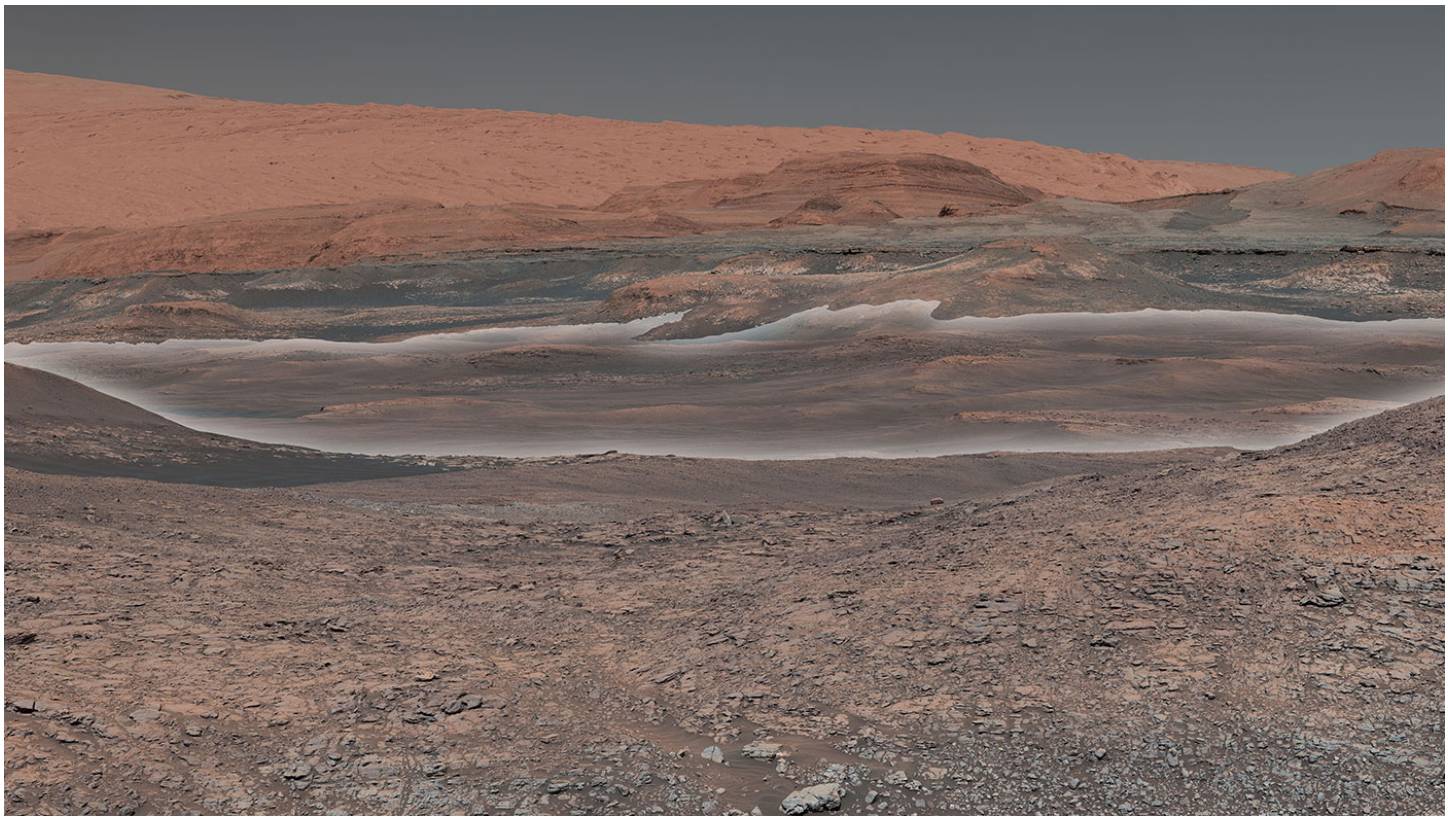
Space News Update

— March 23, 2018 —

Contents

1. Mars Curiosity Celebrates Sol 2,000



NASA's Mars Curiosity rover just hit a new milestone: its two-thousandth Martian day, or sol, on the Red Planet. An image mosaic taken by the rover in January offers a preview of what comes next.

Looming over the image is Mount Sharp, the mound Curiosity has been climbing since September 2014. In the center of the image is the rover's next big, scientific target: an area scientists have studied from orbit and have determined contains clay minerals.

The formation of clay minerals requires water. Scientists have already determined that the lower layers of Mount Sharp formed within lakes that once spanned Gale Crater's floor. The area ahead could offer additional insight into the presence of water, how long it may have persisted, and whether the ancient environment may have been suitable for life.

