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## TTSIQ Sponsor Organizations



### About The National Space Society – <http://www.nss.org/>

The National Space Society was formed in March, 1987 by the merger of the L5 Society and National Space institute. NSS has an extensive chapter network in the United States and a number of international chapters in Europe, Asia, and Australia. NSS hosts the International Space Development Conference in May each year at varying locations. NSS publishes **Ad Astra** magazine quarterly. NSS actively tries to influence US Space Policy.

### About The Moon Society – <http://www.moonsociety.org>

The Moon Society was formed in 2000 and seeks to inspire and involve people everywhere in exploration of the Moon with the establishment of civilian settlements, using local resources through private enterprise both to support themselves and to help alleviate Earth's stubborn energy and environmental problems. The Society has a network of chapters in the US and has been an affiliate of NSS since 2005.

### About Space Renaissance Initiative – <http://www.spacerenaissance.org/>

SRI's focus is on use of space resources to address the challenges of runaway population growth and increasing use of Earth resources at a non-sustainable pace. "The settlement of space would benefit all of humanity by opening a new frontier, energizing society, providing room and resources for the growth of the human race without despoiling Earth, creating a lifeboat for humanity that could survive even a planet-wide catastrophe."

### About The Mars Foundation – <http://marsfoundation.org/> – <http://marshome.org/>

The Foundation seeks to involved interested persons in the design of Mars outposts and settlements, maximizing use of building materials that can be produced on Mars, to illustrate the near-term feasibility of establishing a permanent human presence on Mars.

### About Open Luna Foundation – <http://openluna.org/missions>

The OpenLuna Foundation aims to return to the moon through private enterprise. A stepped program of robotic missions, then a short series of manned missions to construct a small, approximately 8 person outpost .

### About SEDS: Students for the Exploration and Development of Space – <http://www.seds.org/>

SEDS is an independent, student-based organization promoting the exploration and development of space by educating people about the benefits of space, via a network of interested students, providing an opportunity

### About Moon Miners' Manifesto – <http://www.MMM-MoonMinersManifesto.com>

MMM, has been published 10 times a year since issue #1 December 1986 by the Milwaukee Lunar Reclamation Society chapter of the **National Space Society**. It has also served **the Moon Society** and its predecessor, Artemis Society International, since October 1995.

Most issues deal with the **opening of the Lunar frontier**, suggesting how pioneers can make best use of **local resources** and learn to **make themselves at home**. This will involve psychological, social, and physiological adjustment. Much of what will hold for the **Moon**, will also hold true for **Mars** and for space in general. There is one Mars theme issue each year, and occasionally **other space destinations** are discussed: the asteroids, Moon (Jupiter), Titan (Saturn), even the cloud tops of Venus, and interstellar destinations beyond.



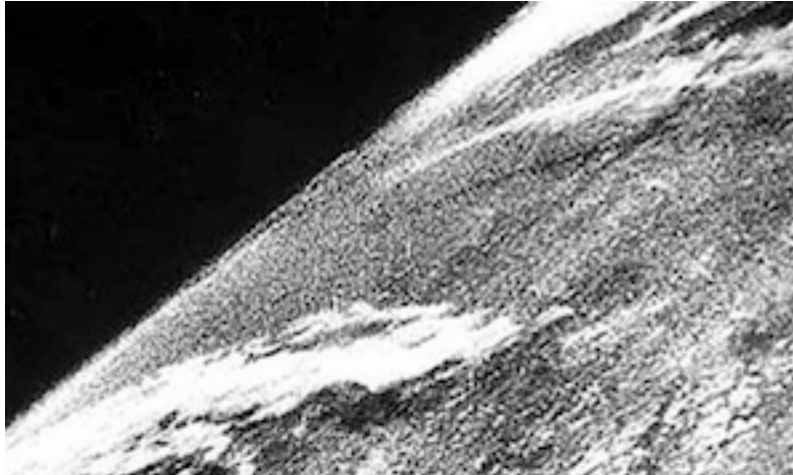
Most of the “editor’s summaries” of news articles give the URL web **address** of the article, its **title** and date, and a **key image** if there is one. We leave it up to the reader to explore further.

– Peter Kokh, Editor, [kokhmmm@aol.com](mailto:kokhmmm@aol.com)



## The very first photo taken from space, in 1946

<http://www.airspacemag.com/space/the-first-photo-from-space-13721411/?no-ist>



View of Earth from a camera on V-2 #13, launched October 24, 1946.  
(White Sands Missile Range/Applied Physics Laboratory)

## ASTRONAUTS

### Record Number of Americans Apply to be an Astronaut at NASA

[www.nasa.gov/press-release/record-number-of-americans-apply-to-be-an-astronaut-at-nasa](http://www.nasa.gov/press-release/record-number-of-americans-apply-to-be-an-astronaut-at-nasa)

15 February, 2016 – More than 18,300 people applied to join NASA’s 2017 astronaut class, almost three times the number of applications received in 2012 for the most recent astronaut class, and far surpassing the previous record of 8,000 in 1978.

