# Space News Update

## — January 5, 2018 —

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## 1. Weighing Massive Stars in Nearby Galaxy Reveals Excess of Heavyweights

An international team of astronomers has revealed an 'astonishing' overabundance of massive stars in a neighbouring galaxy.

The discovery, made in the gigantic star-forming region 30 Doradus in the Large Magellanic Cloud galaxy, has 'far-reaching' consequences for our understanding of how stars transformed the pristine Universe into the one we live in today.

The results are published in the journal *Science*.

Lead author Fabian Schneider, a Hintze Research Fellow in the University of Oxford's Department of Physics, said: 'We were astonished when we realised that 30 Doradus has formed many more massive stars than expected.'

As part of the VLT-FLAMES Tarantula Survey (VFTS), the team used ESO's Very Large Telescope to observe nearly 1,000 massive stars in 30 Doradus, a gigantic stellar nursery also known as the Tarantula nebula. The team used detailed analyses of about 250 stars with masses between 15 and 200 times the mass of our Sun to determine the distribution of massive stars born in 30 Doradus - the so-called initial mass function (IMF).

Massive stars are particularly important for astronomers because of their enormous influence on their surroundings (known as their 'feedback'). They can explode in spectacular supernovae at the end of their lives, forming some of the most exotic objects in the Universe - neutron stars and black holes.

Co-author Hugues Sana from the University of Leuven in Belgium said: 'We have not only been surprised by the sheer number of massive stars, but also that their IMF is densely sampled up to 200 solar masses.' Until recently, the existence of stars up to 200 solar masses was highly disputed, and the study shows that a maximum birth mass of stars of 200-300 solar masses appears likely.

In most parts of the Universe studied by astronomers to date, stars become rarer the more massive they are. The IMF predicts that most stellar mass is in low-mass stars and that less than 1% of all stars are born with masses in excess of ten times that of the Sun. Measuring the proportion of massive stars is extremely difficult - primarily because of their scarcity - and there are only a handful of places in the local Universe where this can be done.

The team turned to 30 Doradus, the biggest local star-forming region, which hosts some of the most massive stars ever found, and determined the masses of massive stars with unique observational, theoretical and statistical tools. This large sample allowed the scientists to derive the most accurate high-mass segment of the IMF to date, and to show that massive stars are much more abundant than previously thought. Chris Evans from the Science and Technology Facilities Council's UK Astronomy Technology Centre, the principal investigator of VFTS and a co-author of the study, said: 'In fact, our results suggest that most of the stellar mass is actually no longer in low-mass stars, but a significant fraction is in high-mass stars.'

Stars are cosmic engines and have produced most chemical elements heavier than helium, from the oxygen we breathe every day to the iron in our blood. During their lives, massive stars produce copious amounts of ionising radiation and kinetic energy through strong stellar winds. The ionising radiation of massive stars was crucial for the re-brightening of the Universe after the so-called Dark Ages, and their mechanical feedback drives the evolution of galaxies. Philipp Podsiadlowski, a co-author of the study from the University of Oxford, said: 'To quantitatively understand all these feedback mechanisms, and hence the role of massive stars in the Universe, we need to know how many of these behemoths are born.'

Fabian Schneider added: 'Our results have far-reaching consequences for the understanding of our cosmos: there might be 70% more supernovae, a tripling of the chemical yields and towards four times the ionising radiation from massive star populations. Also, the formation rate of black holes might be increased by 180%, directly translating into a corresponding increase of binary black hole mergers that have recently been detected via their gravitational wave signals.'

The team's research leaves many open questions, which they intend to investigate in the future: how universal are the findings, and what are the consequences of this for the evolution of our cosmos and the occurrence of supernovae and gravitational wave events?

**Explore further:** The initial mass function

**More information:** F.R.N. Schneider el al., "An excess of massive stars in the local 30 Doradus starburst," *Science* (2018). science.sciencemag.org/cgi/doi ... 1126/science.aan0106

Source: Phys.org

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## 2. NASA Commercial Crew Program Mission in Sight for 2018


NASA and industry partners, Boeing and SpaceX, are targeting the return of human spaceflight from Florida's Space Coast in 2018. Both companies are scheduled to begin flight tests to prove the space systems meet NASA's requirements for certification in the coming year.

Since NASA awarded contracts to Boeing and SpaceX, the companies have matured space system designs and now have substantial spacecraft and launch vehicle hardware in development and testing in preparation for the test flights. The goal of the Commercial Crew Program is safe, reliable and cost-effective transportation to and from the International Space Station from the United States through a public-private approach. NASA, Boeing and SpaceX have significant testing underway, which will ultimately lead to test missions when the systems are ready and meet safety requirements.