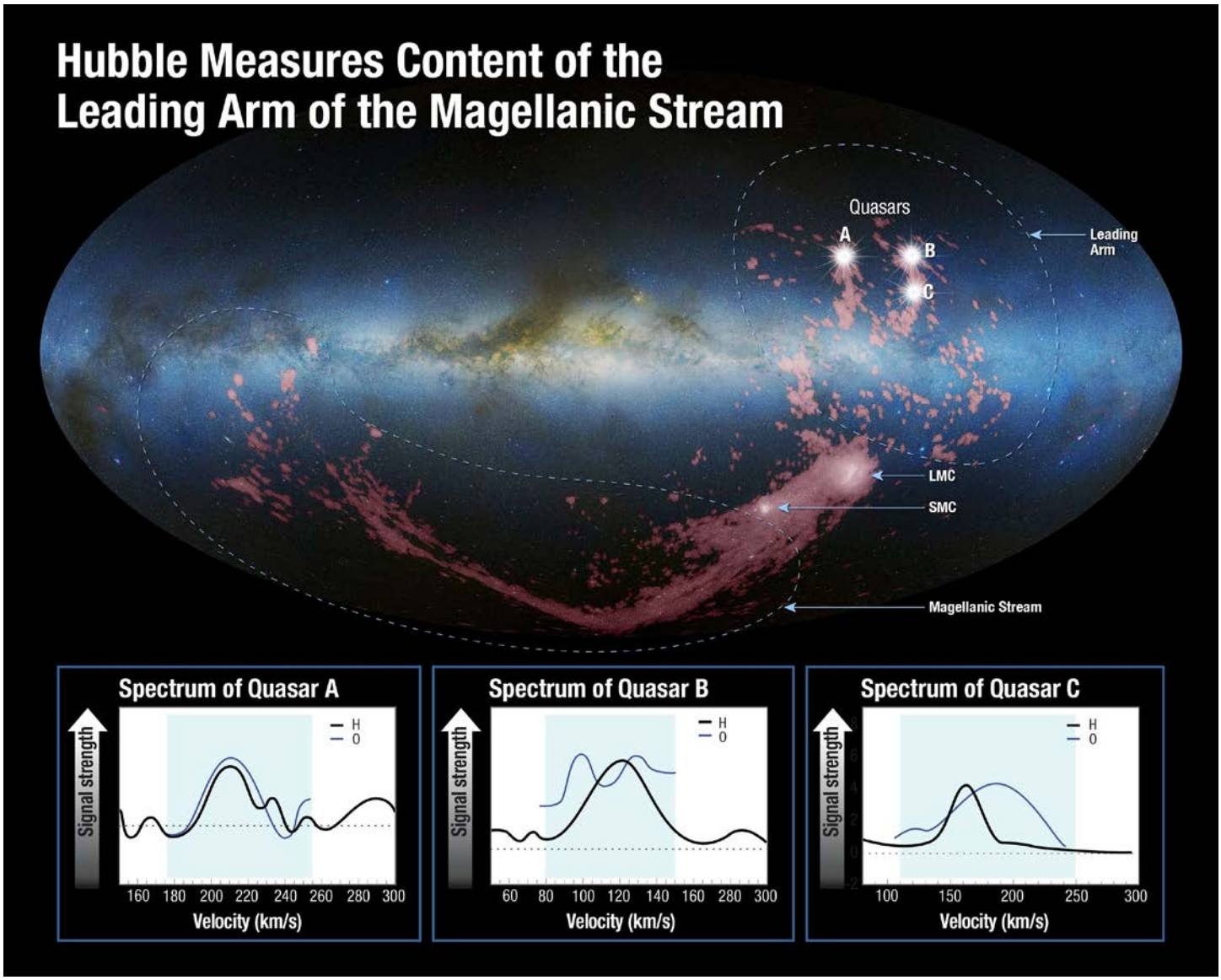
Curiosity's science team is eager to analyze rock samples pulled from the clay-bearing rocks seen in the center of the image. The rover recently started testing its drill again on Mars for the first time since December 2016. A new process for drilling rock samples and delivering them to the rover's onboard laboratories is still being refined in preparation for scientific targets like the area with clay minerals.

Curiosity landed in August 2012 and has traveled 11.6 miles (18.7 kilometers) in that time. In 2013, the mission found evidence of an ancient freshwater-lake environment that offered all the basic chemical ingredients for microbial life. Since reaching Mount Sharp in 2014, Curiosity has examined environments where both waterand wind have left their marks. Having studied more than 600 vertical feet of rock with signs of lakes and groundwater, Curiosity's international science team concluded that habitable conditions lasted for at least millions of years.