### Next-Gen Spacesuits – NASA Builds On Old Technology | Video

[www.space.com/31710-next-gen-spacesuits-nasa-builds-on-old-technology-video.html](http://www.space.com/31710-next-gen-spacesuits-nasa-builds-on-old-technology-video.html)

NASA has been developing new spacesuits for use beyond low Earth orbit. ##

## ROCKETS &amp; SPACE PLANES

## Video of Space-X rocket “sticking it” in landing back on pad

21/12/2015 - [www.space.com/31593-spacex-celebrates-as-falcon-9-sticks-its-landing-video.html](http://www.space.com/31593-spacex-celebrates-as-falcon-9-sticks-its-landing-video.html)

## US Air Force Awards More Rocket Research Contracts

30 December, 2015 - [www.space.com/31485-air-force-rocket-research-contracts.html](http://www.space.com/31485-air-force-rocket-research-contracts.html)



A 1/6 scale model of the AR1 engine currently in development by Aerojet Rocketdyne as a replacement for the Russian-built RD-180 engine that powers United Launch Alliance's Atlas 5 rocket

The U.S. Air Force has awarded another round of research contracts Dec. 23 as part of a broader effort to end U.S. reliance on a Russian rocket engine for launching national security missions.

**Recipients:** \$3.1 million **Orbital ATK** of Dulles, Virginia; \$6 million propulsion provider **Aerojet Rocketdyne** of Sacramento, Ca; and \$5.4 million for **Northrop Grumman** of El Segundo, California. ##

## US Once Again Producing Plutonium for Deep-Space Missions

1 January, 2016 - [www.space.com/31499-us-makes-plutonium-deep-space-fuel.html](http://www.space.com/31499-us-makes-plutonium-deep-space-fuel.html)

For the first time in 30 years, the United States produced an isotope of plutonium that powers NASA's deep-space missions. A total of 50 grams of plutonium-238 was produced at the Department of Energy (DOE)'s Oak Ridge National Laboratory (ORNL) in Tennessee, in the first since the late 1980s.

The small quantity is the first step in producing the energy source for future missions such as the Mars 2020 rover and the Jupiter Europa Orbiter. ##

## NASA Research Could Save Commercial Airlines Billions

[www.nasa.gov/press-release/nasa-research-could-save-commercial-airlines-billions-in-new-era-of-aviation](http://www.nasa.gov/press-release/nasa-research-could-save-commercial-airlines-billions-in-new-era-of-aviation)

4 January, 2016 - Airlines could realize \$255 billion in operational savings between 2025-2050 thanks to **green-related technologies** developed and refined by NASA's **aeronautics researchers** in the past six years under the purview of NASA's **Environmentally Responsible Aviation (ERA) project**:

- **Cut airline fuel use in half,**
- **Cut pollution by 75 percent and**
- **Cut noise to nearly one-eighth of today's levels.**

### The savings come in eight technology demonstrations:

- Tiny embedded nozzles blowing air over the surface of an airplane's vertical tail fin - future aircraft could safely be designed with **smaller tails, reducing weight and drag.** Surface coatings designed to minimize drag caused by bug residue building up on the wing's leading edge.
- By stitching together large sections of lightweight composite materials to create **damage-tolerant structures** used in building uniquely shaped future aircraft that weighed as much as 20 % less than a similar all-metal aircraft.
- A radical new **morphing wing technology** allows an aircraft to **seamlessly extend its flaps, leaving no drag-inducing, noise-enhancing gaps** for air to flow through.

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

- Refine the **design of the compressor stage of a turbine engine to improve its aerodynamic efficiency** that could save 2.5 % in fuel burn.
- Pratt & Whitney geared turbofan jet engine mature advanced fan design to **improve propulsion efficiency and reduce noise** and could reduce fuel burn by 15 % and significantly reduce noise.
- An improved design for a jet engine combustor, the chamber in which fuel is burned, to **reduce the amount of nitrogen oxides pollution by 80 %**.
- New design tools to aid engineers in **reducing noise from deployed wing flaps** and landing gear during takeoffs and landings.
- Significant studies were performed on a **hybrid wing-body concept** : the wings join the fuselage in a continuous, seamless line and the jet engines are mounted on top of the airplane in the rear.



Research included wind-tunnel runs to test how well the aircraft would operate at low speeds and to find the optimal engine placement, while also minimizing fuel burn and reducing noise.

### 3D-Printed Ceramics Could Build Next-Gen Spaceships

5 January, 2016 - [www.space.com/31516-3d-printed-ceramics-next-gen-spaceships.html](http://www.space.com/31516-3d-printed-ceramics-next-gen-spaceships.html)



The retired space shuttle fleet used ceramic tiles on their undersides to dissipate the atmospheric heating on reentry, but the tiles were fragile, prone to cracking and often needed to be replaced

Ceramic parts are strong, lightweight and handle heat better than many metals, ideal for crafting parts for airplanes or rockets – the heat-shielding tiles on the space shuttle, for example.

Now researchers have used a 3D printer to make customized ceramic parts that have also overcome the Achilles' heel of ceramic objects: their tendency to crack. ##

### SpaceX Narrowly Misses Rocket Landing at Sea After Launching Satellite

17 January, 2016 - [www.space.com/31649-spacex-rocket-landing-jason3-satellite-launch.html](http://www.space.com/31649-spacex-rocket-landing-jason3-satellite-launch.html)

SpaceX successfully launched a new satellite from Vandenberg Air Force Base in California into orbit to map Earth's oceans, but the spaceflight company's bold plan to land a rocket on a robotic ship at sea, an "autonomous spaceport droneship" called "Just Read the Instructions," but toppled over on the deck, coming up just short. Space-X has recently successfully landed a rocket on the ground, but the shifting seas are less cooperative than "terra firma."

