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No doubt about it, NASA explores some of the most awe-inspiring locations in our solar system and beyond. Once seen, who can forget the majesty of astronaut Jim Irwin standing before the stark beauty of the Moon's Hadley Apennine mountain range, of the Hubble Space Telescope's gorgeous "Pillars of Creation" or Cassini's magnificent mosaic of Saturn?

Mars also plays a part in this visually compelling equation, with the high-definition imagery from the Curiosity rover of the ridges and rounded buttes at the base of Mount Sharp bringing to mind the majesty of the American Southwest. That said, Elysium Planitia – the site chosen for the Nov. 26 landing of NASA's InSight mission to Mars – will more than likely never be mentioned with those above because it is, well, plain.

"If Elysium Planitia were a salad, it would consist of romaine lettuce and kale – no dressing," said InSight principal investigator Bruce Banerdt at NASA's Jet Propulsion Laboratory in Pasadena, California. "If it were an ice cream, it would be vanilla."

Yes, the landing site of NASA's next Mars mission may very well look like a stadium parking lot, but that is the way the Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight) project likes it.

"Previous missions to the Red Planet have investigated its surface by studying its canyons, volcanoes, rocks and soil," said Banerdt. "But the signatures of the planet's formation processes can be found only by sensing and studying evidence buried far below the surface. It is InSight's job to study the deep interior of Mars, taking the planet's vital signs – its pulse, temperature and reflexes."

Taking those vital signs will help the InSight science team look back to a time when the rocky planets of the solar system formed. The investigations will depend on three instruments:
A six-sensor seismometer called the Seismic Experiment for Interior Structure (SEIS) will record seismic waves traveling through the interior structure of the planet. Studying seismic waves will tell scientists what might be creating the waves. (On Mars, scientists suspect that the culprits may be marsquakes or meteorites striking the surface.)

The mission's Heat Flow and Physical Properties Package (HP$^3$) will burrow deeper than any other scoop, drill or probe on Mars before to gauge how much heat is flowing out of the planet. Its observations will shed light on whether Earth and Mars are made of the same stuff.

Finally, InSight's Rotation and Interior Structure Experiment (RISE) experiment will use the lander's radios to assess the wobble of Mars' rotation axis, providing information about the planet's core.

For InSight to do its work, the team needed a landing site that checked off several boxes, because as a three-legged lander – not a rover – InSight will remain wherever it touches down.

"Picking a good landing site on Mars is a lot like picking a good home: It's all about location, location, location," said Tom Hoffman, InSight project manager at JPL. "And for the first time ever, the evaluation for a Mars landing site had to consider what lay below the surface of Mars. We needed not just a safe place to land, but also a workspace that's penetrable by our 16-foot-long (5-meter) heat-flow probe."

The site also needs to be bright enough and warm enough to power the solar cells while keeping its electronics within temperature limits for an entire Martian year (26 Earth months).

So the team focused on a band around the equator, where the lander's solar array would have adequate sunlight to power its systems year-round. Finding an area that would be safe enough for InSight to land and then deploy its solar panels and instruments without obstructions took a little longer.

"The site has to be a low-enough elevation to have sufficient atmosphere above it for a safe landing, because the spacecraft will rely first on atmospheric friction with its heat shield and then on a parachute digging into Mars' tenuous atmosphere for a large portion of its deceleration," said Hoffman. "And after the chute has fallen away and the braking rockets have kicked in for final descent, there needs to be a flat expanse to land on – not too undulating and relatively free of rocks that could tip the tri-legged Mars lander."

Of 22 sites considered, only Elysium Planitia, Isidis Planitia and Valles Marineris met the basic engineering constraints. To grade the three remaining contenders, reconnaissance images from NASA's Mars orbiters were scoured and weather records searched. Eventually, Isidis Planitia and Valles Marineris were ruled out for being too rocky and windy.

That left the 81-mile long, 17-mile-wide (130-kilometer-long, 27-kilometer-wide) landing ellipse on the western edge of a flat, smooth expanse of lava plain.

