Space News Update

– March 6, 2018 –

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1. NASA InSight Mission to Mars Arrives at Launch Site

Personnel supporting NASA's InSight mission to Mars load the crated InSight spacecraft into a C-17 cargo aircraft at Buckley Air Force Base, Denver, for shipment to Vandenberg Air Force Base, California. The spacecraft, built in Colorado by Lockheed Martin Space, was shipped February 28, 2018, in preparation for launch from Vandenberg in May 2018. Credits: NASA/JPL-Caltech/Lockheed Martin Space

NASA's InSight spacecraft has arrived at Vandenberg Air Force Base in central California to begin final preparations for a launch this May. The spacecraft was shipped from Lockheed Martin Space, Denver on February 28th and arrived at Vandenberg later that day. The launch period for InSight opens May 5 and continues through June 8. InSight will be the first mission to look deep beneath the Martian surface, studying the planet's interior by listening for marsquakes and measuring the planet's heat output. It will also be the first planetary spacecraft to launch from the West Coast.

"The Air Force C-17 crew from the 21st Airlift Squadron gave us a great ride," said Tom Hoffman, InSight project manager, from NASA's Jet Propulsion Laboratory in Pasadena, California. "Next time InSight travels as high and as fast, it will be about 23 seconds into its launch, on the way to Mars."

At the Astrotech payload processing facility at Vandenberg, InSight will soon be removed from its shipping container -- the first of several remaining milestones to prepare it for launch. Later next week, the spacecraft will begin functional testing to verify its state of health after the flight from Colorado. After that, the team will load updated flight software and perform a series of mission readiness tests. These tests involve the entire spacecraft flight system, the associated science instruments and the ground data system.

"One of the most important activities before launch is to load the spacecraft with the fuel needed for the journey to Mars," said Hoffman. "After fuel loading, the spacecraft will undergo a spin-balance test to determine precisely the center of mass. This knowledge is needed to be sure the entry and descent into the Mars atmosphere goes as planned."

InSight will be carried into space aboard a United Launch Alliance Atlas V-401 rocket lifting off from Space Launch Complex 3E at Vandenberg Air Force Base. For a May 5 liftoff, the launch window opens at 4:05 a.m. PDT (7:05 a.m. EDT) and remains open through 6:05 a.m. PDT (9:05 a.m. EDT).

InSight will use the seismic waves generated by marsquakes to map the deep interior of Mars. These waves travel through geologic materials at different speeds and reflect off boundaries, giving scientists a glimpse of the composition and structure of the planet's interior. They reflect the initial formation of the planet, and the resulting insights into how Mars formed will help us better understand how other rocky planets are created, including our own Earth.

JPL manages InSight for NASA's Science Mission Directorate. InSight is part of NASA's Discovery Program, managed by the agency's Marshall Space Flight Center in Huntsville, Alabama. The InSight spacecraft, including cruise stage and lander, was built and tested by Lockheed Martin Space in Denver. A number of European partners, including France's Centre National d'Études Spatiales (CNES) and the German Aerospace Center (DLR), are supporting the InSight mission.

A truck carrying NASA s InSight spacecraft leaves Lockheed Martin Space, Denver, where the spacecraft was built and tested Credit: NASA