Boeing's Starliner will launch on a United Launch Alliance Atlas V rocket from Space Launch Complex 41 and SpaceX's Crew Dragon will launch on the company's Falcon 9 rocket from Launch Complex 39A.

After completion of each company's uncrewed and crewed flight tests, NASA will review the flight data to verify the systems meet the requirements for certification. Upon NASA certification, the companies are each slated to fly six crew missions to the International Space Station beginning in 2019 and continuing through 2024.

Here's a look at what's ahead in 2018:

**Boeing**

**Spacecraft:** In 2018, Boeing will continue with the production and outfitting of three crew modules and multiple service modules inside the Commercial Crew and Cargo Processing Facility at NASA's Kennedy Space Center in Florida. Boeing already has a structural version of its spacecraft going through loads, shock and separation test events in Huntington Beach, California. It will conduct a series of service module hot-fire tests in White Sands, New Mexico, as well as environmental testing to include thermal, vacuum and electromagnetic frequency in El Segundo, California.

**Spacesuit:** Boeing's spacesuit will continue to undergo integrated system verification tests. These include environmental control and life support system testing, immersing the suit in water, egress demos with the aid of virtual reality, suited launch and landing cabin operations, prelaunch emergency exit with ground crews, ascent simulations with mission operations teams and post-landing egress.

**Engine Testing:** Boeing and Aerojet Rocketdyne will finish qualification testing of the launch abort engines and thrusters that will power the Starliner through the pad abort, uncrewed and crew flight tests. Each of the four launch abort engines and 48 thrusters is tested at the White Sands Test Facility in New Mexico prior to installation on the service module.

**Parachute Testing:** Boeing will continue with the Starliner's parachute test program in 2018. To date, Boeing has completed two of five planned qualification tests. The testing involves a giant helium-filled balloon that lifts a full-size version of the spacecraft over the desert in New Mexico before releasing it. The spacecraft climbs more than 1,000 feet per minute before it is dropped from an altitude of about 40,000 feet. A choreographed parachute deployment sequence initiates, involving two drogue, three pilot and three main chutes that slow the spacecraft enough for a safe touchdown on land. Additional parachute testing with a long-dart shaped vehicle released from a C-17 aircraft near Yuma, Arizona, is also scheduled to begin next year.

**Space Launch Complex 41:** During 2018, Boeing and United Launch Alliance will make final preparations to the launch pad to ready the Atlas V complex for human spaceflight operations. Modifications are nearly complete, including the installation and testing of a crew access tower, swing arm, clean room, personnel escape system and water deluge system.

**Pad Abort Test:** In 2018, Boeing will complete an uncrewed pad abort test at White Sands Missile Range in New Mexico to demonstrate the ability of the Starliner to safely accomplish an emergency escape of the capsule and its crew members from a rocket. During the test, four launch abort engines and 20 orbital maneuvering engines will fire to simulate an abort from the Atlas V rocket on the launch pad. Together, the engines produce about 188,000 pounds of thrust for about six seconds to push the spacecraft to one mile in altitude to clear the launch vehicle in an emergency. At the proper time in the abort sequence, the service module will separate from the crew module so that it can parachute down to a safe landing.

**Orbital Flight Test:** Following launch from Space Launch Complex 41, the uncrewed Starliner will dock to the International Space Station. After about two weeks connected to the station during which the teams will gather extensive performance data, the spacecraft will return to Earth under parachutes to land in the Western United States. The test will demonstrate the launch vehicle, Starliner, the ground system and the Boeing team are ready to perform a crew flight test.

**Crew Flight Test:** Two crew members will be aboard the Starliner for Boeing's first commercial spaceflight to the International Space Station. The spacecraft will launch atop a United Launch Alliance Atlas V rocket from Space Launch Complex 41 and land again in the western United States. The mission will represent a major milestone in the return of human spaceflight from the United States. After the test and NASA certification, Boeing's Starliner can begin regularly flying astronauts to and from the space station on NASA missions.

**Recovery Training:** Boeing, NASA, and the Department of Defense will conduct rehearsals of crew recovery training during the coming year. The final full scale rehearsal tests will simulate astronaut returns to Earth in the Western region of the United States. Boeing's Starliner is designed to land on land, but testing is also being conducted to prepare for water landings in case of an emergency.