"If you were a Martian coming to explore Earth's interior like we are exploring Mars' interior, it wouldn't matter if you put down in the middle of Kansas or the beaches of Oahu," said Banerdt. "While I'm looking forward to those first images from the surface, I am even more eager to see the first data sets revealing what is happening deep below our landing pads. The beauty of this mission is happening below the surface. Elysium Planitia is perfect."

After a 205-day journey that began on May 5, NASA's InSight mission will touch down on Mars on Nov. 26 a little before 3 p.m. EST (12 p.m. PST). Its solar panels will unfurl within a few hours of touchdown. Mission engineers and scientists will take their time assessing their "workspace" prior to deploying SEIS and HP$^3$ on the surface – about three months after landing – and begin the science in earnest.
InSight was the 12th selection in NASA's series of Discovery-class missions. Created in 1992, the Discovery Program sponsors frequent, cost-capped solar system exploration missions with highly focused scientific goals.

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. **Lockheed Martin Space in Denver built the InSight spacecraft, including its cruise stage and lander, and supports spacecraft operations for the mission.**

**Note:** The InSight lander is scheduled to touch down on the Red Planet at approximately 3 p.m. EST Nov. 26, and viewers everywhere can watch coverage of the event live on NASA Television, the agency's website and social media platforms.

Source: [NASA](#)
On ancient Mars, water carved channels and transported sediments to form fans and deltas within lake basins. Examination of spectral data acquired from orbit show that some of these sediments have minerals that indicate chemical alteration by water. Here in Jezero Crater delta, sediments contain clays and carbonates. The image combines information from two instruments on NASA’s Mars Reconnaissance Orbiter, the Compact Reconnaissance Imaging Spectrometer for Mars and the Context Camera. Credits: NASA/JPL/JHUAPL/MSSS/Brown University

NASA has chosen Jezero Crater as the landing site for its upcoming Mars 2020 rover mission after a five year search, during which every available detail of more than 60 candidate locations on the Red Planet was scrutinized and debated by the mission team and the planetary science community.

The rover mission is scheduled to launch in July 2020 as NASA’s next step in exploration of the Red Planet. It will not only seek signs of ancient habitable conditions – and past microbial life -- but the rover also will collect rock and soil samples and store them in a cache on the planet’s surface. NASA and ESA (European Space Agency) are studying future mission concepts to retrieve the samples and return them to Earth, so this landing site sets the stage for the next decade of Mars exploration.

“The landing site in Jezero Crater offers geologically rich terrain, with landforms reaching as far back as 3.6 billion years old, that could potentially answer important questions in planetary evolution and astrobiology,” said Thomas Zurbuchen, associate administrator for NASA’s Science Mission Directorate. “Getting samples from this unique area will revolutionize how we think about Mars and its ability to harbor life.”

Jezero Crater is located on the western edge of Isidis Planitia, a giant impact basin just north of the Martian equator. Western Isidis presents some of the oldest and most scientifically interesting landscapes Mars has to offer. Mission scientists believe the 28-mile-wide (45-kilometer) crater, once home to an ancient river delta, could have...
collected and preserved ancient organic molecules and other potential signs of microbial life from the water and sediments that flowed into the crater billions of years ago.

Jezero Crater’s ancient lake-delta system offers many promising sampling targets of at least five different kinds of rock, including clays and carbonates that have high potential to preserve signatures of past life. In addition, the material carried into the delta from a large watershed may contain a wide variety of minerals from inside and outside the crater.

The geologic diversity that makes Jezero so appealing to Mars 2020 scientists also makes it a challenge for the team’s entry, descent and landing (EDL) engineers. Along with the massive nearby river delta and small crater impacts, the site contains numerous boulders and rocks to the east, cliffs to the west, and depressions filled with aeolian bedforms (wind-derived ripples in sand that could trap a rover) in several locations.