Source: NASA

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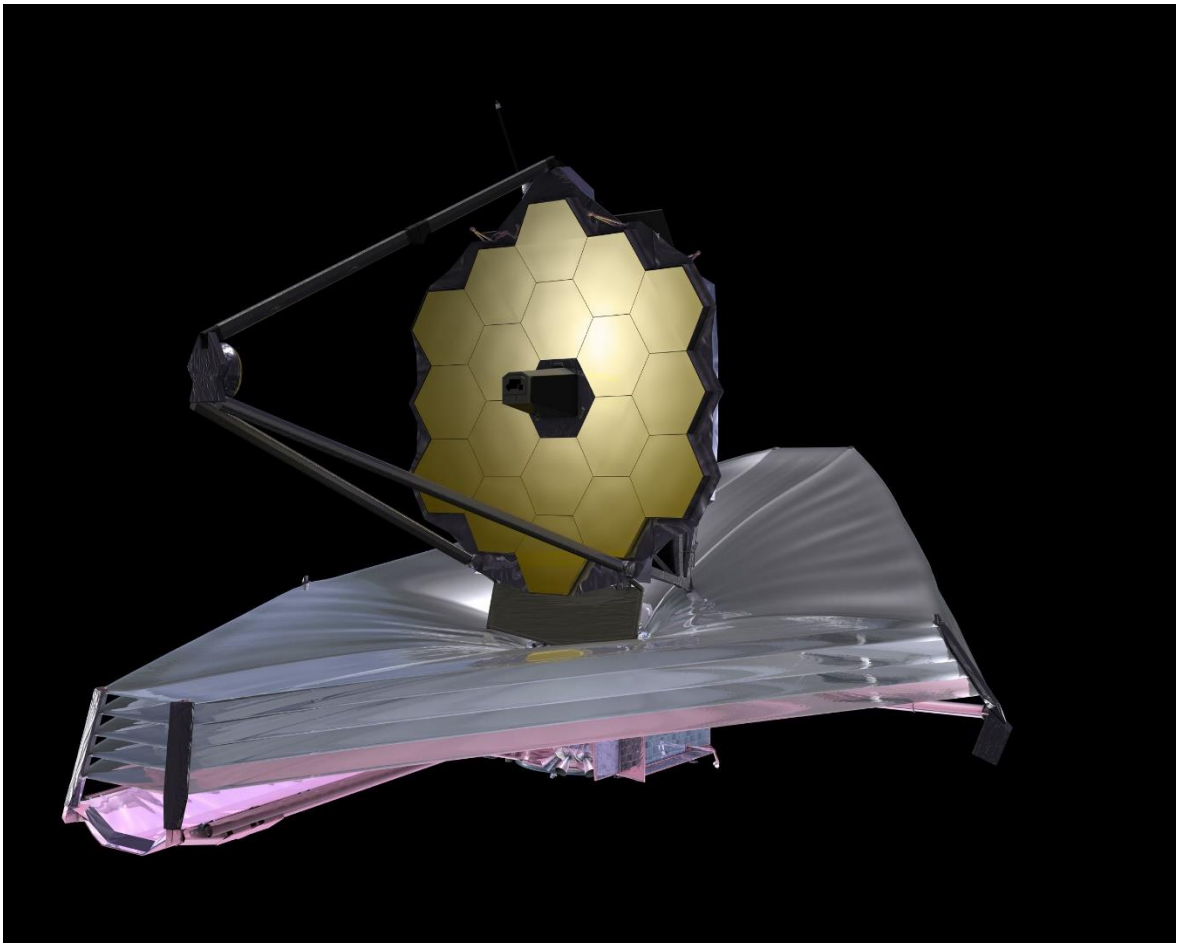
2. James Webb Space Telescope: Additional Delays “Likely”



Artist's conception of James Webb Space Telescope NASA

The U.S. Government Accountability Office (GAO), a non-partisan group that investigates federal spending and performance, has issued a report on the James Webb Space Telescope that has astronomers worried. “It's likely the launch date will be delayed again,” the report concludes — an ominous statement, given that any further delays could risk project cancellation.

Last year NASA announced a delay in the telescope’s launch to sometime between March and June 2019. The 5- to 8-month delay came from problems integrating spacecraft components, especially