Source: JPL

Return to Contents

2. Hubble solves cosmic 'whodunit' with interstellar forensics



On the outskirts of our galaxy, a cosmic tug-of-war is unfolding—and only NASA's Hubble Space Telescope can see who's winning.

The players are two dwarf galaxies, the Large Magellanic Cloud and the Small Magellanic Cloud, both of which orbit our own Milky Way Galaxy. But as they go around the Milky Way, they are also orbiting each other. Each one tugs at the other, and one of them has pulled out a huge cloud of gas from its companion.

Called the Leading Arm, this arching collection of gas connects the Magellanic Clouds to the Milky Way. Roughly half the size of our galaxy, this structure is thought to be about 1 or 2 billion years old. Its name comes from the fact that it's leading the motion of the Magellanic Clouds.

The enormous concentration of gas is being devoured by the Milky Way and feeding new star birth in our galaxy. But which dwarf galaxy is doing the pulling, and whose gas is now being feasted upon? After years of debate, scientists now have the answer to this "whodunit" mystery.

"There's been a question: Did the gas come from the Large Magellanic Cloud or the Small Magellanic Cloud? At first glance, it looks like it tracks back to the Large Magellanic Cloud," explained lead researcher Andrew Fox of

the Space Telescope Science Institute in Baltimore, Maryland. "But we've approached that question differently, by asking: What is the Leading Arm made of? Does it have the composition of the Large Magellanic Cloud or the composition of the Small Magellanic Cloud?"

Fox's research is a follow-up to his 2013 work, which focused on a trailing feature behind the Large and Small Magellanic Clouds. This gas in this ribbon-like structure, called the Magellanic Stream, was found to come from both dwarf galaxies. Now Fox wondered about its counterpart, the Leading Arm. Unlike the trailing Magellanic Stream, this tattered and shredded "arm" has already reached the Milky Way and survived its journey to the galactic disk.

The Leading Arm is a real-time example of gas accretion, the process of gas falling onto galaxies. This is very difficult to see in galaxies outside the Milky Way, because they are too far away and too faint. "As these two galaxies are in our backyard, we essentially have a front-row seat to view the action," said collaborator Kat Barger at Texas Christian University.

In a new kind of forensics, Fox and his team used Hubble's ultraviolet vision to chemically analyze the gas in the Leading Arm. They observed the light from seven quasars, the bright cores of active galaxies that reside billions of light-years beyond this gas cloud. Using Hubble's Cosmic Origins Spectrograph, the scientists measured how this light filters through the cloud.

In particular, they looked for the absorption of ultraviolet light by oxygen and sulfur in the cloud. These are good gauges of how many heavier elements reside in the gas. The team then compared Hubble's measurements to hydrogen measurements made by the National Science Foundation's Robert C. Byrd Green Bank Telescope at the Green Bank Observatory in West Virginia, as well as several other radio telescopes.

"With the combination of Hubble and Green Bank Telescope observations, we can measure the composition and velocity of the gas to determine which dwarf galaxy is the culprit," explained Barger.

After much analysis, the team finally had conclusive chemical "fingerprints" to match the origin of the Leading Arm's gas. "We've found that the gas matches the Small Magellanic Cloud," said Fox. "That indicates the Large Magellanic Cloud is winning the tug-of-war, because it has pulled so much gas out of its smaller neighbor."

This answer was possible only because of Hubble's unique ultraviolet capability. Because of the filtering effects of Earth's atmosphere, ultraviolet light cannot be studied from the ground. "Hubble is the only game in town," explained Fox. "All the lines of interest, including oxygen and sulfur, are in the ultraviolet. So if you work in the optical and infrared, you can't see them."

Gas from the Leading Arm is now crossing the disk of our galaxy. As it crosses, it interacts with the Milky Way's own gas, becoming shredded and fragmented.

This is an important case study of how gas gets into galaxies and fuels star birth. Astronomers use simulations and try to understand the inflow of gas in other galaxies. But here, the gas is being caught red-handed as it moves across the Milky Way's disk. Sometime in the future, planets and solar systems in our galaxy may be born out of material that used to be part of the Small Magellanic Cloud.

The team's study appears in the Feb. 20, 2018, issue of the *Astrophysical Journal*.

As Fox and his team look ahead, they hope to map out the full size of the Leading Arm—something that is still unknown.

Source: Phys.org Return to Contents

3. SpaceX Rocket Launch Created Shock Wave 4 Times Larger Than California

A SpaceX Falcon 9 rocket launch last year generated a record-setting shock wave in Earth's atmosphere four times larger than the state of California, a new study reports.