**SpaceX**

**Spacecraft:** SpaceX is making significant progress on the six Crew Dragon spacecraft that the company currently has in various stages of production and testing. SpaceX's structural qualification module has undergone extensive testing, which is scheduled to be complete in the first half of 2018. The company will continue ongoing hardware and software testing on its Environment Control and Life Support System, or ECLSS, module, through early 2018. The crew module that will be used to support SpaceX's upcoming Demonstration Mission 1 has had its critical onboard avionics powered up and has completed integration of the module's pressure section and service section's structural

components with preparations ongoing for its flight in 2018. Progress continues on SpaceX's spacecraft for Demonstration Mission 2 and both of the company's initial crew rotation missions.

**Spacesuit:** SpaceX will continue ongoing qualification and validation testing on its advanced spacesuits next year, including NASA's four CCP flight test astronauts for a variety of the assessments, including suit-fit, reach and visibility assessments, and pressure tests. The company is in the process of manufacturing custom suits for each of the four astronauts, which will ensure a proper fit and comfortable ride to and from the International Space Station in the Crew Dragon spacecraft.

**Merlin/SuperDraco Testing:** 2018 will see continued, rigorous qualification testing of SpaceX's Block 5 M1D and MVacD engines at the company's engine development and testing facility in McGregor, Texas. These advanced engines are manufactured by SpaceX at their headquarters in Hawthorne, California, and will power Falcon 9's first and second stages respectively as they lift the Crew Dragon spacecraft into orbit to rendezvous with the International Space Station. SpaceX also will complete major integrated system testing of its Draco and 3-D-printed SuperDraco thrusters on the company's SuperModule test stand in 2018.

**Demo-1 Flight Test:** SpaceX is targeting the second quarter of 2018 for its first demonstration mission with Crew Dragon to and from the International Space Station. This uncrewed mission will launch from Pad 39A, serving as an important rehearsal for later missions carrying NASA astronauts. Using Crew Dragon's advanced autonomous rendezvous and docking capabilities, SpaceX will complete a full mission profile to test the crewed Block 5 Falcon 9, the Dragon Spacecraft, and associated ground systems including Mission Control in Hawthorne.

**In-Flight Abort Test:** SpaceX is slated to complete an important in-flight abort test using both Falcon 9 and Crew Dragon in the time between the company's two demonstration flights in 2018. Using Crew Dragon's powerful onboard SuperDraco thrusters, built at the company's headquarters in California and tested in Texas, SpaceX will demonstrate its capability to swiftly carry astronauts to safety in the unlikely event of an in-flight anomaly. The test will be conducted from Launch Complex 39A at the Kennedy Space Center.

**Demo-2 Flight Test:** SpaceX is progressing towards its first crewed mission under the Commercial Crew Program – Demo-2 – in the third quarter of 2018. This mission will see two NASA astronauts flying to and from the International Space Station in SpaceX's Crew Dragon spacecraft from Launch Complex 39A at NASA's Kennedy Space Center in Florida. This mission will represent a major milestone in the return of crewed flights to the space station from American soil. This second demonstration mission will serve as a precursor to fully operational crew rotation missions under NASA's Commercial Crew Program.

**Launch Complex 39A:** Over the course of 2017, SpaceX reactivated Launch Complex 39A at NASA's Kennedy Space Center, successfully launching a dozen missions from the historic pad. In 2018, SpaceX will continue upgrading LC-39A to support upcoming commercial crew missions, including the installation of their Crew Access Arm and white room on LC-39A's fixed service structure in the spring.

**Parachutes:** SpaceX completed the first round of qualification testing for Crew Dragon's parachute system in 2017. The second round of parachute system validation testing will be completed by mid-2018.

**Recovery Trainer Testing:** In preparation for the unlikely event of an unusual recovery situation, SpaceX has been working closely with NASA and the Department of Defense to practice to ensure safety throughout various contingency crew recovery scenarios. The company will complete an additional round of in-water rescue trainer exercises off the coast of Florida in 2018.

Source: NASA Return to Contents

## 3. Library of Galaxy Histories Reconstructed from Motions of Stars


Just like the Sun is moving in our galaxy, the Milky Way, all the stars in galaxies are moving, but with very different orbits: some of the stars have strong rotations, while others may be moving randomly with no clear rotation.

Comparing the fraction of stars on different orbits we can find out how galaxies form and evolve. An international team of astronomers has derived directly, for the first time, the orbital distribution of a galaxy sample, containing more than 300 galaxies of the local universe. The results, published in Nature Astronomy, are based on the CALIFA survey, a project developed at Calar Alto Observatory and conceived from the Institute of Astrophysics of Andalusia (IAA-CSIC).