its complex, five-layered sunshield, which must unfold perfectly when the telescope is deployed. Right after requesting the change in launch readiness date, the mission learned of further delays from its contractor, Northrop Grumman, due to “lessons learned from conducting deployment exercises of the spacecraft element and sunshield.”

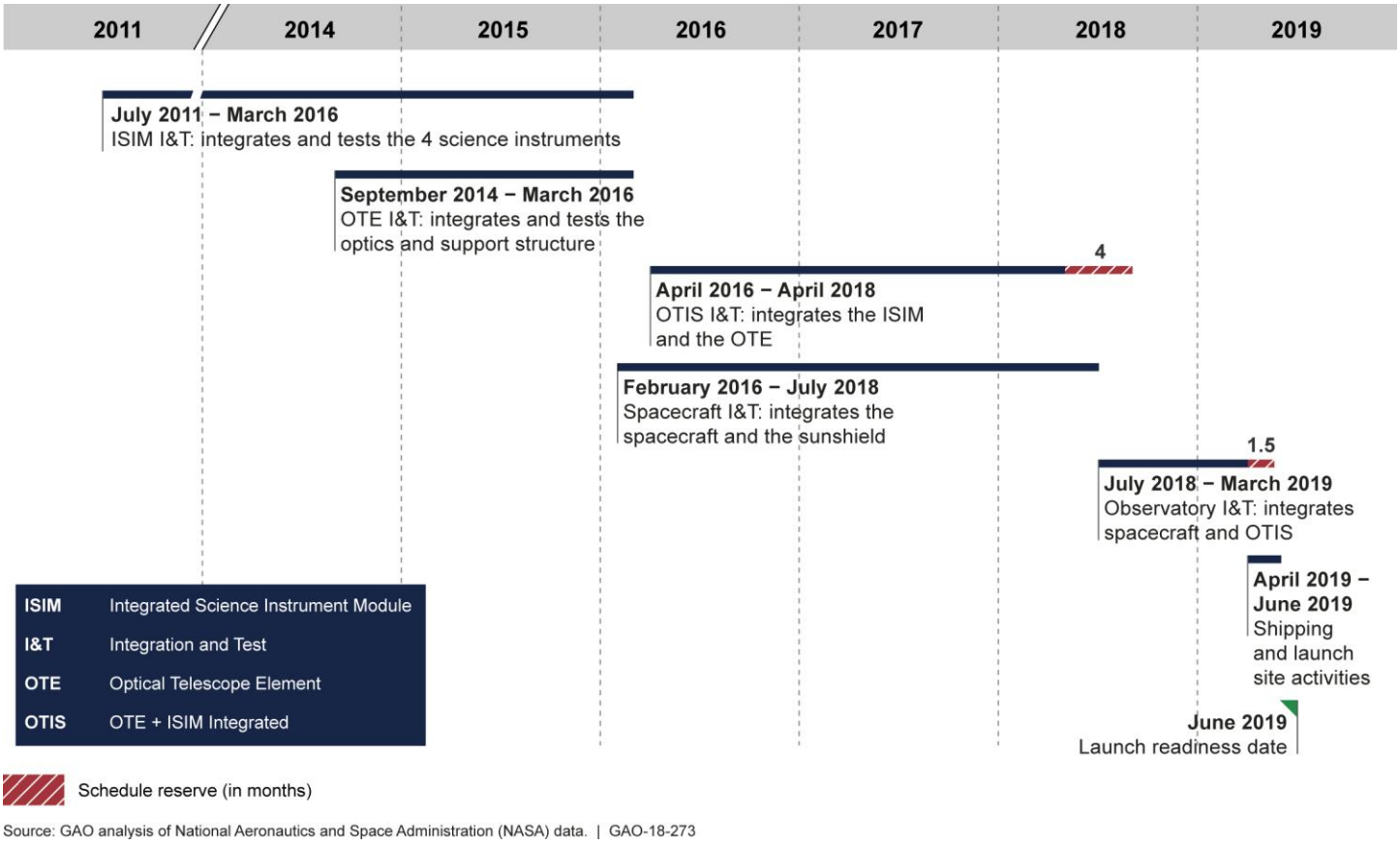
The mission now has 1.5 months of schedule reserve remaining, the GAO finds. Delays during integration and testing are common, “the phase in development where problems are most likely to be found and schedules tend to slip.” The project has a total of five phases of integration and testing, and has made significant progress on phases three and four, with the fifth phase beginning in July.