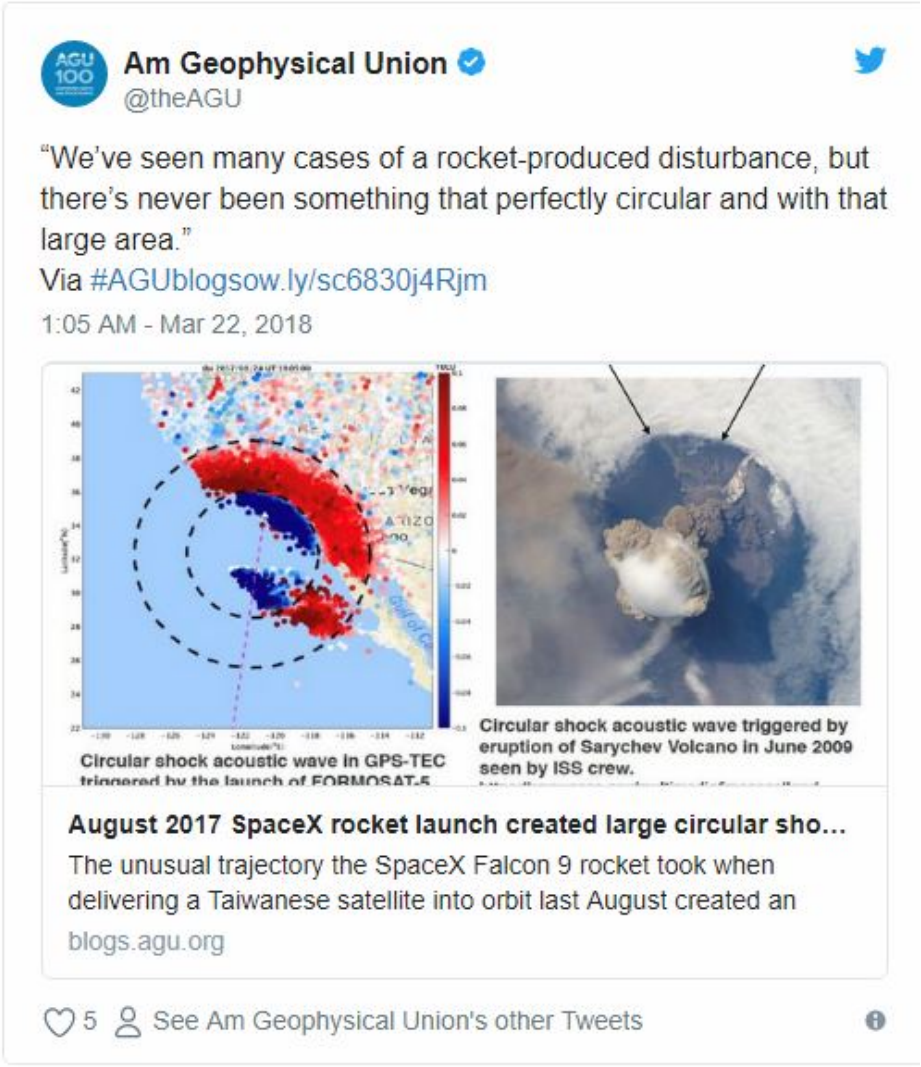
The shock wave created during the August 2017 launch of Taiwan's Earth-observing Formosat-5 satellite was circular, in contrast to the V-shaped shock waves produced by most rockets, study team members said.

And it was really, really big.

"We've seen many cases of a rocket-produced disturbance, but there's never been something that perfectly circular and with that large [an] area," study lead author Charles Lin, a geophysicist at the National Cheng Kung University in Taiwan, said in a statement.

Shock waves zoom through the atmosphere faster than the speed of sound. These waves are invisible to the naked eye, but researchers can map their contours by analyzing GPS data.

That's just what Lin and his colleagues did for the shock wave generated by the Formosat-5 launch from California's Vandenberg Air Force Base. This work allowed them to discern the wave's enormous size and to determine that the launch also punched a temporary hole in the ionosphere — a part of Earth's upper atmosphere that extends from about 45 to 620 miles (75 to 1,000 kilometers) in altitude.



The hole was created by the interaction of water vapor in the Falcon 9's exhaust with charged particles in the ionosphere above California, the researchers said. Such ionospheric disturbances can mess with GPS signals, and this hole may have caused navigation errors of up to 3.3 feet (1 meter) for an hour or two after the launch, according to the study.

Lin and his team also performed computer simulations of rocket launches, which suggested that the August 2017 shock wave's large size and odd shape are due to the unique trajectory taken by the Falcon 9.

Rockets usually take a curved path to space and drop off satellites about 120 miles (200 km) up, at which point the payloads maneuver to their final orbits. But Formosat-5 was an uncommonly light payload, so the Falcon 9 journeyed pretty much straight up and deployed the satellite at its final destination, 450 miles (720 km) above Earth's surface.