Galaxies are the largest structures in the universe, and scientist study how they evolve to understand the history of the universe. Galaxy formation entails the hierarchical assembly of halos of dark matter (a type of matter that has not been directly observed and whose existence and properties are inferred from its gravitational effects), along with the condensation of normal matter at the halos' center, where stellar formation takes place. Stars that formed from a settled, thin gas disk and then lived though dynamically quiescent times will present near circular orbits, while stars with random motions are the result of turbulent environments, either at birth or later, with galactic mergers.

Thus, the motions of stars in a galaxy are like a history book; they record the information about their birth and growth environment, and it may tell us how the galaxy was formed. "However, the motion of each single star

is not directly observable in external galaxies. External galaxies are projected on the observational plane as an image and we cannot resolve the discrete stars in it," says Ling Zhu, researcher from the Max Planck Institute for Astronomy who leads the study. "The CALIFA survey uses a recently developed technique, integral field spectroscopy, which can observe the external galaxies in such a way that it provides the overall motion of stars. Thus, we can get kinematic maps of each galaxy."

The researchers then build models for each galaxy by superposing stars on different types of orbits. By constraining the model with the observed image and kinematic maps, they can find out the amount of stars moving on different types of orbits in each galaxy. They call it the stellar orbit distribution and, for this study, the team has built models for all 300 galaxies, representative of the general properties of galaxies in the local universe.

The maps show changes in galactic orbit distribution depending on the total stellar mass of the galaxies. The ordered-rotating orbits are most prominent in galaxies with total stellar masses of 10 billion solar masses, and least important for the most massive ones. Random-motion orbits unsurprisingly dominate the most massive galaxies (more than 100 billion solar masses). "This is the first orbit-based mass sequence across all morphological types. It includes flourishing information of a galaxy's past, basically whether it had been a quiet succession of only smaller mergers or shaped by a violent major merger. Further studies are needed to understand the details," says Glenn van de Ven (ESO).

The researchers had found a new and accurate method of reading off a galaxy's history -- and their survey with its data sets for 300 galaxies turned out to be the largest existing library of galaxy history books.

"This work highlights the importance of integral field spectroscopy and, in particular, of large-scale surveys such as the CALIFA project. The significant contribution of what we call 'hot' orbits, a mixture of rotation and random movements of the stellar component, poses important challenges to cosmological models of galaxy formation and evolution," says Rubén García Benito, a researcher at the Institute of Astrophysics of Andalusia (IAA-CSIC) participating in the project.

CALIFA's results represent an observationally-determined orbit distribution of galaxies in the present-day universe. They lend themselves thus to direct comparison with samples of cosmological simulations of galaxies in a cosmological context. In this sense, these results open a new window for comparing galaxy simulations to the observed galaxy population in the present-day universe.

Reference: "The Stellar Orbit Distribution in Present-Day Galaxies Inferred from the CALIFA Survey," Ling Zhu et al., 2018 Jan. 1, Nature Astronomy [https://doi.org/10.1038/s41550-017-0348-1, preprint: https://arxiv.org/abs/1711.06728].

Text & Graphics: http://www.iaa.es/en/news/library-galaxy-histories-reconstructed-motions-stars