“The Mars community has long coveted the scientific value of sites such as Jezero Crater, and a previous mission contemplated going there, but the challenges with safely landing were considered prohibitive,” said Ken Farley, project scientist for Mars 2020 at NASA’s Jet Propulsion Laboratory. “But what was once out of reach is now conceivable, thanks to the 2020 engineering team and advances in Mars entry, descent and landing technologies.”

When the landing site search began, mission engineers already had refined the landing system such that they were able to reduce the Mars 2020 landing zone to an area 50 percent smaller than that for the landing of NASA’s Curiosity rover at Gale Crater in 2012. This allowed the science community to consider more challenging landing sites. The sites of greatest scientific interest led NASA to add a new capability called Terrain Relative Navigation (TRN). TRN will enable the “sky crane” descent stage, the rocket-powered system that carries the rover down to the surface, to avoid hazardous areas.

The site selection is dependent upon extensive analyses and verification testing of the TRN capability. A final report will be presented to an independent review board and NASA Headquarters in the fall of 2019.

"Nothing has been more difficult in robotic planetary exploration than landing on Mars,” said Zurbuchen. “The Mars 2020 engineering team has done a tremendous amount of work to prepare us for this decision. The team will continue their work to truly understand the TRN system and the risks involved, and we will review the findings independently to reassure we have maximized our chances for success.”

Selecting a landing site this early allows the rover drivers and science operations team to optimize their plans for exploring Jezero Crater once the rover is safely on the ground. Using data from NASA’s fleet of Mars orbiters, they will map the terrain in greater detail and identify regions of interest – places with the most interesting geological features, for example – where Mars 2020 could collect the best science samples.

The final four candidate Mars 2020 landing sites. Curiosity and Spirit Rovers are near the Columbia Hills site. The InSight Lander will also be located in that area.

This topographic map of Mars was created by the Mars Orbital Laser Altimeter (MOLA) on board the robot Mars Global Surveyor spacecraft. MOLA measured heights on Mars by precisely determining the time it took for a low power laser beam to bounce off the surface.

Credit: NASA/MGS/MOLA Science Team

Source: NASA
Astronomers sifting through data from the Gaia spacecraft have found a previously unseen dwarf galaxy lurking near the Milky Way. In this artist's impression, the Large Magellanic cloud can be seen to the left of the Milky Way, center, while the newly discovered dwarf is visible as a dim cloud to the far right. Image: V. Belokurov based on the images by Marcus and Gail Davies and Robert Gendler

Scientists studying data from the European Space Agency’s Gaia spacecraft have discovered a previously unknown dwarf galaxy lurking just outside the Milky Way, an extremely low-density swarm of stars two thirds the size of Earth’s galaxy. The so-called “ghost” galaxy, known as Antlia 2, is one third the size of the Milky Way, as big as the Large Magellanic Cloud.

How did it remain unknown for so long? Ant 2 is 10,000 times fainter than the Large Magellanic Cloud and it is hidden behind the disk of the Milky Way. It could only be found using Gaia’s high-precision data and it poses a mystery for astronomers: it is either too large for its luminosity or far too dim for its size.

““This is a ghost of a galaxy,” said Gabriel Torrealba, lead author of an on-line paper describing the discovery. “Objects as diffuse as Ant 2 have simply not been seen before. Our discovery was only possible thanks to the quality of the Gaia data.”

Gaia collected high-precision measurements on millions of stars across the Milky Way. The researchers used that data to look for old, metal-poor RR Lyrae stars, typical denizens of dwarf galaxies, that pulse, or change brightness, every 12 hours or so.
RR Lyrae had been found in every known dwarf satellite, so when we found a group of them sitting above the Galactic disc, we weren’t totally surprised,” said co-author Vasily Belokurov from Cambridge's Institute of Astronomy. “But when we looked closer at their location on the sky it turned out we found something new, as no previously identified object came up in any of the databases we searched through.”

The team confirmed the Ant 2 discovery after collecting spectra showing the stars were moving together. But unlike a typical ghost, there’s nothing scary about Ant 2: the data shows the dwarf galaxy always stays about 130,000 light years from the Milky Way.

