiser urea limits the amount of water necessary in the recipe. (ESA)

Airbus wins ESA contract to construct third European Service Module for NASA's Orion spacecraft (26 May 2020)
The European Space Agency (ESA) has signed a contract with Airbus for the construction of the third European Service Module (ESM) for Orion, the American crewed spacecraft. The contract is worth around €250 million. By ordering this additional service module, ESA ensures the necessary continuity in NASA's Artemis programme. The third European Service Module (Artemis III Mission) will be used to fly astronauts to Earth's neighbour in space in

2024, the first to land on the Moon since Apollo 17 following a hiatus of more than 50 years. (Airbus)

SwRI to develop lunar LASVEGAS instrument (27 May 2020)
NASA has awarded Southwest Research Institute $3 million to develop a lunar version of its Laser Absorption Spectrometer for Volatiles and Evolved Gas (LASVEGAS) instrument. This spectrometer can precisely measure the volatile compounds present in planetary atmospheres and surfaces, critical information for space science and exploration. LASVEGAS is about half the size of a paper towel roll. It's extremely compact, low mass, low volume and low power, all important characteristics for spaceflight. It can be deployed on the smallest of rovers or landers as well as carried in a single hand by an astronaut sauntering across the lunar surface in search of water ice, methane and other useful resources. The instrument measures gases from planetary atmospheres such as Mars to understand their composition. It can also heat a sample of a planetary surface such as the icy surface of Jupiter's moon Europa or from lunar soil to determine the composition of released gases. LASVEGAS heats a thimble-sized sample from a planetary surface to release water and other volatile gases like methane. The gas flows into a small, cylindrical chamber where laser light of different wavelengths is bounced back and forth between mirrors on each end. As the light passes repeatedly through the gas in the sample, the different molecular species in the gas absorb the light differently depending on the wavelength. Then the laser light is directed onto a detector that measures its intensity to determine the abundance of the volatile compounds. Each molecular species in the gas has a distinct "fingerprint" of absorption, revealing its overall abundance. (SwRI)

PLUTO

SOFIA finds clues hidden in Pluto's haze (12 May 2020)
When the New Horizons spacecraft passed by Pluto in 2015, one of the many fascinating features its images revealed was that this small, frigid world in the distant solar system has a hazy atmosphere. Now, new data helps explain how Pluto's haze is formed from the faint light of the Sun 3.7 billion miles away as it moves through an unusual orbit. Remote observations of Pluto by NASA's telescope on an airplane, the Stratospheric Observatory for Infrared Astronomy, or SOFIA, show that the thin haze enshrouding Pluto is made of very small particles that remain in the atmosphere for prolonged periods of time rather than immediately falling to the surface. SOFIA's data clarify that these haze particles are actively being replenished; a discovery that is revising predictions on the fate of Pluto's atmosphere as it moves into even colder areas of space on its 248-Earth-year orbit around the Sun. The results are published in the scientific journal Icarus. (NASA)

SATELLITES

Tiny crown at heart of miniature space thruster (26 May 2020)
The spiked tungsten crown measuring just 1 cm in diameter, half the size of a ten cent euro coin, is at the heart of Europe's smallest, most precise thruster. The Indium FEEP Multiemitter (IFM) Nano Thruster is able to push back against scanty atmospheric drag or the faint but steady push of sunlight itself if needed, to hold its host satellite steady in space. Alternatively, a single thruster or cluster of thrusters can be fitted onto a CubeSat or other small spacecraft, targeting the operating requirements of satellite constellations in particular. The compact thruster might also be used as an efficient means of deorbiting small satellites,

fulfilling space debris regulations. The IFM Nano Thruster is a miniaturised ion thruster, with an electric field applied to accelerate electrically-charged atoms (known as ions) to produce thrust, that uses liquid indium as its propellant. The liquid metal flows by capillary action inside the porous tungsten crown's 28 needles, resting at tiny holes in their razor-sharp tips. It is held in place there by surface tension, until an electric field is generated. This causes tiny cones to form in the liquid metal, which have positive ions shooting from their tips to create thrust. While the thrust of other ion engines is measured in millinewtons, the IFM Nano Thruster's performance is assessed in terms of micronewtons, a unit one thousand times smaller. Its thrust range goes from 10 to 400 micronewtons, with a possible peak thrust up to 1 000 micronewtons (1 millinewton). (ESA)