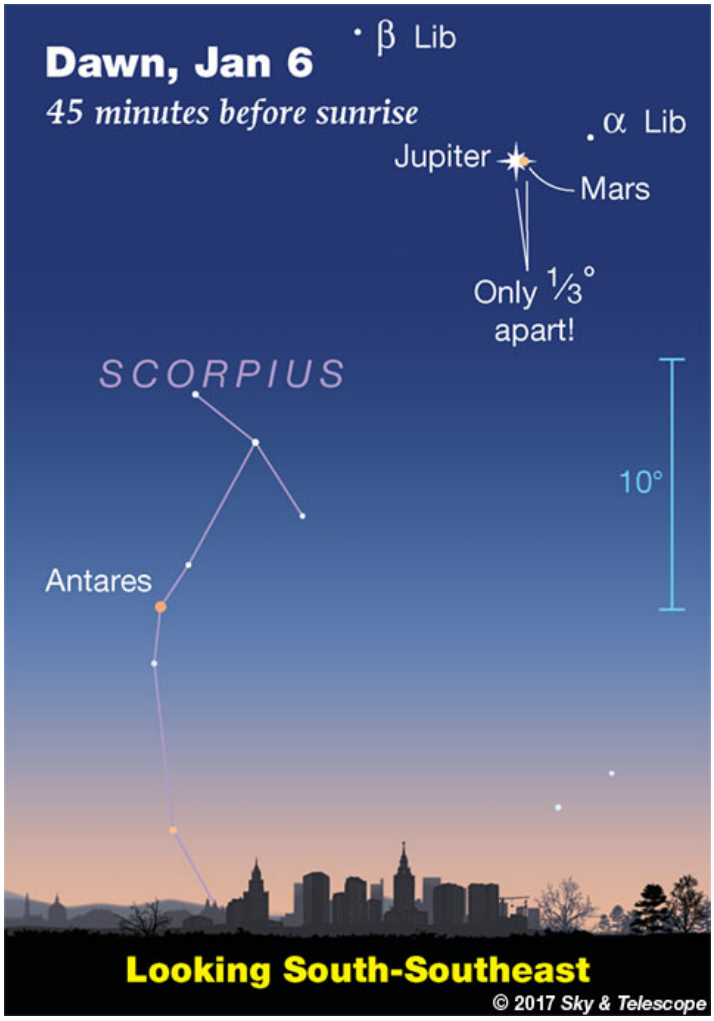
Source: Spaceref.com Return to Contents

# The Night Sky

**Friday, January 5**

• Orion strides boldly up the southeastern sky after dusk in the January cold. Above it glitters orange Aldebaran, 65 light-years away. Above Aldebaran are the Pleiades, about 435 light-years away. Far left of Aldebaran and the Pleiades, brilliant Capella shines from a distance of 42 light-years.

• Before dawn on Saturday morning the 6th, spot bright Jupiter in the south-southeast. Fainter Mars is barely to its right, by just 1/3° — less than the width of a chopstick at arm's length. The two planets will fit in a medium-power telescopic view, but both are near their maximum distances from Earth and about as small as they ever look. Mars is especially tiny.




**Saturday, January 6**

• Before dawn on Sunday the 7th, again spot bright Jupiter in the south-southeast. Mars is now 1/3° *below* it (at the times of dawn for North America). To their right is 3rd-magnitude Alpha (α) Librae, a very wide double star for binoculars.

**Sunday, January 7**

• The Northern Cross in Cygnus, with Deneb at its top, plants itself nearly upright on the northwest horizon around 7 or 8 p.m. at this time of year.

**Monday, January 8**

• Last-quarter Moon (exact at 5:25 p.m.). The Moon rises around midnight or 1 a.m. tonight, in Virgo. Once it does, look for Spica about 6° or 7° to its left or lower left. Brighter Arcturus shines 25° to the Moon's upper left.

By the time dawn begins to brighten on Tuesday the 9th they're all high in the south, and the line they form is more nearly vertical.

Source: Sky & Telescope

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# ISS Sighting Opportunities

For Denver:

| Date | Visible | Max Height | Appears | Disappears |
|---|---|---|---|---|
| Sat Jan 6, 6:32 AM | 2 min | 11° | 10° above NNW | 10° above NNE |
| Sun Jan 7, 5:41 AM | < 1 min | 10° | 10° above N | 10° above NNE |
| Mon Jan 8, 6:24 AM | 4 min | 14° | 10° above NNW | 10° above NE |
| Tue Jan 9, 5:33 AM | 1 min | 12° | 11° above NNE | 10° above NNE |

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

# NASA-TV Highlights

**(all times Eastern Daylight Time)**

**Friday, January 5**

6 p.m., Replay of SpaceCast Weekly (all channels)

10 p.m., Replay of SpaceCast Weekly (NTV-1 (Public))

**Saturday, January 6**

9 a.m., 5 p.m., 8 p.m., Replay of "Going for GOLD: Exploring the Interface to Space" (NTV-1 (Public))

10 a.m., 2 p.m., 6 p.m., Saturday, January 6 - Replay of SpaceCast Weekly (all channels)

**Sunday, January 7**

8 a.m., 4 p.m., 7 p.m., Replay of "Going for GOLD: Exploring the Interface to Space" (NTV-1 (Public))

9 a.m., 5 p.m., 9 p.m., Replay of SpaceCast Weekly (all channels)

**Monday, January 8**

7:30 a.m., ISS Expedition 54 In-Flight Event with the Hamagin Space Technology Museum in Kanagawa Prefecture in Japan with Flight Engineer Norishige Kanai of the Japan Aerospace Exploration Agency (JAXA) (Starts at 7:45 a.m.) (all channels)