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## Blue Origin Launches Rocket Into Space, Lands It Safely for 2nd Time

23 January, 2016 – [www.space.com/31719-blue-origin-2nd-rocket-launch-landing-video.html](http://www.space.com/31719-blue-origin-2nd-rocket-launch-landing-video.html)  
[www.space.com/31718-blue-origin-new-shepard-rocket-2nd-flight-photos.html](http://www.space.com/31718-blue-origin-new-shepard-rocket-2nd-flight-photos.html)  
[www.space.com/31716-blue-origin-booster-reused-lands-safely-after-2nd-launch-video.html](http://www.space.com/31716-blue-origin-booster-reused-lands-safely-after-2nd-launch-video.html)



The company owned by Jeff Bezos of Amazon.com has launched a private rocket into space and landed it back on Earth. A bonus, Blue Origin reused the same rocket from its first launch-landing test flight.

**“Blue Origin” – meaning of the name?** “Earth, In all its (blue) beauty, is just our starting place. We are of “Blue Origin”, and here is where it begins.” ##

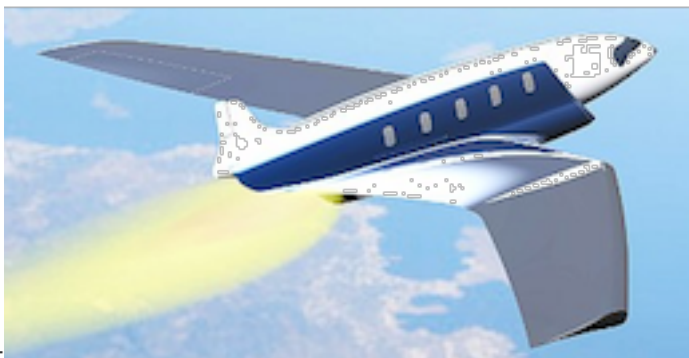
## Europe to Invest in Sierra Nevada's Dream Chaser Cargo Vehicle

26 January, 2016 – [www.space.com/31701-europe-invests-in-dream-chaser-spacecraft.html](http://www.space.com/31701-europe-invests-in-dream-chaser-spacecraft.html)

Sierra Nevada Corp.'s win of a NASA contract to ferry cargo to the International Space Station will trigger a \$36 million investment by the 22-nation European Space Agency following a cooperation agreement to be signed in the coming weeks. ESA will begin work building the first flight model of the **International Berthing and Docking Mechanism (IBDM)**, which Sierra Nevada's Dream Chaser Cargo System will use to attach itself to the space station. ##

## Concept plane could travel from New York to London in 11 minutes

[www.aol.com/article/2016/02/11/concept-plane-could-travel-from-new-york-to-london-in-11-minutes/21311357/](http://www.aol.com/article/2016/02/11/concept-plane-could-travel-from-new-york-to-london-in-11-minutes/21311357/) [www.cnn.com/2016/01/27/aviation/antipode-hypersonic-concept-plane/](http://www.cnn.com/2016/01/27/aviation/antipode-hypersonic-concept-plane/)



11 February, 2016 –

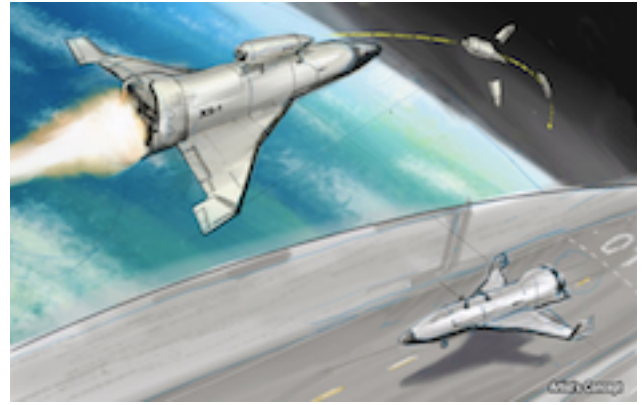
11 mind-expanding photos

## Reusable Military Spaceplane Tops DARPA's Budget Request, Again

25 February, 2016 – [www.space.com/32051-reusable-military-spaceplane-darpa-budget.html](http://www.space.com/32051-reusable-military-spaceplane-darpa-budget.html)  
[www.space.com/26530-xs1-experimental-military-space-plane-pictures.html](http://www.space.com/26530-xs1-experimental-military-space-plane-pictures.html)

- a reusable first stage that could carry an expendable upper stage capable of placing payloads weighing up to 1,800 kilograms into orbit
- the vehicle could ultimately fly 10 times in 10 days and boost payloads into low Earth orbit for less than \$5 million per launch.
- Boeing is one of 3 teams designing new spaceplanes for **DARPA's Experimental Spaceplane-1 program, XS-1**. The program leads DARPA's space-related budget requests for fiscal year 2017

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## US to lack full space launch capability beyond 2019 without Russian engine

[www.spacedaily.com/reports/US\\_to\\_lack\\_full\\_space\\_launch\\_capability\\_beyond\\_2019\\_Without\\_Russian\\_engine\\_999.html](http://www.spacedaily.com/reports/US_to_lack_full_space_launch_capability_beyond_2019_Without_Russian_engine_999.html)

28 January, 2016 – Full US space launch capability may be delayed beyond 2019 if it cuts its supply of Russian-made RD-180 rocket engines. The United States currently relies on the Atlas V rocket powered by Russia's RD-180 engine for its national defense space launches. In 2014, Congress passed a law requiring the Pentagon to cut its reliance on the RD-180 after the downturn in US-Russia relations. US companies are currently competing to produce engines to replace the RD-180, but the full flight certification process and focus on a single component of the space launch platform would result in delays and higher costs.