“The simplest explanation of why Ant 2 appears to have so little mass today is that it is being taken apart by the galactic tides of the Milky Way,” said co-author Sergey Koposov from Carnegie Mellon University. “What remains unexplained, however, is the object’s giant size. Normally, as galaxies lose mass to the Milky Way’s tides, they shrink, not grow.”

Said co-author Matthew Walker, also from Carnegie Mellon: “Compared to the rest of the 60 or so Milky Way satellites, Ant 2 is an oddball. We are wondering whether this galaxy is just the tip of an iceberg, and the Milky Way is surrounded by a large population of nearly invisible dwarfs similar to this one.”
The Night Sky

Tuesday, November 20

• Whenever Fomalhaut is "southing" (crossing the meridian due south, which it does around 7 or 8 p.m. this week), the first stars of Orion are just about to rise above the east horizon. And the Pointers of the Big Dipper stand upright low due north, straight below Polaris.

Wednesday, November 21

• Does the Sun already seem to be setting about as early as it ever will? You're right! We're still a whole month away from the winter solstice — but the Sun sets its earliest around December 7th if you're near latitude 40° north, and right now it already sets within only about 3 minutes of that time.

A surprising result of this: The Sun actually sets a trace earlier on Thanksgiving than on Christmas — even though Christmas is around solstice time!

This offset from the solstice date is balanced out by the opposite happening at sunrise: the Sun doesn't come up its latest until January 4th. Blame the tilt of Earth's axis and the eccentricity of Earth's orbit.

Thursday, November 22

• Full Moon tonight (exact at 12:29 a.m. Friday morning EST). The Moon lights the eastern sky this evening, with the Pleiades faintly visible to its upper left and orange Aldebaran to its lower left as shown here.

Friday, November 23

• Now the Moon shines closer to Aldebaran than yesterday, and on its other side. Watch the Moon draw farther away from Aldebaran through the hours of the night.

Saturday, November 24

• The bright waning gibbous Moon rises around the end of twilight and climbs high through the evening. It's now below the horns of Taurus: Beta (β) and fainter Zeta (ζ) Tauri.

Source: Sky and Telescope

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ISS Sighting Opportunities (from Denver)

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Sighting information for other cities can be found at [NASA’s Satellite Sighting Information](#).

NASA-TV Highlights  (all times Eastern Time Zone)

**November 20, Tuesday**
- 10:55 a.m. – ISS Expedition 57 Facebook Live In-Flight Event for the 20th Anniversary of ISS with ISS Commander Alexander Gerst of the European Space Agency and Flight Engineers Serena Aunon-Chancellor of NASA and Sergey Prokopyev of Roscosmos (All Channels)

**November 21, Wednesday**
- 11 a.m. – SpaceCast Weekly Center (All Channels)
- 1 p.m. - Mars InSight Mission Engineering Overview News Conference (All Channels)
- 2 p.m. - Mars InSight Mission Science Overview News Conference (All Channels)