Webb, often called the successor to the Hubble Space Telescope, would see the universe at infrared wavelengths, investigating everything from exoplanet atmospheres to the first galaxies. But the revolutionary telescope has had a troubled funding history. An original budget of $1 billion ballooned until in 2011 Congress capped its funding at $8 billion for development, with another $800 million set aside for operations over a five-

year window following the telescope's launch. Funding reserves and 13 months of scheduling reserves were built into the 2011 plan, but now it seems the mission is bumping up against its constraints.

NASA has issued a statement that acknowledges all of the work that has already been done on this immense undertaking, adding, "NASA looks forward to the mission's final integration and test phase now that the two major observatory elements (science payload and spacecraft with sunshield) are together under one roof for the first time." The mission has its own review board and will be issuing a report in mid-April.

[Read the full GAO report here.]



Integration and Test (I&T) Schedule for the James Webb Space Telescope Source: GAO

Source: Sky and Telescope

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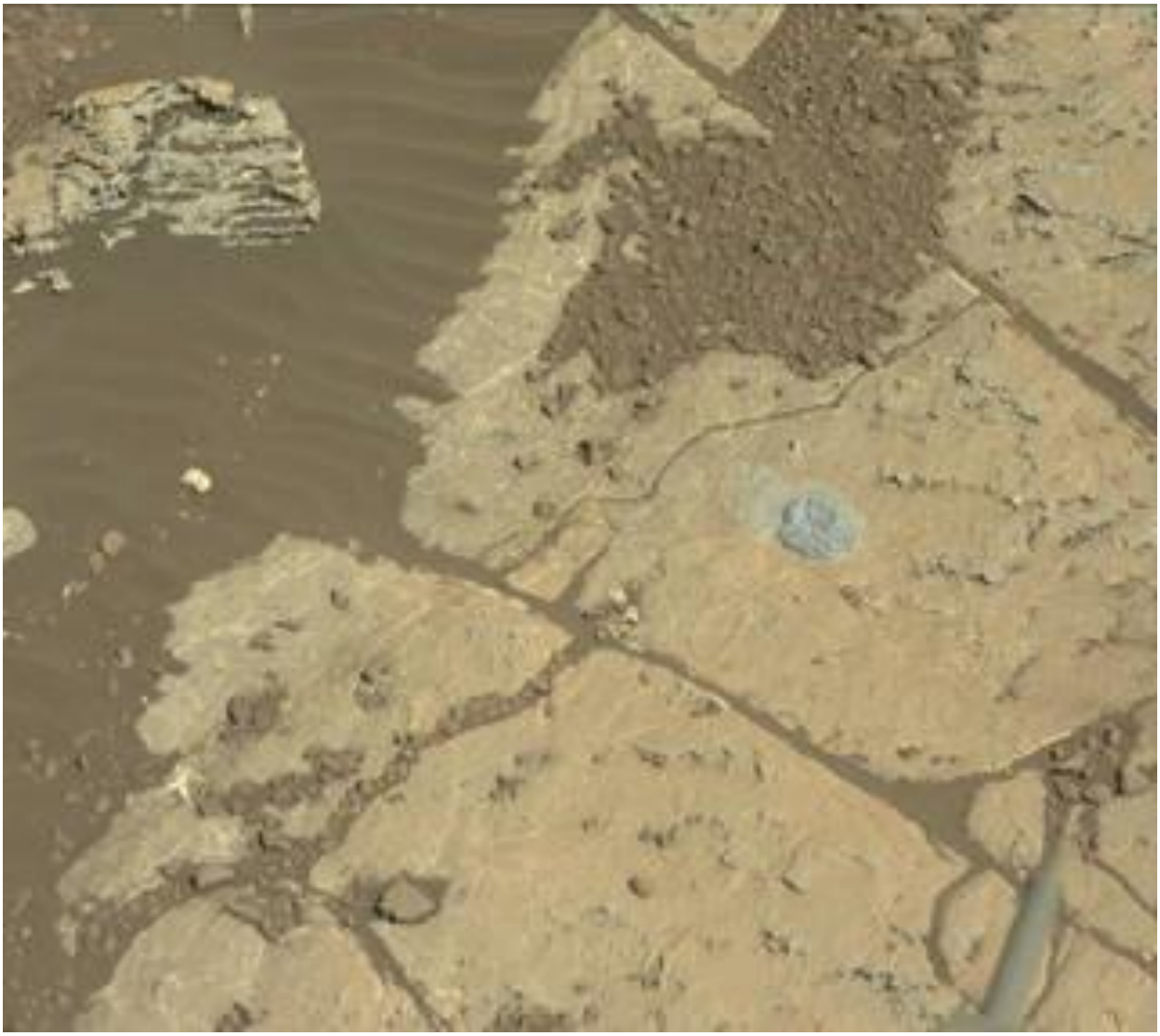
3. Curiosity Tests a New Way to Drill on Mars



NASA's Curiosity Mars rover used a new drill method to produce a hole on February 26 in a target named Lake Orcadie. The hole marks the first operation of the rover's drill since a motor problem began acting up more than a year ago. Credits: NASA/JPL-Caltech/MSSS

After more than a year without the use of the NASA's Curiosity Mars rover's drill, engineers have devised a workaround and tested it for the first time on the Red Planet.

This early test produced a hole about a half-inch (1-centimeter) deep at a target called Lake Orcadie -- not enough for a full scientific sample, but enough to validate that the new method works mechanically. This was just the first in what will be a series of tests to determine how well the new drill method can collect samples. If this drill had achieved sufficient depth to collect a sample, the team would have begun testing a new sample delivery process, ultimately delivering to instruments inside the rover.

The drill is used for pulverizing rock samples into powder, which are then deposited into two of Curiosity's laboratory instruments, Sample Analysis at Mars, or SAM, and Chemistry and Mineralogy, or CheMin. Curiosity has used its drill to collect samples 15 times since landing in 2012. Then, in December of 2016, a key part of the drill stopped working. The drill was designed to use two finger-like stabilizers to steady itself against rock; a faulty motor prevented the drill bit from extending and retracting between these stabilizers.

After months of effort, Curiosity's engineering team was able to extend the drill all the way out past the stabilizers, but the motor issue persisted. The team posed a challenge for themselves: could they hack the space robot's drill so that it didn't require stabilizers?

Images of a new hole on upper Vera Rubin Ridge, Curiosity's current location, suggest this “MacGyvering” is paying off. By leaving the drill in an extended position, engineers were able to practice this freehand drilling for months during testing here on Earth. This hole at Lake Orcadie provides the first insights into how this operation will work in the Martian environment.

If the previous method was like a drill press, holding the bit steady as it extends into a surface, it's now more freehand. The NASA rover is using its entire arm to push the drill forward, re-centering itself while taking measurements with a force sensor. That sensor was originally included to stop the rover's arm if it received a high-force jolt. It now offers Curiosity a vital sense of touch, preventing the drill bit from drifting sideways too much and getting stuck in rock.

"We're now drilling on Mars more like the way you do at home," said Steven Lee, deputy project manager at NASA's Jet Propulsion Laboratory, Pasadena, California. "Humans are pretty good at re-centering the drill, almost without thinking about it. Programming Curiosity to do this by itself was challenging -- especially when it wasn't designed to do that."

It hasn't been easy. JPL engineers spent many double-shifts testing the new method, including on weekends and holidays. They also had to perform "invasive surgery" on their testbed -- a near-exact replica of Curiosity -- installing a force sensor to match the one on Mars. The Earth-based testbed's sensor had stopped working before Curiosity's launch in 2012, but there had never been reason to replace it before now.