Only two families of launch vehicle, Atlas and Delta, are able to reach the full range of orbits and carry the heaviest payloads for the United States. In January, the US Air Force awarded contracts to Orbital ATK and SpaceX to develop prototypes of US-built rocket engines to replace the RD-180. ##

## NASA Begins Work to Build a Quieter Supersonic Passenger Jet

[www.nasa.gov/press-release/nasa-begins-work-to-build-a-quieter-supersonic-passenger-jet](http://www.nasa.gov/press-release/nasa-begins-work-to-build-a-quieter-supersonic-passenger-jet)  
<http://phys.org/news/2016-03-nasa-quieter-supersonic-passenger-jet.html>

29 February, 2016 – If supersonic passenger jets are to return, they must be **both quieter and more affordable**. Below is a Lockheed Martin artist's concept of a possible Low Boom Flight Demonstration Quiet Supersonic Transport (QueSST) X-plane design. Lockheed Martin will receive about \$20 million over 17 months for QueSST preliminary design work.



[www.space.com/32143-nasa-supersonic-jet-design-contract.html](http://www.space.com/32143-nasa-supersonic-jet-design-contract.html)

## Blue Origin Plans Growth Spurt This Year

9 March, 2016 – [www.space.com/32204-blue-origin-growth-spurt-this-year.html](http://www.space.com/32204-blue-origin-growth-spurt-this-year.html)



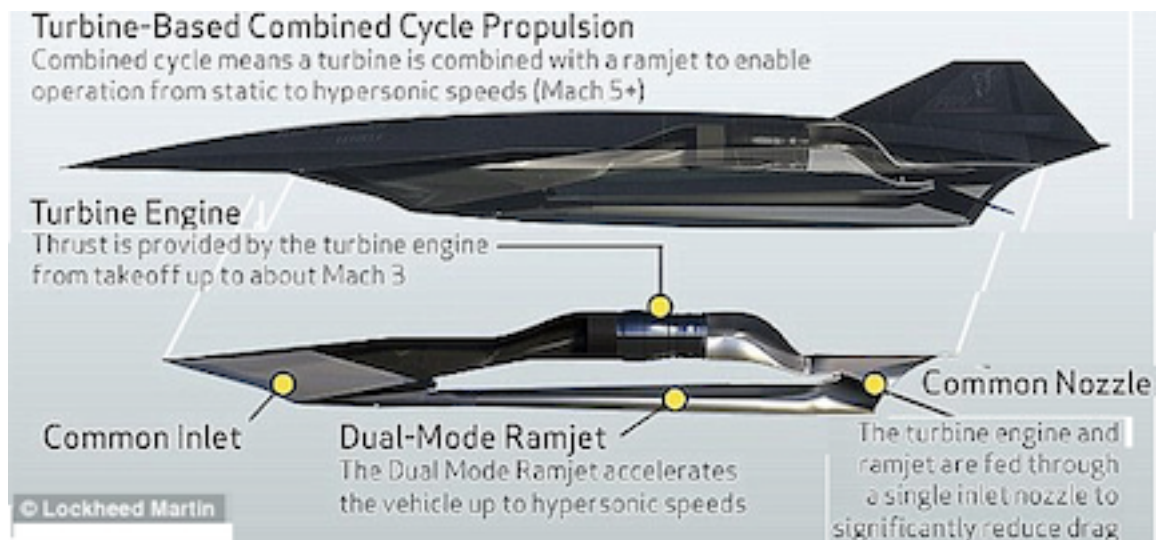
Inside Blue Origin's Kent, Washington plant

Blue Origin plans to grow significantly over the next year as the company ramps up development of its BE-4 engine and an orbital launch vehicle, and test flights of its New Shepard suborbital vehicle.

## Demonstrator hypersonics by 2018 – reusable ones in the 2020s

15 March, 2016 – <http://nextbigfuture.com/2016/03/lockheed-confident-they-can-fly.html>

[www.ibtimes.com/lockheed-martins-sr-72-hypersonic-plane-could-be-built-under-1b-likely-be-ready-2030s-2337383](http://www.ibtimes.com/lockheed-martins-sr-72-hypersonic-plane-could-be-built-under-1b-likely-be-ready-2030s-2337383)



## Space Race Losers? US Leadership in Danger, Report Warns

8 March, 2016 – [www.space.com/32185-united-states-space-exploration-leadership.html](http://www.space.com/32185-united-states-space-exploration-leadership.html)

The United States could lose its long-held leadership position in space science, technology and exploration if the country doesn't renew its commitment to those fields soon, a coalition of space-industry organizations has warned. Such a commitment should include the

- **completion of a crewed launch system**
- **stable NASA budgets** and
- **continued partnerships with other nations** on projects such as the International Space Station

The group plans to send the white paper, which is called "Ensuring U.S. Leadership in Space," to candidates for office, from the presidential race on down to local congressional campaigns. ##



## Boeing's 1st 'Full-Blown' Starliner Space Capsule Takes Shape

[www.space.com/32873-boeing-first-starliner-crew-capsule.html](http://www.space.com/32873-boeing-first-starliner-crew-capsule.html)

### SPACE STATIONS

## Space Fungus! Mold Attacks Space Station Plants

8 January, 2016 – [www.space.com/31556-space-fungus-attacks-space-station-plants.html](http://www.space.com/31556-space-fungus-attacks-space-station-plants.html)

Four zinnia plants on the International Space Station are sickly or dead after mold was discovered in the Veggie experiment facility late December. The problem was immediately traced back to excessive water in the experiment, which was addressed. ##

## Ground Control to David Bowie: You Really Made the Grade

[www.space.com/31599-ground-control-to-david-bowie-you-really-made-the-grade.html](http://www.space.com/31599-ground-control-to-david-bowie-you-really-made-the-grade.html)

12 January, 2016 – Among real space explorers, few songs have resonated as powerfully as David Bowie's iconic "Space Oddity," the soulful ballad of a solitary fictional astronaut, Major Tom.