Such analyses will likely be increasingly important as the cost of building and lofting satellites continues to decrease, Lin and his colleagues said.

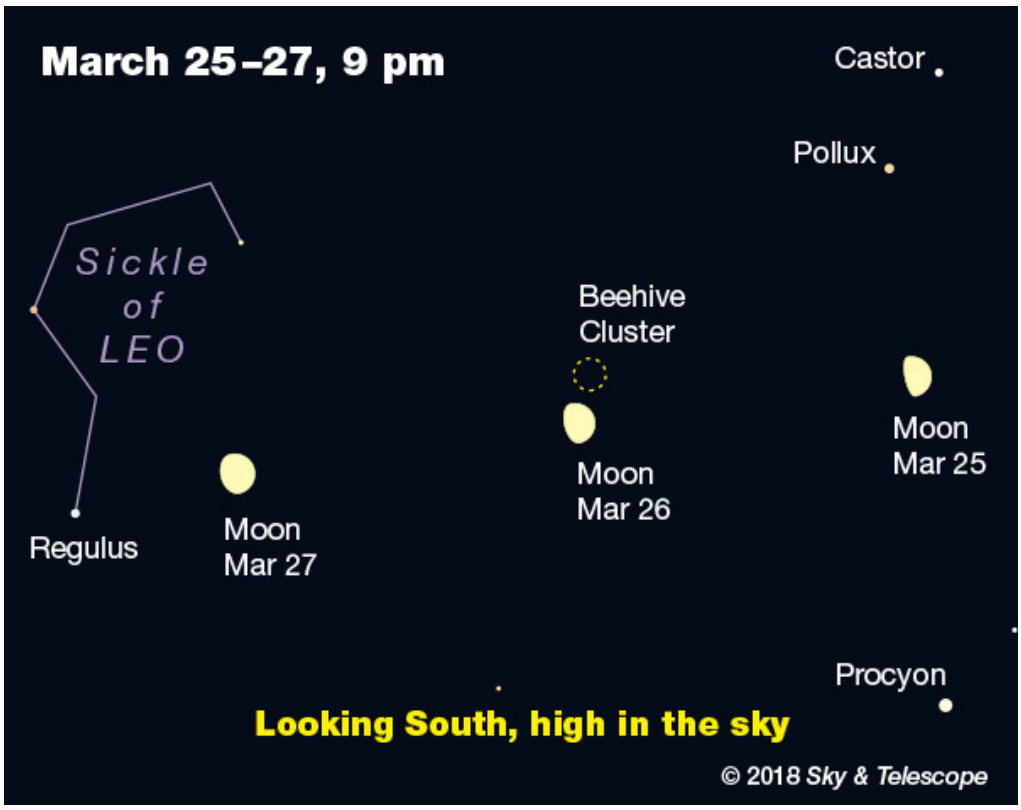
"Understanding how the rocket launches affect our upper atmosphere and space environment is important, as these anthropogenic space weather events are expected to increase at an enormous rate in the near future," the researchers wrote in the new study, which was published in January in the journal Space Weather.

Source: Space.com

Return to Contents

The Night Sky

Friday, March 23
• The Moon stands at the horntips of Taurus tonight, as shown at right. Traditional portrayals of Taurus show the Bull with remarkably long horns. Aldebaran and the brightest Hyades stars are supposed to represent his fiery eye and V-shaped face.



Lower left of the Moon you'll find Betelgeuse, out of the picture here.

More than twice as far to the Moon's right or upper right shines Capella.

• Now that it's spring, the signature fall-and-winter constellation Cassiopeia retreats downward after dark. But for skywatchers at mid-northern latitudes Cassiopeia is circumpolar, never going away completely. Look for it fairly low in the north-northwest these evenings. It's still standing nearly on end. By 2 a.m. it's at its lowest due north, lying not quite horizontally.

Saturday, March 24
• First-quarter Moon (exact at 11:35 a.m. EDT). This evening the Moon shines high above Orion, in the feet of Gemini below Castor and Pollux.

Sunday, March 25
• At dusk, look above the Moon for Pollux (with Castor), and look farther below the Moon for Procyon. The Moon is 1.3 light-seconds from Earth — compared to Procyon's distance of 11 light-*years,* Pollux at 34 light-years, and Castor at 52.

• Meanwhile Arcturus, the "Spring Star," now rises above the east-northeast horizon around the time the stars come out. How soon can you spot it?

Monday, March 26
• This is the time of year when the dim Little Dipper juts to the right from Polaris (the Little Dipper's handle-end) during late evening. The much brighter Big Dipper curls over high above it, "dumping water" into it. They do the reverse water-dump in the fall.