"This is a really good sign for the new drilling method," said Doug Klein of JPL, one of Curiosity's sampling engineers. "Next, we have to drill a full-depth hole and demonstrate our new techniques for delivering the sample to Curiosity's two onboard labs."

Leaving the drill in its extended position means it no longer has access to a device that sieves, portions and delivers the rock powder to the rover's instruments (called Collection and Handling for In-Situ Martian Rock Analysis, or CHIMRA).

JPL also had to invent a new way to deposit the powder without this device. The new solution makes Curiosity look as though it is adding seasoning to its science, shaking out grains from the drill's bit as if it were tapping salt from a shaker.

This tapping has been successfully tested here on Earth -- but Earth's atmosphere and gravity are very different from that of Mars. Whether rock powder on Mars will fall out in the same volume and in a controlled way has yet to be seen.

In the days ahead, Curiosity's engineers will evaluate the results of this recent test and likely drill again nearby. If enough sample is collected, they will test portioning the sample out, using the rover's Mastcam to estimate how much powder can be shaken from the drill bit.

Though this first test of the drill didn't produce a full sample, Curiosity's science team is excited to see this step on the path back to routine drilling. There's high interest in getting multiple drilled samples from Vera Rubin Ridge, especially from the upper ridge that contains both gray and red rocks. The latter are rich in hematite, an iron oxide mineral that forms in the presence of water. Drilled samples might shed light on the origin of the ridge and the history of its interaction with water.

Source: NASA Return to Contents

The Night Sky

Tuesday, March 6

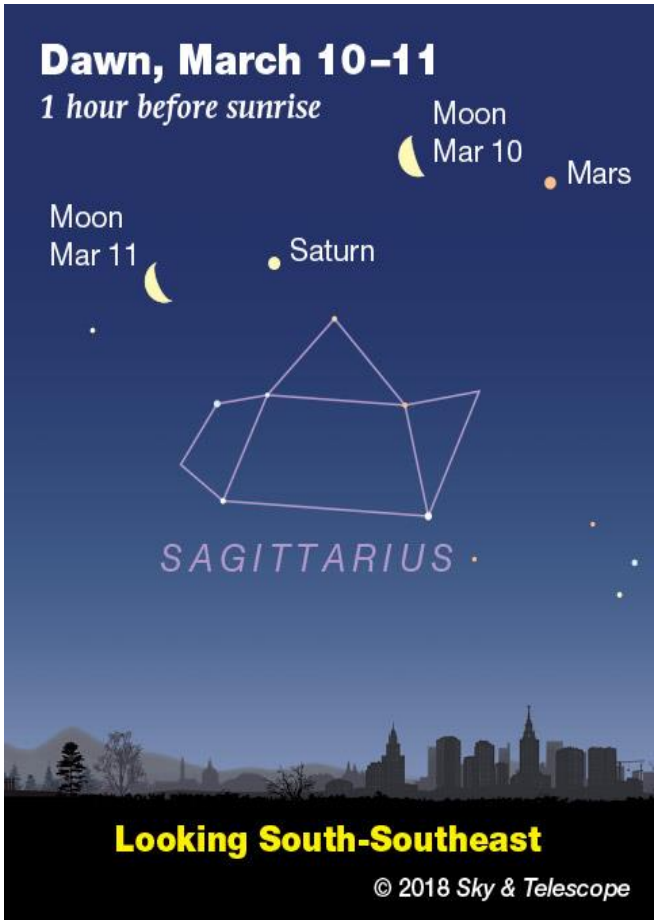
- Jupiter and the waning gibbous Moon rise in company around the middle of the night tonight. By early dawn on Thursday, they hang together in fine view in the south.

Wednesday, March 7

- With the Moon out of the evening sky, this is a fine week to look for the zodiacal light if you live in the mid-northern latitudes — now that the ecliptic tilts high upward from the western horizon at nightfall. From a clear, clean, dark site, look west at the very end of twilight for a vague but huge, narrow pyramid of pearly light. It's very tall and tilted to the left, aligning along the constellations of the zodiac.
- What you're seeing is sunlit interplanetary dust, orbiting the Sun near the ecliptic plane. Believe it or not, seen from interstellar distances this would be the solar system's most prominent feature after the Sun itself. The "zodiacal lights" of dust around other stars may be a real obstacle to someday seeing their small, terrestrial planets.

Thursday, March 8

- Orion is starting to tilt westward after dark now. Later in the night, and later in the month, he turns down further, putting his three-star belt into its horizontal springtime position.
- Last-quarter Moon (exact at 6:20 a.m. March 9th EST). The Moon rises around 1 a.m. tonight. In another hour or two once it's high enough, you can see that it's to the right of Antares and above Mars.



The waning Moon at dawn passes by Mars, then Saturn.

Friday, March 9

- Bright Sirius stands due south on the meridian just after twilight fades away into night. Sirius is the bottom star of the equilateral Winter Triangle. The other two stars of the Triangle are orange Betelgeuse to Sirius's upper right (Orion's shoulder) and Procyon to Sirius's upper left.
- In the early dawn of Saturday, the Moon forms a low, flat triangle with Mars and Saturn, as shown here.