Bowie, who died on Sunday, January 10, from cancer, published the song as a single in July 1969 — the year and month of the first Apollo Moon landing. David died of cancer

**Editor:** I prefer Canadian astronaut **Chris Hadfield's** version, produced on the International Space Station with views of Earth's surface out the window, and of Hadfield and his guitar floating inside the Station. I've watched it a zillion times and never tire of it. – <https://www.youtube.com/watch?v=apemYk2oz7M>

(I first saw David Bowie in "The Man who Fell to Earth" science fiction film, 1978, 37 plus years ago.)

<http://www.imdb.com/title/tt0074851/>

plot summary: [http://www.imdb.com/title/tt0074851/plotsummary?ref\\_=tt\\_ov\\_pl](http://www.imdb.com/title/tt0074851/plotsummary?ref_=tt_ov_pl)

## NASA Awards International Space Station Cargo Transport Contracts

### Sierra Nevada Corp to join Space-X and ATK

14 January, 2016 – [www.space.com/31624-nasa-cargo-contracts-space-station.html](http://www.space.com/31624-nasa-cargo-contracts-space-station.html)

[www.spacedaily.com/reports/NASA\\_Awards\\_International\\_Space\\_Station\\_Cargo\\_Transport\\_Contracts\\_999.html](http://www.spacedaily.com/reports/NASA_Awards_International_Space_Station_Cargo_Transport_Contracts_999.html)

[www.space.com/31638-dream-chaser-spaceplane-to-supply-the-space-station.html](http://www.space.com/31638-dream-chaser-spaceplane-to-supply-the-space-station.html)

Between 2019 and 2024, NASA will purchase a minimum of **six uncrewed cargo missions from each of the three companies,**



Above L, M, R: Space-X and ATK Cygnus cargo vessels, Sierra Nevada Dream Chaser piloted shuttle craft. All three will resume the work of retired Space Shuttle fleet, carrying cargo to ISS. The robotic version of Dream Chaser features foldable wings so the spaceship can fit inside standard 5-meter payload fairings, used by United Launch Alliance's Atlas 5 rocket, the baseline vehicle for the cargo resupply missions, as well as Arianespace's Ariane booster.

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**Editor:** Of the three, the Dream Chaser, the proposal of Jim Benson of SpaceDev, is the oldest. Benson's premature death left the project hanging. It is gratifying to see his dream come true. Benson was a special guest of honor of the 1998 International Space Development Conference in Milwaukee, which I chaired. ##

## 2016 Goals Vital to Commercial Crew Success

[www.spacedaily.com/reports/2016\\_Goals\\_Vital\\_to\\_Commercial\\_Crew\\_Success\\_999.html](http://www.spacedaily.com/reports/2016_Goals_Vital_to_Commercial_Crew_Success_999.html)

21 January, 2016 – By the time the year closes, Boeing's CST-100 Starliner and SpaceX's Crew Dragon will be poised for the flight tests that allow our astronauts to travel to the International Space Station lifting off from Florida's Space Coast.



Space Launch Complex 41 has seen a new Crew Access Tower tailored to the needs of astronauts and ground support staff who will access Boeing's CST-100 Starliner as it stands on the pad for launch atop a United Launch Alliance Atlas V

Successful missions will require a comprehensive testing regimen of numerous systems on the ground and in space. The result of each evaluation will be vital in the design of the systems. From parachute tests, to launch pad certifications, to the completion of spacecraft that will fly into orbit,##

## Fishing For Answers on Bone Loss in Space

[www.spacedaily.com/reports/Fishing\\_For\\_Answers\\_on\\_Bone\\_Loss\\_in\\_Space\\_999.html](http://www.spacedaily.com/reports/Fishing_For_Answers_on_Bone_Loss_in_Space_999.html)



22 January, 2016 –

JAXA astronaut Akihiko Hoshida at the Aquatic Habitat in the Kibo module of the International Space Station, where Medaka fish were reared for an experiment on the loss of bone density in space.

## Astronaut Plays Zero-G Ping-Pong With a Ball of Water (Video)

26 January, 2016 – [www.space.com/31733-weightless-water-ping-pong-astronaut-video.html](http://www.space.com/31733-weightless-water-ping-pong-astronaut-video.html)



As astronaut Scott Kelly passed more than 300 consecutive days in space last week, he took a time-out from his duties to play a little ping-pong — not using a traditional ball, but a ball of water. ##

## Staying Alive on Tiangong 2

15 February, 2016 - [www.spacedaily.com/reports/Staying\\_Alive\\_on\\_Tiangong\\_2\\_999.html](http://www.spacedaily.com/reports/Staying_Alive_on_Tiangong_2_999.html)



China's next taiko(astro)nauts will launch this year aboard the Shenzhou 11 spacecraft. Their target will be the Tiangong 2 space laboratory, which will probably launch at least a few weeks before them. The crew will consist of three astronauts, with a previously flown astronaut as the commander.

An unresolved issue. How long will the astronauts inhabit the Tiangong 2 space laboratory?