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

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# Space Calendar

- Jan 05 - UPDATED [Jan 03] "Zuma" Falcon 9 Launch
- Jan 05 - Moon Occults Regulus
- Jan 05 - Comet C/2017 T1 (Heinze) Closest Approach To Earth (0.223 AU)
- Jan 05 - Comet C/2015 X5 (PANSTARRS) Closest Approach To Earth (5.909 AU)
- Jan 05 - Comet C/2015 X5 (PANSTARRS) At Opposition (5.909 AU)
- Jan 05 - Apollo Asteroid 12711 Tukmit Closest Approach To Earth (0.624 AU)
- Jan 05 - Asteroid 76272 De Jong Closest Approach To Earth (1.137 AU)
- Jan 05 - Asteroid 26715 South Dakota Closest Approach To Earth (1.514 AU)
- Jan 05 - Asteroid 631 Philippina Closeset Approach To Earth (1.685 AU)
- Jan 05 - Asteroid 8952 ODAS Closest Approach To Earth (1.751 AU)
- Jan 05 - Asteroid 129564 Christy Closest Approach To Earth (1.933 AU)
- Jan 05 - Apollo Asteroid 2011 MD Closest Approach To Earth (1.999 AU)
- Jan 05 - Asteroid 9250 Chamberlin Closest Approach To Earth (2.621 AU)
- Jan 05 - Harold Gatty's 115th Birthday (1903)
- Jan 06 - HOT [Jan 01] 50th Anniversary (1968), Surveyor 7 Launch (Moon Lander)
- Jan 06 - Comet 288P At Opposition (2.066 AU)
- Jan 06 - Comet 279P/La Sagra Closest Approach To Earth (2.890 AU)
- Jan 06 - Comet C/2017 U4 (PANSTARRS) Closest Approach To Earth (6.941 AU)
- Jan 06 - NEW [Dec 31] Aten Asteroid 2017 YG7 Near-Earth Flyby (0.062 AU)
- Jan 06 - Apollo Asteroid 2017 YC2 Near-Earth Flyby (0.087 AU)
- Jan 06 - Aten Asteroid 2015 YG Near-Earth Flyby (0.094 AU)
- Jan 06 - Asteroid 3953 Perth Closest Approach To Earth (1.309 AU)
- Jan 06 - Asteroid 3265 Fletcher Closest Approach To Earth (1.442 AU)
- Jan 06 - Asteroid 4923 Clarke Closest Approach To Earth (1.593 AU)
- Jan 06 - 20th Anniversary (1998), Lunar Prospector Launch (Moon Orbiter)
- Jan 07 - Mars Passes 0.2 Degrees From Jupiter
- Jan 07 - Comet 149P/Mueller At Opposition (2.699 AU)
- Jan 07 - NEW [Dec 31] Apollo Asteroid 2017 YK7 Near-Earth Flyby (0.027 AU)
- Jan 07 - NEW [Dec 31] Apollo Asteroid 2017 YJ7 Near-Earth Flyby (0.030 AU)
- Jan 07 - Aten Asteroid 2013 AT72 Near-Earth Flyby (0.085 AU)
- Jan 07 - Apollo Asteroid 2017 YT3 Near-Earth Flyby (0.094 AU)
- Jan 07 - Asteroid 6984 Lewiscarroll Closest Approach To Earth (2.316 AU)
- Jan 07 - Asteroid 9340 Williamholden Closest Approach To Earth (2.604 AU)
- Jan 07 - Kuiper Belt Object 230965 (2004 XA192) At Opposition (34.607 AU)
- Jan 08 - Comet C/2017 K4 (ATLAS) Perihelion (2.648 AU)
- Jan 08 - Apollo Asteroid 2017 XT61 Near-Earth Flyby (0.029 AU)
- Jan 08 - Apollo Asteroid 2017 YX4 Near-Earth Flyby (0.038 AU)
- Jan 08 - Asteroid 2398 Jilin Closest Approach To Earth (0.853 AU)
- Jan 08 - Asteroid 1740 Paavo Nurmi Closest Approach To Earth (1.462 AU)
- Jan 08 - Asteroid 5608 Olmos Closest Approach To Earth (1.782 AU)
- Jan 08 - Asteroid 243097 Batavia Closest Approach To Earth (1.792 AU)
- Jan 08 - Asteroid 2483 Guinevere Closest Approach To Earth (2.020 AU)
- Jan 08 - 45th Anniversary (1973), Luna 21 Launch (USSR Moon Rover Mission - Lunokhod 2)
- Jan 08 - Sir Frank Dyson's 150th Birthday (1868)