Tuesday, March 27
• Look lower left of the Moon this evening for Regulus, the brightest star of Leo and the bottom of Leo's Sickle: a backward question mark about a fist at arm's length tall.

Source: Sky & Telescope

Return to Contents

ISS Sighting Opportunities

For Denver:

Date	Visible	Max Height	Appears	Disappears
Fri Mar 23, 7:44 PM	2 min	12°	10° above SSE	10° above ESE
Fri Mar 23, 9:18 PM	2 min	28°	10° above WSW	28° above WSW
Sat Mar 24, 8:26 PM	5 min	61°	10° above SW	27° above ENE
Sun Mar 25, 7:37 PM	2 min	28°	28° above ESE	11° above ENE
Sun Mar 25, 9:12 PM	2 min	30°	25° above WNW	27° above N
Mon Mar 26, 8:20 PM	5 min	52°	26° above W	10° above NE
Mon Mar 26, 9:57 PM	< 1 min	12°	12° above NW	12° above NW
Tue Mar 27, 9:05 PM	2 min	18°	17° above NW	13° above NNE

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

NASA-TV Highlights

(all times Eastern Daylight Time)

- **2 p.m., 8 p.m., 10 p.m., Friday, March 23 -** Replay of SpaceCast Weekly (all channels)
- **3 p.m., Friday, March 23 -** Coverage of the Docking of the ISS Expedition 55-56 Crew (Artemyev, Feustel, Arnold) to the ISS on Soyuz MS-08 (Docking scheduled at 3:41 p.m. EDT) (all channels)
- **5 p.m., Friday, March 23 -** Coverage of the Hatch Opening and Welcoming Ceremony for the ISS Expedition 55-56 Crew (Artemyev, Feustel, Arnold) on the ISS (Hatch opening scheduled at 5:45 p.m. EDT) (all channels)
- **9 p.m., 11 p.m., Friday, March 23 -** Replay of the Docking of the ISS Expedition 55-56 Crew (Artemyev, Feustel, Arnold) to the ISS and the Hatch Opening and Welcoming Ceremony (all channels)
- **9 a.m., 2 p.m., 8 p.m., Saturday, March 24 -** Replay of the Launch of the ISS Expedition 55-56 Crew (Artemyev, Feustel, Arnold) to the ISS on Soyuz MS-08 and Post-Launch Interviews (all channels)
- **9:30 a.m., 2:30 p.m., 8:30 p.m., Saturday, March 24** - Replay of the Docking of the ISS Expedition 55-56 Crew (Artemyev, Feustel, Arnold) to the ISS and the Hatch Opening and Welcoming Ceremony (all channels)
- **10 a.m., 6 p.m., 9 p.m., Saturday, March 24 -** Replay of SpaceCast Weekly (all channels)
- **9 a.m., 2 p.m., 6 p.m., Sunday, March 25 -** Replay of SpaceCast Weekly (all channels)
- **10 a.m., 4 p.m., 8 p.m., Sunday, March 25 -** Replay of the Launch of the ISS Expedition 55-56 Crew (Artemyev, Feustel, Arnold) to the ISS on Soyuz MS-08 and Post-Launch Interviews (all channels)

- **10:30 a.m., 4:30 p.m., 8:30 p.m., Sunday, March 25 -** Replay of the Docking of the ISS Expedition 55-56 Crew (Artemyev, Feustel, Arnold) to the ISS and the Hatch Opening and Welcoming Ceremony (all channels)
- **2 p.m., Tuesday, March 27 -** U.S. Spacewalk # 49 Preview Briefing (all channels)