A small module, Tiangong cannot realistically support the multi-month expeditions staged to the International Space Station. But we could expect a residency of roughly one month, at least.##

## Made in Space Think Big with Archinaut, a Robotic 3D-Printing Demo

[www.space.com/32036-nasa-made-in-space-archinaut-3d-printing.html](http://www.space.com/32036-nasa-made-in-space-archinaut-3d-printing.html)

[www.space.com/22359-3d-printing-space-manufacturing-photos.html](http://www.space.com/22359-3d-printing-space-manufacturing-photos.html)

26 February, 2016 - Within five years, companies could begin in-orbit manufacturing and assembly of communications satellite reflectors or other large structures according to Made in Space, the Silicon Valley startup that sent the first 3D printer to the International Space Station in 2014.

The company is beginning work with Northrop Grumman and Oceaneering Space Systems on Archinaut, an ambitious effort to build a 3D printer equipped with a robotic arm that the team plans to install in an external space station pod, under a two-year, \$20 million NASA contract. The project will culminate in 2018 with an on-orbit demonstration of Archinaut's ability to additively manufacture and assemble a large, complex structure.

## One-year spaceman sees ISS mission as 'stepping stone' to Mars

<http://phys.org/news/2016-02-one-year-spaceman-mission-steppingstone-mars.html>

28 February, 2016 – Scott Kelly's 340-day mission—the longest by 125 days for NASA—comes to a dramatic end March 2nd on the remote steppes of Kazakhstan. **Once out of the capsule, the two will submit to a multitude of field tests.** As soon as he returns from the ISS, he will try to pop up from a lying position and stand still for three minutes.

He'll take a crack at a mini-obstacle course and attempt to walk a straight line, heel to toe—all so researchers can see whether he'd hit the ground running if this were Mars instead of Earth.

**NASA considers it crucial prep work for future Mars explorers who will have to spend much longer in space and won't have the help of a welcoming committee. In fact, this mission—which began with a launch last March—is all about Mars. ##**

## China's ambition after Space Station

8 March 2016 – [www.spacedaily.com/reports/Chinas\\_ambition\\_after\\_space\\_station\\_999.html](http://www.spacedaily.com/reports/Chinas_ambition_after_space_station_999.html)

China will exploit the space between Earth and the Moon for solar power and other resources after it builds a space station in 2020. Resources on the Moon will be used to build solar power stations in Earth orbit. ##

## China Readies Next Human Space Mission for Launch This Year

2 March, 2016 – [www.space.com/32100-china-next-human-spaceflight-mission.html](http://www.space.com/32100-china-next-human-spaceflight-mission.html)



Artist's concept of the Tiangong-1 in Earth orbit.

China is set to launch its second space laboratory – Tiangong-2 – in the third quarter of this year. That launch is to be followed by the liftoff of the piloted Shenzhou-11 spacecraft. A core module of its space station will be orbited in 2018 to test related technologies and to research engineering issues. The station would become fully operational in about 2022 ##

## CUBESATS

### 13 Cubesats selected\_for\_NASA\_Space\_Launch\_Systems\_first\_flight

[www.space-travel.com/reports/ASU\\_satellite\\_selected\\_for\\_NASA\\_Space\\_Launch\\_Systems\\_first\\_flight\\_999.html](http://www.space-travel.com/reports/ASU_satellite_selected_for_NASA_Space_Launch_Systems_first_flight_999.html)

4 February, 2016 – The first flight of NASA's new rocket, the Space Launch System (SLS), will carry 13 low-cost CubeSats to test innovative ideas along with an uncrewed Orion spacecraft in 2018.

These small satellite secondary payloads will carry science and technology investigations to help pave the way for future human exploration in deep space, including the Journey to Mars.

SLS' first flight, referred to as Exploration Mission-1 (EM-1), provides **the rare opportunity for these small experiments to reach deep-space destinations, as most launch opportunities for CubeSats are limited to low-Earth orbit. ##**

## MISSION TO PLANET EARTH

**Life on Earth Can Thank Its Lucky Stars for Jupiter and Saturn**

12 January, 2016 – [www.space.com/31577-earth-life-jupiter-saturn-giant-impacts.html](http://www.space.com/31577-earth-life-jupiter-saturn-giant-impacts.html)

Without Jupiter and Saturn orbiting out past Earth, life may not have been able to gain a foothold on our planet. The two gas giants likely helped stabilize the solar system, protecting Earth and other inner system rocky planets from frequent run-ins with big, fast-moving objects, such as the one in which a sizable early planet dubbed “Theia” collided with the proto-Earth, resulting in the formation of the Moon. If such impacts continued to happen, early Earth (once it had settled down after the Moon-forming event) could have lost its atmosphere and primeval oceans. Without the influence of giant planets, the fragments formed a large, dangerous cloud orbiting close within the system that took much longer to disperse.

First, the researchers took into account the fragmenting that occurs when objects ram into one another, rather than assuming they combine perfectly. And second, they ran hundreds of simulations to see all the possible ways the chaotic formation process could play out. ##

**NASA to Capture Best-Ever Portrait of Coral Reef Health**

15 January, 2016 – [www.space.com/31640-nasa-campaign-studies-coral-reefs.html](http://www.space.com/31640-nasa-campaign-studies-coral-reefs.html)

NASA will use airplanes and water instruments to survey Earth’s delicate coral reef structures and capture the most detailed views ever.



Corals are crucial to Earth's ecosystem, but they are typically studied only occasionally, during diving expeditions. This means that many of the world's reefs have never been surveyed. Yet they host one-quarter of all ocean fish species, shelter shorelines from storms and are a source of food for millions of people.