Saturday, March 10

- On the traditional divide between the winter and spring sky lies the dim constellation Cancer. It's between Gemini to its west and Leo to its east. Cancer holds something unique: the Beehive Star Cluster, M44, in its middle.
- The Beehive shows dimly to the naked eye if you have little or no light pollution. With binoculars it's easy, even under worse conditions. Look for it a little less than halfway from Pollux in Gemini to Regulus in Leo.
- Daylight-saving time starts at 2 a.m. Sunday morning for most of North America.

Source: Sky and Telescope

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ISS Sighting Opportunities (from Denver)

Date	Visible	Max Height	Appears	Disappears
Wed Mar 7, 4:44 AM	1 min	14°	14° above N	11° above NNE
Thu Mar 8, 5:29 AM	< 1 min	10°	10° above N	10° above N
Fri Mar 9, 4:37 AM	< 1 min	11°	11° above N	10° above N
Sat Mar 10, 5:21 AM	2 min	11°	10° above N	10° above NNE

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

NASA-TV Highlights (all times Eastern Time Zone)

Tuesday, March 6

- 12:30 p.m. - ISS Expedition 55 In-Flight Educational Event with the University of Massachusetts Dartmouth in North Dartmouth, Massachusetts and NASA Flight Engineer Scott Tingle (all channels)

Wednesday, March 7

- 10 a.m. - House Committee on Science, Space, and Technology Subcommittee on Space, "An Overview of the National Aeronautics and Space Administration Budget for Fiscal Year 2019" (all channels)

Friday, March 9

- 9 a.m. - ISS Expedition 55 In-Flight Interview with KSAZ-TV, Phoenix, Arizona and Flight Engineers Scott Tingle of NASA and Norishige Kanai of the Japan Aerospace Exploration Agency (JAXA) (starts at 9:25 a.m.) (all channels)

Watch NASA TV online by going to the NASA website.

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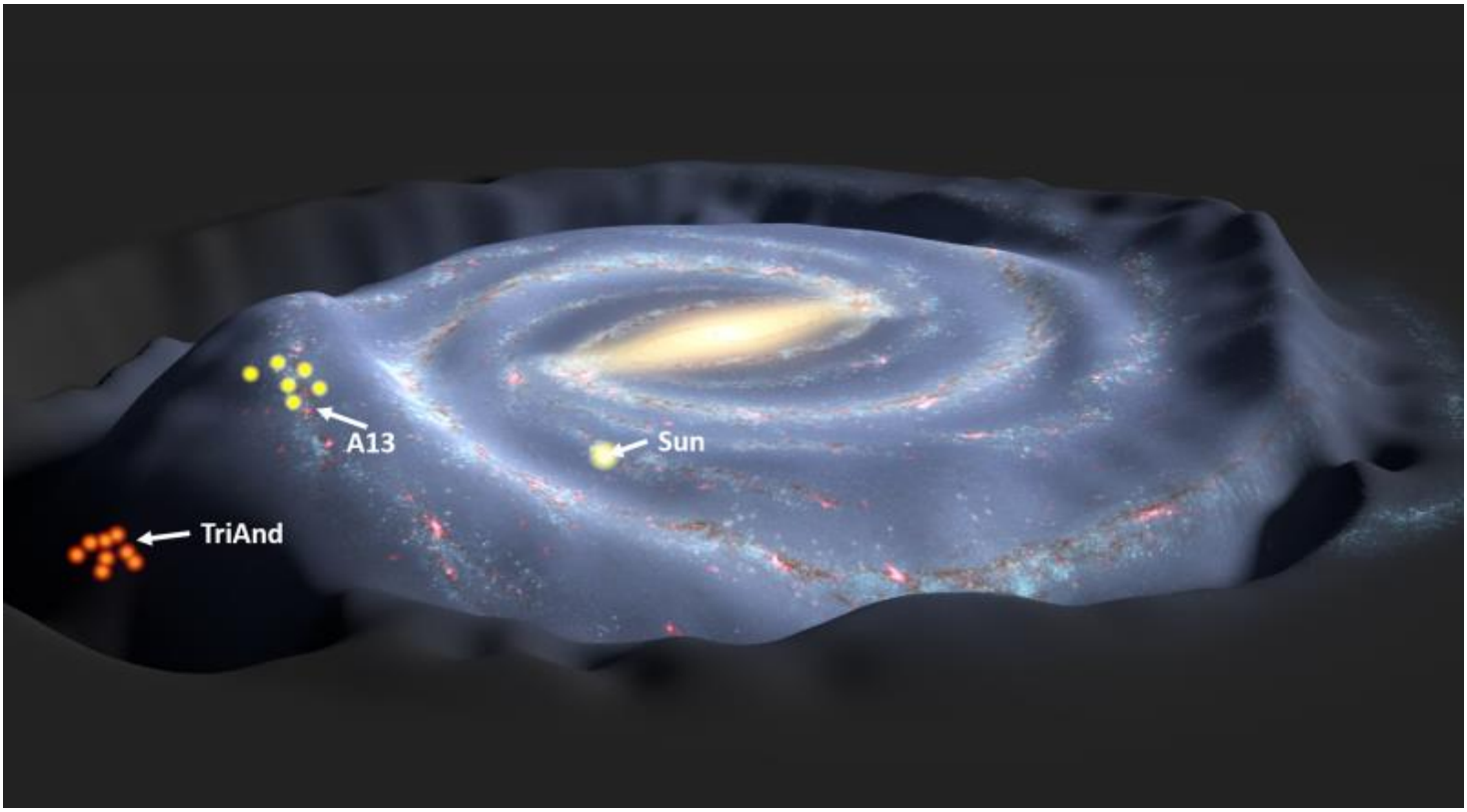
Space Calendar