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

Space Calendar

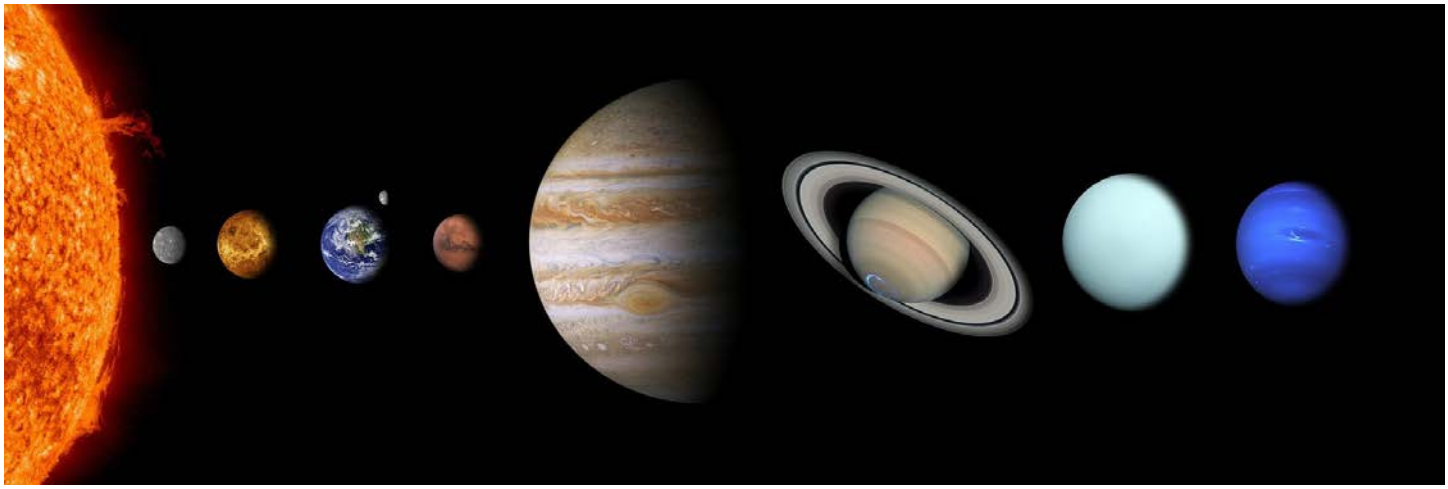
- Mar 23 - Comet 73P-T/Schwassmann-Wachmann Perihelion (0.950 AU)
- Mar 23 - Comet 363P/Lemmon Perihelion (1.508 AU)
- Mar 23 - Comet C/2017 K1 (PANSTARRS) Perihelion (7.262 AU)
- Mar 23 - Comet 306P/LINEAR At Opposition (3.569 AU)
- Mar 23 - Comet 17P/Holmes At Opposition (4.122 AU)
- Mar 23 - NEW [Mar 22] Apollo Asteroid 2018 FC3 Near-Earth Flyby (0.013 AU)
- Mar 23 - NEW [Mar 22] Apollo Asteroid 2018 FL2 Near-Earth Flyby (0.023 AU)
- Mar 23 - NEW [Mar 22] Apollo Asteroid 2018 FA2 Near-Earth Flyby (0.029 AU)
- Mar 23 - Apollo Asteroid 267940 (2004 EM20) Near-Earth Flyby (0.096 AU)
- Mar 23 - Asteroid 65675 Mohr-Gruber Closest Approach To Earth (1.770 AU)
- Mar 24 - Comet P/2017 W3 (Gibbs) Closest Approach To Earth (2.860 AU)
- Mar 24 - Comet P/2017 W3 (Gibbs) At Opposition (2.860 AU)
- Mar 24 - NEW [Mar 22] Apollo Asteroid 2018 FW1 Near-Earth Flyby (0.024 AU)
- Mar 24 - Amor Asteroid 2018 ER3 Near-Earth Flyby (0.082 AU)
- Mar 24 - Amor Asteroid 2018 DY1 Near-Earth Flyby (0.094 AU)
- Mar 24 - Asteroid 72432 Kimrobinson Closest Approach To Earth (1.305 AU)
- Mar 24 - Asteroid 25137 Seansolomon Closest Approach To Earth (1.424 AU)
- Mar 24 - West Midlands Branch Talks, Droitwich, United Kingdom
- Mar 24 - 25th Anniversary (1993), Discovery of Comet Shoemaker-Levy 9
- Mar 24 - 85th Anniversary (1933), Pasamonte Meteorite Shower in New Mexico
- Mar 24 - Walter Baade's 125th Birthday (1893)
- Mar 25 - European Summer Time - Set Clock Ahead 1 Hour (European Union)
- Mar 25 - Comet C/2017 M3 (PANSTARRS) At Opposition (4.479 AU)
- Mar 25 - Asteroid 773 Irmintraud Occults HIP 98842 (5.1 Magnitude Star)
- Mar 25 - Asteroid 4 Vesta Occults 2UCAC 25366909 (12.0 Magnitude Star)
- Mar 25 - NEW [Mar 22] Apollo Asteroid 2018 FQ1 Near-Earth Flyby (0.014 AU)
- Mar 25 - NEW [Mar 22] Apollo Asteroid 2018 FB3 Near-Earth Flyby (0.024 AU)
- Mar 25 - Aten Asteroid 2017 FZ2 Near-Earth Flyby (0.071 AU)
- Mar 25 - Asteroid 9249 Yen Closest Approach To Earth (1.271 AU)
- Mar 25 - Asteroid 274301 Wikipedia Closest Approach To Earth (1.643AU)
- Mar 25 - Asteroid 1024 Hale Closest Approach To Earth (2.547 AU)
- Mar 25 - Neptune Trojan 316179 (2010 EN65) At Opposition (25.620 AU)
- Mar 25 - Dwarf Planet 136472 Makemake At Opposition (51.639 AU)
- Mar 25 - 35th Anniversary (1983), Michael Jackson's Moonwalk Debut (Pasadena Civic Auditorium)
- Mar 25 - James Lovell's 90th Birthday (1928)
- Mar 25 - Kenneth Franklin's 95th Birthday (1923)
- Mar 25 - Christopher Clavius' 480th Birthtday (1538)
- Mar 26 - Comet 183P/Korlevic-Juric Closest Approach To Earth (2.899 AU)
- Mar 26 - NEW [Mar 21] Comet C/2018 F1 (Grauer) At Opposition (2.944 AU)
- Mar 26 - Comet 314P/Montani At Opposition (4.062 AU)
- Mar 26 - NEW [Mar 22] Apollo Asteroid 2018 FR1 Near-Earth Flyby (0.016 AU)
- Mar 26 - Asteroid 19911 Rigaux Closest Approach To Earth (1.194 AU)
- Mar 26 - Asteroid 2625 Jack London Closest Approach To Earth (1.318 AU)
- Mar 26 - Asteroid 3018 Godiva Closest Approach To Earth (1.545 AU)
- Mar 26 - 15th Anniversary (2003), Park Forest Meteorite Shower (Hit Houses in Illinois)
- Mar 26 - Nathaniel Bowditch's 245th Birthday (1773)
- Mar 27 - Comet 300P/Catalina At Opposition (1.661 AU)
- Mar 27 - Comet 183P/Korlevic-Juric At Opposition (2.899 AU)
- Mar 27 - Comet P/2007 S1 (Zhao) At Opposition (3.932 AU)