As part of the campaign, CORAL researchers will visit the Great Barrier Reef and other reefs in Australia, as well as reefs in Florida, Hawaii, Palau and the Mariana Islands.##

**Jason-3 Launches to Monitor Global Sea Level Rise**

[www.nasa.gov/press-release/jason-3-launches-to-monitor-global-sea-level-rise](http://www.nasa.gov/press-release/jason-3-launches-to-monitor-global-sea-level-rise)

[www.nesdis.noaa.gov/jason-3/](http://www.nesdis.noaa.gov/jason-3/)

17 January, 2016 – Jason-3 lifted off from Vandenberg Air Force Base in California Sunday aboard a SpaceX Falcon 9 rocket. Led by the National Oceanic and Atmospheric Administration (NOAA) in partnership with NASA, the French space agency CNES, and the European Organisation for the Exploitation of Meteorological Satellites, Jason-3 will take the pulse of our changing planet by gathering environmental intelligence from the world’s oceans.

The goal is to improve weather, climate and ocean forecasts, including helping NOAA’s National Weather Service and other global weather and environmental forecast agencies more accurately forecast the strength of tropical cyclones. ##

## Rising Seas More Accurately Measured From Space | Video

[www.space.com/31729-rising-seas-more-accurately-measured-from-space-video.html](http://www.space.com/31729-rising-seas-more-accurately-measured-from-space-video.html)

## NASA, University Study: Rising Seas Slowed by Increasing Water on Land

[www.nasa.gov/press-release/nasa-university-study-shows-rising-seas-slowed-by-increasing-water-on-land](http://www.nasa.gov/press-release/nasa-university-study-shows-rising-seas-slowed-by-increasing-water-on-land)

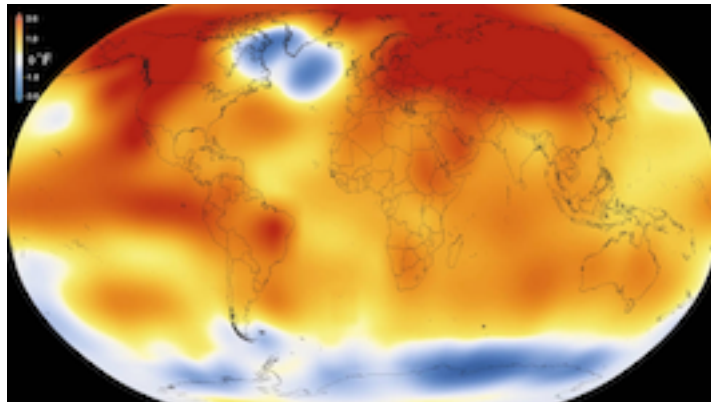
**11 February, 2016** – New measurements from a NASA satellite have allowed researchers to identify and quantify, for the first time, how climate-driven increases of liquid water storage on land have affected the rate of sea level rise.

“while ice sheets and glaciers continue to melt, changes in weather and climate over the past decade have caused Earth’s continents to soak up and store an extra 3.2 trillion tons of water in soils, lakes and underground aquifers, temporarily slowing the rate of sea level rise by about 20%.” ##

## NASA-NOAA Analyses Record-Shattering Global Warm Temperatures 2015

[www.nasa.gov/press-release/nasa-noaa-analyses-reveal-record-shattering-global-warm-temperatures-in-2015](http://www.nasa.gov/press-release/nasa-noaa-analyses-reveal-record-shattering-global-warm-temperatures-in-2015)

20 January, 2016 – According to independent analyses by NASA and the National Oceanic and Atmospheric Administration (NOAA) 2015 was the warmest year since modern record-keeping began in 1880, according to a new analysis by NASA’s Goddard Institute for Space Studies. The record-breaking year continues a long-term warming trend – 15 of the 16 warmest years on record have occurred since 2001.

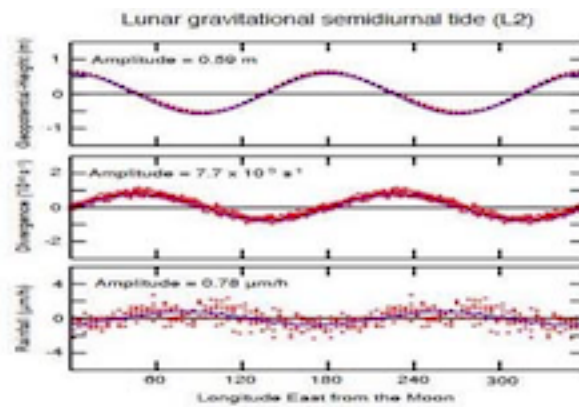


Watch the Video which covers 135 years,1880–2015 ##

## Phase of the Moon affects amount of rainfall

[www.space-travel.com/reports/Phase\\_of\\_the\\_moon\\_affects\\_amount\\_of\\_rainfall\\_999.html](http://www.space-travel.com/reports/Phase_of_the_moon_affects_amount_of_rainfall_999.html)

31 January, 2016 – When the Moon is high in the sky, it creates bulges in the atmosphere that creates imperceptible changes in the amount of rain that falls below. New U. of Washington research shows that the lunar forces affect the amount of rain – though very slightly.