- Mar 06 - Asteroid 2791 Paradise Closest Approach To Earth (1.047 AU)
- Mar 06 - Asteroid 250840 Motorhead Closest Approach To Earth (2.149 AU)
- Mar 06 - Asteroid 742 Edisona Closest Approach To Earth (2.400 AU)
- Mar 06 - Asteroid 39382 Opportunity Closest Approach To Earth (2.990 AU)
- Mar 06-07 - Meeting: Exoplanet Science Strategy, Washington DC
- Mar 06-08 - 8th DTA Symposium: Challenge to Super-Earths and Their Atmospheres - Where Do They Come From?, Tokyo, Japan
- Mar 06-08 - Meeting: Astrobiology Science Strategy for the Search for Life in the Universe, Washington DC
- Mar 07 - Comet 225P/LINEAR At Opposition (3.612 AU)
- Mar 07 - Comet P/2015 TO19 (Lemmon-PANSTARRS) At Opposition (3.694 AU)
- Mar 07 - Comet C/2017 X1 (PANSTARRS) Closest Approach To Earth (3.909 AU)
- Mar 07 - Comet 284P/McNaught At Opposition (4.064 AU)
- **Mar 07 - Apollo Asteroid 2017 VR12 Near-Earth Flyby (0.010 AU)**
- Mar 07 - Aten Asteroid 2003 EM1 Near-Earth Flyby (0.043 AU)
- Mar 07 - Apollo Asteroid 11500 Tomaiyowit Closest Approach To Earth (0.327 AU)
- Mar 07 - Asteroid 386622 New Zealand Closest Approach To Earth (1.669 AU)
- Mar 07 - Asteroid 4151 Alanhale Closest Approach To Earth (1.742 AU)
- Mar 07 - Kuiper Belt Object 2013 FY27 At Opposition (79.109 AU)
- Mar 07 - Colloquium: The Chicxulub Asteroid Impact and the K-Pg Extinction, Greenbelt, Maryland
- Mar 07 - Event: Collaborating to grow the space economy workshop with EU Commissioner Bienkowska, Canberra, Australia
- Mar 08 - Comet P/2015 TP200 (LINEAR) At Opposition (3.658 AU)
- Mar 08 - Comet C/2017 D3 (ATLAS) Closest Approach To Earth (4.585 AU)
- Mar 08 - Apollo Asteroid 2015 FM34 Near-Earth Flyby (0.058 AU)
- Mar 08 - Apollo Asteroid 2018 CC14 Near-Earth Flyby (0.064 AU)
- Mar 08 - Asteroid 70783 Kenwilliams Closest Approach To Earth (1.796 AU)
- Mar 08 - Asteroid 617 Patroclus Closest Approach To Earth (5.000 AU)
- Mar 08 - EU/AU Industry Mission and Matchmaking Event, Sydney, Australia
- Mar 08 - Forum: Integrated and Sustained Ocean Observing: a European Strategy, Brussels, Belgium
- **Mar 09 - O3b F4 Soyuz Launch**
- Mar 09 - Comet P/2005 J1 (McNaught) Closest Approach To Earth (1.822 AU)
- Mar 09 - Comet 93P/Lovas At Opposition (2.638 AU)
- Mar 09 - Apollo Asteroid 2018 BK7 Near-Earth Flyby (0.026 AU)
- Mar 09 - Aten Asteroid 2013 ND15 (Venus Trojan) Closest Approach To Earth (0.650 AU)
- Mar 09 - Asteroid 9548 Fortran Closest Approach To Earth (1.228 AU)
- Mar 09 - Asteroid 73491 Robmatson Closest Approach To Earth (1.380 AU)
- Mar 09 - Asteroid 25930 Spielberg Closest Approach To Earth (1.565 AU)

Source: JPL Space Calendar Return to Contents

Food for Thought

Stars around the Milky Way: Cosmic Space Invaders or Victims of Galactic Eviction?