- Mar 27 - Comet P/2010 TO20 (LINEAR-Grauer) At Opposition (4.990 AU)
- Mar 27 - Comet C/2016 C1 (PANSTARRS) At Opposition (8.593 AU)
- Mar 27 - Apollo Asteroid 2018 DH1 Near-Earth Flyby (0.024 AU)
- Mar 27 - Apollo Asteroid 2004 EU22 Near-Earth Flyby (0.084 AU)
- Mar 27 - Asteroid 96192 Calgary Closest Approach To Earth (1.606 AU)
- Mar 27 - Asteroid 4636 Chile Closest Approach To Earth (2.021 AU)

Source: JPL Space Calendar Return to Contents

Food for Thought

New theory to explain why planets in our solar system have different compositions



A team of researchers with the University of Copenhagen and the Museum für Naturkunde, Leibniz-Institut für Evolutions has come up with a new explanation regarding the difference in composition of the planets in our solar system. In their paper published in the journal *Nature*, they describe their study of the calcium-isotope composition of certain meteorites, Earth itself, and Mars, and use what they learned to explain how the planets could be so different. Alessandro Morbidelli with Observatoire de la Côte d'Azur in France offers a News & Views piece on the work done by the team in the same journal issue.

As Morbidelli notes, most planetary scientists agree that the planets in our solar system had similar origins as small rocks orbiting the sun, comprising the protoplanetary disk, which collided and fused, creating increasingly larger rocks that eventually became protoplanets. But from that point on, it is not clear why the planets turned out so differently. In this new effort, the researchers have come up with a new theory to explain how that happened.

The protoplanets all grew at the same rate, the group suggests, but stopped growing at different times. Those that were smaller, they continue, stopped growing sooner than those that were larger. During this time, they further suggest, material was constantly being added to the disk. Early on it, it appears that the composition of the material was different from the material that came later, which explains why the rocky planets we see today have such differences in composition.

The researchers developed their theory after studying the calcium-isotope composition of several meteorites called angrites and ureilites, as well as that of Mars and Earth, and also from the asteroid Vesta. Calcium isotopes, they note, are involved in the formation of rock, and because of that, offer clues about their origins. The researchers found that isotopic ratios in samples correlated with the masses of their parent planets and asteroids, which they claim provides a proxy for their accretion timeline. And that, they further claim, provides evidence of the different compositions of the planets, as the smaller ones ceased accreting material while the larger ones continued to add material that was different from what had come before.

Source: Phys.org

Return to Contents

Space Image of the Week

Two Veggie Units Are Operating Aboard The International Space Station

Crew aboard the International Space Station are now running two Veggie facilities simultaneously!

They have grown two batches of mixed greens, including mizuna, red romaine lettuce and tokyo bekana cabbage.

Organisms grow differently in space, from single-celled bacteria to plants and humans. But future long-duration space missions will require crew members to grow their own food, so understanding how plants respond to microgravity is an important step toward that goal. The Veg-03 experiment uses the Veggie plant growth facility to cultivate a type of cabbage, lettuce and mizuna which are harvested on-orbit with samples returned to Earth for testing.

Source: SpaceRef.com

Return to Contents