Watch NASA TV online by going to the [NASA website](#).
Space Calendar

- Nov 20 - Apollo Asteroid 2018 VP7 Near-Earth Flyby (0.020 AU)
- Nov 20 - Apollo Asteroid 2018 VQ6 Near-Earth Flyby (0.029 AU)
- Nov 20 - Asteroid 3169 Ostro Closest Approach To Earth (0.977 AU)
- Nov 20 - Asteroid 10183 Ampere Closest Approach To Earth (1.392 AU)
- Nov 20 - Asteroid 2713 Luxemburg Closest Approach To Earth (1.917 AU)
- Nov 20 - International Space Station Forum, London, United Kingdom
- Nov 20 - Seminar: Counting Black Hole Microstates in AdS5/CFT4, Trieste, Italy
- Nov 20 - 10th Anniversary (2008), Buzzard Coulee Meteorite Fall (Hit Barn in Canada)
- Nov 20-21 - 3rd Quantum Technology - Implementations for Space Workshop, Noordwijk, The Netherlands
- Nov 21 - Comet 198P/ODAS At Opposition (1.027 AU)
- Nov 21 - Nov 21 - Amor Asteroid 2013 PA7 Near-Earth Flyby (0.091 AU)
- Nov 21 - Asteroid 163693 Atira Closest Approach To Earth (1.485 AU)
- Nov 21 - Asteroid 12413 Johnnyweir Closest Approach To Earth (1.384 AU)
- Nov 21 - Asteroid 293 Brasilia Closest Approach To Earth (1.856 AU)
- Nov 21 - Lecture: Getting to the Moon, London, United Kingdom
- Nov 21 - 235th Anniversary (1783), First Manned Balloon Flight
- Nov 21-22 - Workshop on Air Quality Policy Implementation Related to Ozone, Madrid, Spain
- Nov 21-23 - 2nd South American Dark Matter Workshop, Sao Paulo, Brazil
- Nov 22 - Apollo Asteroid 410088 (2007 EJ) Near-Earth Flyby (0.062 AU)
- Nov 22 - Asteroid 397 Vienna Closest Approach To Earth (1.220 AU)
- Nov 22 - Atira Asteroid 2006 WE4 Closest Approach To Earth (1.493 AU)
- Nov 22 - Seminar: Dyon Degeneracies from Mathieu Moonshine Symmetry, Trieste, Italy
- Nov 23 - Comet 198P/ODAS Closest Approach To Earth (1.026 AU)
- Nov 23 - Comet 25D/Neujmin Closest Approach To Earth (1.906 AU)
- Nov 23 - Apollo Asteroid 2018 VR Near-Earth Flyby (0.074 AU)
- Nov 23 - Amor Asteroid 2011 AA37 Near-Earth Flyby (0.099 AU)
- Nov 23 - Asteroid 3355 Onizuka Closest Approach To Earth (1.066 AU)
- Nov 23 - Asteroid 16740 Kithorne Closest Approach To Earth (1.620 AU)
- Nov 23-25 - World Extreme Medical Conference, Edinburgh, United Kingdom
- Nov 24 - Amor Asteroid 2018 VZ7 Near-Earth Flyby (0.073 AU)
- Nov 24 - Asteroid 5277 Brisbane Closest Approach To Earth (1.188 AU)
- Nov 24 - Asteroid 12410 Donald Duck Closest Approach To Earth (1.263 AU)
- Nov 25 - Comet 69P/Taylor Closest Approach To Earth (1.532 AU)

Source: JPL Space Calendar
Food for Thought

Exploding Stars Make Key Ingredient in Sand, Glass

We are all, quite literally, made of star dust. Many of the chemicals that compose our planet and our bodies were formed directly by stars. Now, a new study using observations by NASA's Spitzer Space Telescope reports for the first time that silica — one of the most common minerals found on Earth — is formed when massive stars explode.

Look around you right now and there's a good chance you will see silica (silicon dioxide, SiO₂) in some form. A major component of many types of rocks on Earth, silica is used in industrial sand-and-gravel mixtures to make concrete for sidewalks, roads and buildings. One form of silica, quartz, is a major component of sand found on beaches along the U.S. coasts. Silica is a key ingredient in glass, including plate glass for windows, as well as fiberglass. Most of the silicon used in electronic devices comes from silica.

In total, silica makes up about 60 percent of Earth's crust. Its widespread presence on Earth is no surprise, as silica dust has been found throughout the universe and in meteorites that predate our solar system. One known source of cosmic dust is AGB stars, or stars with about the mass of the Sun that are running out of fuel.
and puff up to many times their original size to form a red giant star. (AGB stars are one type of red giant star.) But silica is not a major component of AGB star dust, and observations had not made it clear if these stars could be the primary producer of silica dust observed throughout the universe.

The new study reports the detection of silica in two supernova remnants, called Cassiopeia A and G54.1+0.3. A supernova is a star much more massive than the Sun that runs out of the fuel that burns in its core, causing it to collapse on itself. The rapid implosion of matter creates an intense explosion that can fuse atoms together to create "heavy" elements, like sulfur, calcium and silicon.