Virgin Orbit ignites LauncherOne rocket during first launch demo, mission safely terminated (25 May 2020)
Virgin Orbit, the California-based satellite launch company, conducted a launch demonstration of its innovative air-launched rocket today in the skies over the Pacific Ocean just off the California coast. The company successfully completed all of its pre-launch procedures, the captive carry flight out to the drop site, clean telemetry lock from multiple dishes, a smooth pass through the racetrack, terminal count, and a clean release. After being released from the carrier aircraft, the LauncherOne rocket successfully lighted its booster engine on cue, the first time the company had attempted an in-air ignition. An anomaly then occurred early in first stage flight, and the mission safely terminated. The carrier aircraft Cosmic Girl and all of its crew landed safely at Mojave Air and Space Port, concluding the mission. (Virgin Orbit)

SOLAR WIND

NASA CubeSat mission to gather vital space weather data (7 May 2020)
NASA has selected a new pathfinding CubeSat mission to gather data not collected since the agency flew the Dynamics Explorer in the early 1980s. The new mission, called Dione after the ancient Greek goddess of the oracles, will carry four miniaturized instruments to study how Earth's upper atmospheric layers react to the ever-changing flow of solar energy into the magnetosphere, the enveloping bubble of magnetic field around Earth that deflects most of the particles that erupt from the Sun. Earth's upper atmosphere is where most low-Earth-orbiting satellites reside, and their orbits are strongly affected by sudden density changes created by space weather. Expected to launch in 2022, Dione will help give scientists insights into these physical processes which contribute to atmospheric drag, a process that causes low-Earth-orbiting satellites to prematurely re-enter the atmosphere and provide data needed to improve space weather forecast. (NASA Goddard)

STARS AND STAR CLUSTERS

New gravitational-wave model can bring neutron stars into even sharper focus (21 May 2020)
Gravitational-wave researchers at the University of Birmingham have developed a new model that promises to yield fresh insights into the structure and composition of neutron stars. The model shows that vibrations, or oscillations, inside the stars can be directly measured from the gravitational-wave signal alone. This is because neutron stars will become deformed under the influence of tidal forces, causing them to oscillate at characteristic frequencies, and these encode unique information about the star in the gravitational-wave signal. This makes asteroseismology, the study of stellar oscillations, with gravitational

waves from colliding neutron stars a promising new tool to probe the elusive nature of extremely dense nuclear matter. (University of Birmingham)

TECHNOLOGY

Tests start on 3D-printed thrust chamber (28 May 2020)
Based on hot-fire tests of an Expander-cycle Integrated Demonstrator (ETID) that proved the technology and methods last year, ESA, ArianeGroup and DLR German Aerospace Center have built and hot-fire tested a fully additively-manufactured thrust chamber. This first test lasted 30 seconds and was carried out on 26 May 2020 at the DLR German Aerospace Center's Lampoldshausen testing facility. Additional tests are planned next week. The data from this test campaign will be collected and analyzed. This fully 3D-printed thrust chamber is built in just three parts and could power the upper stages of future rockets. Additive layer manufacturing also known as 3D-printing, allows more complex designs for higher performance, vastly reduces the number of parts in this case from hundreds to three, and speeds up production time. This reduces costs and significantly improves the competitiveness of liquid propulsion engines for European launch vehicles. This full-scale chamber has a 3D-printed copper liner with integrated cooling channels and a high-strength jacket built on via cold-gas spraying. Its manifold and single-piece injector head are also 3D-printed. (ESA)

Pat Williams May 2020