The Milky Way galaxy, perturbed by the tidal interaction with a dwarf galaxy, as predicted by N-body simulations. The locations of the observed stars above and below the disk, which are used to test the perturbation scenario, are indicated. Credit: T. MUELLER/C. LAPORTE/NASA/JPL-CALTECH

An international team of astronomers led by the Max Planck Institute for Astronomy (MPIA) has made a surprising discovery about the birthplace of groups of stars located in the halo of our Milky Way galaxy.

These halo stars are grouped together in giant structures that orbit the center of our galaxy, above and below the flat disk of the Milky Way. Researchers thought they may have formed from debris left behind by smaller galaxies that invaded the Milky Way in the past.

But in a study published Feb. 26 in the journal *Nature*, astronomers now have compelling evidence showing that some of these halo structures actually originate from the Milky Way's disk itself, but were kicked out.

"This phenomenon is called galactic eviction," said co-author Judy Cohen, Kate Van Nuys Page Professor of Astronomy at Caltech. "These structures are pushed off the plane of the Milky Way when a massive dwarf galaxy passes through the galactic disk. This passage causes oscillations, or waves, that eject stars from the disk, either above or below it depending on the direction that the perturbing mass is moving."

"The oscillations can be compared to sound waves in a musical instrument," said lead author Maria Bergemann of MPIA. "We call this 'ringing' in the Milky Way galaxy 'galactoseismology,' which has been predicted theoretically decades ago. We now have the clearest evidence for these oscillations in our galaxy's disk obtained so far!"

For the first time, Bergemann's team presented detailed chemical abundance patterns of these halo stars using the W. M. Keck Observatory on Maunakea, Hawaii.

"The analysis of chemical abundances is a very powerful test, which allows, in a way similar to the DNA matching, to identify the parent population of the star. Different parent populations, such as the Milky Way disk or halo, dwarf satellite galaxies or globular clusters, are known to have radically different chemical compositions. So once we know what the stars are made of, we can immediately link them to their parent populations," said Bergemann.

The scientists investigated 14 stars located in two different halo structures - the Triangulum-Andromeda (Tri-And) and the A13 stellar over-densities. These two structures lie on opposite sides of the Milky Way disk; about 14,000 light years above and below the Galactic plane (see Figure 1).

The team obtained spectra of the halo stars using Keck Observatory's High-Resolution Echelle Spectrometer (HIRES).

"The high throughput and high spectral resolution of HIRES were crucial to the success of the observations of the stars in the outer part of the Milky Way," said Cohen. "Another key factor was the smooth operation of Keck Observatory; good pointing and smooth operation allows one to get spectra of more stars in only a few nights of observation. The spectra in this study were obtained in only one night of Keck time, which shows how valuable even a single night can be."

The team also obtained a spectrum of one additional star taken with the European Southern Observatory's Very Large Telescope (VLT) in Chile.

When comparing the chemical compositions of these stars with the ones found in other cosmic structures, the scientists were surprised to find that the chemical compositions are almost identical, both within and between these groups, and closely match the abundance patterns of the Milky Way outer disk stars.

This provides compelling evidence that the halo stars most likely originate from the Galactic thin disk (the younger part of Milky Way, strongly concentrated towards the Galactic plane) itself.

These findings are very exciting because they indicate the Milky Way's disk and its dynamics are significantly more complex than previously thought.

"We showed that it may be fairly common for groups of stars in the disk to be relocated to more distant realms within the Milky Way - having been 'kicked out' by an invading satellite galaxy. Similar chemical patterns may also be found in other galaxies, indicating a potential galactic universality of this dynamic process," said co-author Allyson Sheffield of LaGuardia Community College/CUNY.

As a next step, the astronomers plan to analyze the spectra of additional stars in the Tri-And and A13 over-densities, as well as stars in other stellar structures further away from the disk. They also plan to determine masses and ages of these stars so they can constrain the time limits of when this galactic eviction took place.

Source: W. M. Keck Observatory

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Space Image of the Week

Colorful Airglow Bands Surround Milky Way

Image Credit & Copyright: Xiaohan Wang

Explanation: Why would the sky glow like a giant repeating rainbow? Airglow. Now air glows all of the time, but it is usually hard to see. A disturbance however -- like an approaching storm -- may cause noticeable rippling in the Earth's atmosphere. These gravity waves are oscillations in air analogous to those created when a rock is thrown in calm water. Red airglow likely originates from OH molecules about 87-kilometers high, excited by ultraviolet light from the Sun, while orange and green airglow is likely caused by sodium and oxygen atoms slightly higher up.

While driving near Keluke Lake in Qinghai Provence in China, the photographer originally noticed mainly the impressive central band of the Milky Way Galaxy. Stopping to photograph it, surprisingly, the resulting sensitive camera image showed airglow bands to be quite prominent and span the entire sky. The featured image has been digitally enhanced to make the colors more vibrant.

Source: NASA APOD

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