Source: JPL Space Calendar

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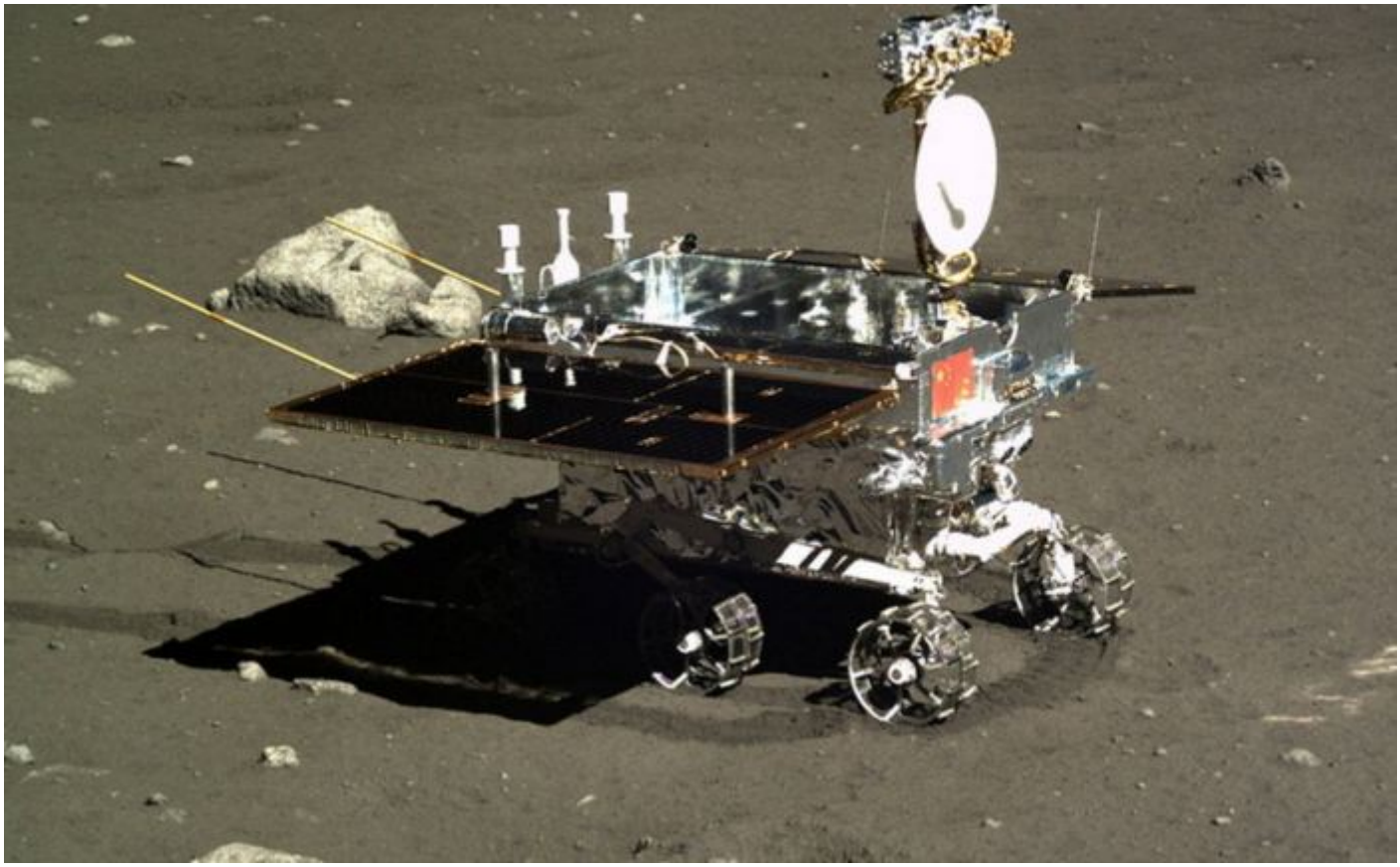
# Food for Thought

## Upcoming Chinese Lander Will Carry Insects and Plants to the Surface of the Moon



It would be no exaggeration to say that we live in an age of renewed space exploration. In particular, the Moon has become the focal point of increasing attention in recent years. In addition to President Trump's recent directive to NASA to return to the Moon, many other space agencies and private aerospace companies are planning their own missions to the lunar surface.

A good example is the Chinese Lunar Exploration Program (CLEP), otherwise known as the Chang'e Program. Named in honor of the ancient Chinese lunar goddess, this program has sent two orbiters and one lander to the Moon already. And later this year, the Chang'e 4 mission will begin departing for the far side of the Moon, where it will study the local geology and test the effects of lunar gravity on insects and plants.