**Chemical Fingerprints**

To identify silica in Cassiopeia A and G54.1+0.3, the team used archival data from Spitzer's IRS instrument and a technique called spectroscopy, which takes light and reveals the individual wavelengths that compose it. (You can observe this effect when sunlight passes through a glass prism and produces a rainbow: The different colors are the individual wavelengths of light that are typically blended together and invisible to the naked eye.)

Chemical elements and molecules each emit very specific wavelengths of light, meaning they each have a distinct spectral "fingerprint" that high-precision spectrographs can identify. In order to discover the spectral fingerprint of a given molecule, researchers often rely on models (typically done with computers) that recreate the molecule's physical properties. Running a simulation with those models then reveals the molecule's spectral fingerprint.

But physical factors can subtly influence the wavelengths that molecules emit. Such was the case with Cassiopeia A. Although the spectroscopy data of Cassiopeia A showed wavelengths close to what would be expected from silica, researchers could not match the data with any particular element or molecule.

Jeonghee Rho, an astronomer at the SETI Institute in Mountain View, California, and the lead author on the new paper, thought that perhaps the shape of the silica grains could be the source of the discrepancy, because existing silica models assumed the grains were perfectly spherical.

She began building models that included some grains with nonspherical shapes. It was only when she completed a model that assumed all the grains were not spherical but, rather, football-shaped that the model "really clearly produced the same spectral feature we see in the Spitzer data," Rho said.

Rho and her coauthors on the paper then found the same feature in a second supernova remnant, G54.1+0.3. The elongated grains may tell scientists something about the exact processes that formed the silica.

The authors also combined the observations of the two supernova remnants from Spitzer with observations from the European Space Agency's Herschel Space Observatory in order to measure the amount of silica produced by each explosion. Herschel detects different wavelengths of infrared light than Spitzer. The researchers looked at the entire span of wavelengths provided by both observatories and identified the wavelength at which the dust has its peak brightness. That information can be used to measure the temperature of dust, and both brightness and temperature are necessary in order to measure the mass. The new work implies that the silica produced by supernovas over time was significant enough to contribute to dust throughout the universe, including the dust that ultimately came together to form our planet.

The study was published on Oct. 24, 2018, in the Monthly Notices of the Royal Astronomical Society, and it confirms that every time we gaze through a window, walk down the sidewalk or set foot on a pebbly beach, we are interacting with a material made by exploding stars that burned billions of years ago.

Source: NASA
Space Image of the Week

Abell 1033: To Boldly Go into Colliding Galaxy Clusters
Credit: X-ray: NASA/CXC/Leiden Univ./F. de Gasperin et al; Optical: SDSS; Radio: LOFAR/ASTRON, NCRA/TIFR/GMRT

Explanation: Hidden in a distant galaxy cluster collision are wisps of gas resembling the starship Enterprise — an iconic spaceship from the "Star Trek" franchise. Galaxy clusters — cosmic structures containing hundreds or even thousands of galaxies — are the largest objects in the Universe held together by gravity. Multi-million-degree gas fills the space in between the individual galaxies. The mass of the hot gas is about six times greater than that of all the galaxies combined. This superheated gas is invisible to optical telescopes, but shines brightly in X-rays, so an X-ray telescope like NASA's Chandra X-ray Observatory is required to study it.

By combining X-rays with other types of light, such as radio waves, a more complete picture of these important cosmic objects can be obtained. A new composite image of the galaxy cluster Abell 1033, including X-rays from Chandra (purple) and radio emission from the Low-Frequency Array (LOFAR) network in the Netherlands (blue), does just that. Optical emission from the Sloan Digital Sky Survey is also shown. The galaxy cluster is located about 1.6 billion light years from Earth.

Using X-ray and radio data, scientists have determined that Abell 1033 is actually two galaxy clusters in the process of colliding.

Source: NASA