The mission will consist of a relay orbiter being launched aboard a Long March 5 rocket in June of 2018. This relay will assume orbit around the Earth-Moon L2 Lagrange Point, followed by the launch of the lander and rover about six months later. In addition to an advanced suite of instruments for studying the lunar surface, the lander will also be carrying an aluminum alloy container filled with seeds and insects.

s Zhang Yuanxun – chief designer of the container – told the Chongqing Morning Post (according to China Daily):

*"The container will send potatoes, arabidopsis seeds and silkworm eggs to the surface of the Moon. The eggs will hatch into silkworms, which can produce carbon dioxide, while the potatoes and seeds emit oxygen through photosynthesis. Together, they can establish a simple ecosystem on the Moon."*

The mission will also be the first time that a mission is sent to an unexplored region on the far side of the Moon. This region is none other than the South Pole-Aitken Basin, a vast impact region in the southern hemisphere. Measuring roughly 2,500 km (1,600 mi) in diameter and 13 kilometers (8.1 mi) deep, it is the single-largest impact basin on the Moon and one of the largest in the Solar System.

This basin is also source of great interest to scientists, and not just because of its size. In recent years, it has been discovered that the region also contains vast amounts of water ice. These are thought to be the results of impacts by meteors and asteroids which left water ice that survived because of how the region is permanently shadowed. Without direct sunlight, water ice in these craters has not been subject to sublimation and chemical dissociation.

Since the 1960s, several missions have explored this region from orbit, including the *Apollo 15, 16* and *17* missions, the Lunar Reconnaissance Orbiter (LRO) and India's Chandrayaan-1 orbiter. This last mission (which was mounted in 2008) also involved sending the Moon Impact Probe to the surface to trigger the release of material, which was then analyzed by the orbiter.

The mission confirmed the presence of water ice in the Aitken Crater, a discovery which was confirmed about a year later by NASA's LRO. Thanks to this discovery, there have been several in the space exploration community who have stated that the South Pole-Aitken Basin would be the ideal location for a lunar base. In this respect, the Chang'e 4 mission is investigating the very possibility of humans living and working on the Moon.

Aside from telling us more about the local terrain, it will also assess whether or not terrestrial organisms can grow and thrive in lunar gravity – which is about 16% that of Earths (or 0.1654 *g*). Previous studies conducted aboard the ISS have shown that long-term exposure to microgravity can have considerable health effects, but little is known about the long-term effects of *lower* gravity.

The European Space Agency has also been vocal about the possibility of building an International Lunar Village in the southern polar region by the 2030s. Intrinsic to this is the proposed Lunar Polar Sample Return mission, a joint effort between the ESA and Roscosmos that will involve sending a robotic probe to the Moon's South Pole-Aitken Basin by 2020 to retrieve samples of ice.

In the past, NASA has also discussed ideas for building a lunar base in the southern polar region. Back in 2014, NASA scientists met with Harvard geneticist George Church, Peter Diamandis (creator of the X Prize Foundation) and other parties to discuss low-cost options. According to the papers that resulted from the meeting, this base would exist at one of the poles and would be modeled on the U.S. Antarctic Station at the South Pole.

If all goes well for the Chang'e 4 mission, China intends to follow it up with more robotic missions, and an attempted crewed mission in about 15 years. There has also been talk about including a radio telescope as part of the mission. This RF instrument would be deployed to the far side of the Moon where it would be undistributed by radio signals coming from Earth (which is a common headache when it comes to radio astronomy).

And depending on what the mission can tell us about the South Pole-Aitken Basin (i.e. whether the water ice is plentiful and the radiation tolerable), it is possible that space agencies will be sending more missions there in the coming years. Some of them might even be carrying robots and building materials!

Source: Universe Today Return to Contents

# Space Image of the Week


## Carina over Lake Ballard

**Explanation** A jewel of the southern sky, the Great Carina Nebula, also known as NGC 3372, is one of our galaxy's largest star forming regions. Easily visible to the unaided eye it stands high above the signature hill of Lake Ballard, ephemeral salt lake of Western Australia, in this serene night skyscape from December 25, 2017. The Milky Way itself stretches beyond the southern horizon. Along the Milky Way, bright stars Alpha and Beta Centauri lie just above the hill's right flank, with the Southern Cross and dark Coalsack Nebula above the hill top. Based on a 22 panel mosaic, the scene was cropped to reveal more closely the beauty of this region of the southern Milky Way. On that short summer night, a star tracking camera mount was used to record the mosaic images of the sky, but turned off to image the foreground in moonlight.

Source: APOD

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