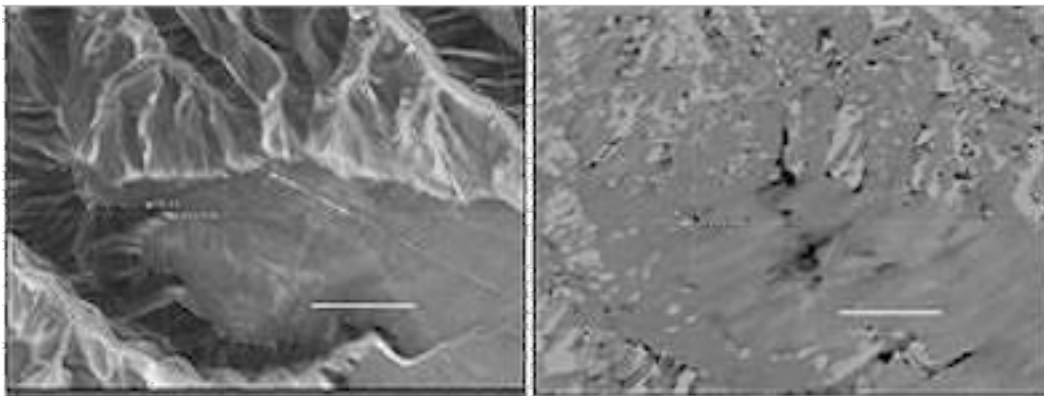
Satellite data over the tropics, between 10 °S and 10 °N, shows a slight dip in rainfall **when the Moon is directly overhead or underfoot**. The top panel shows the **air pressure**, the middle shows the **rate of change in air pressure**, and the bottom shows the **rainfall difference from the average**, 0.78 micrometers, or **less than one ten thousandth of an inch, per hour**.

## NASA Radar Brings a New View of World Heritage Site

[www.spacedaily.com/reports/NASA\\_Radar\\_Brings\\_a\\_New\\_View\\_of\\_World\\_Heritage\\_Site\\_999.html](http://www.spacedaily.com/reports/NASA_Radar_Brings_a_New_View_of_World_Heritage_Site_999.html)

29 January, 2016 – In just two 10-minute overflights, an airborne NASA synthetic aperture radar proved it could pinpoint areas of disturbance in Peru's Nasca lines World Heritage Site.

The data collected on the two flights will help Peruvian authorities fully catalog the thousand-year-old designs drawn on the ground in and around the site for the first time, as well as giving them a new tool for protecting the fragile constructions from both careless humans and natural disturbances such as floods.



The hummingbird glyph and its surroundings in the Nasca world heritage site as seen by standard photography, **left**, and by NASA's UAVSAR instrument, **right**. Dark areas in the UAVSAR image are where the site has been disturbed. ##

## Third Sentinel satellite launched for Copernicus

[www.spacedaily.com/reports/Third\\_Sentinel\\_satellite\\_launched\\_for\\_Copernicus\\_999.html](http://www.spacedaily.com/reports/Third_Sentinel_satellite_launched_for_Copernicus_999.html)

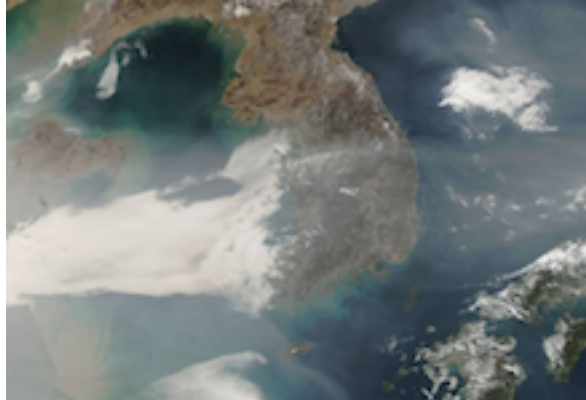
15 February, 2016 – The third ESA-developed satellite carrying four Earth-observing instruments was launched today, ready to provide a 'bigger picture' for Europe's Copernicus environment programme.



**Sentinel-3** is the most comprehensive of all the Sentinel missions for Europe's Copernicus programme. Carrying a suite of state-of-the-art instruments, it provides systematic measurements of Earth's oceans, land, ice and atmosphere to monitor and understand large-scale global dynamics and provide critical information for ocean and weather forecasting.

## NASA Partners on Air Quality Study in East Asia

24 February, 2016 – [www.nasa.gov/press-release/nasa-partners-on-air-quality-study-in-east-asia](http://www.nasa.gov/press-release/nasa-partners-on-air-quality-study-in-east-asia)



A new field study seeks to advance NASA's ability to monitor air quality from space. This 2007 NASA satellite image shows a swath of air pollution sweeping across the **Korean peninsula to Japan**

**The Korea U.S.-Air Quality study (KORUS-AQ)** will assess air quality across urban, rural and coastal areas of South Korea using the combined observations of aircraft, ground sites, ships and satellites. Findings will play a critical role in the development of observing systems of ground and space-based sensors and computer models to provide improved air quality assessments for decision makers. ##

## NASA: Sea Ice Is Melting Faster Than Expected

[www.space.com/32386-sea-ice-is-melting-faster-than-expected-nasa-says-exclusive-interview.html](http://www.space.com/32386-sea-ice-is-melting-faster-than-expected-nasa-says-exclusive-interview.html) – [www.space.com/28264-arctic-sea-ice-has-declined-steeply-since-1979-video.html](http://www.space.com/28264-arctic-sea-ice-has-declined-steeply-since-1979-video.html)

During the winter of 2015–2016 satellites have 'seen' significantly less Arctic ice compared to the long term trend. NASA scientist Walt Meier and LiveScience writer Laura Geggel discuss how climate researchers interpret these data. ##

## NASA Selects Instruments to Study Air Pollution, Tropical Cyclones

[www.nasa.gov/press-release/nasa-selects-instruments-to-study-air-pollution-tropical-cyclones](http://www.nasa.gov/press-release/nasa-selects-instruments-to-study-air-pollution-tropical-cyclones)

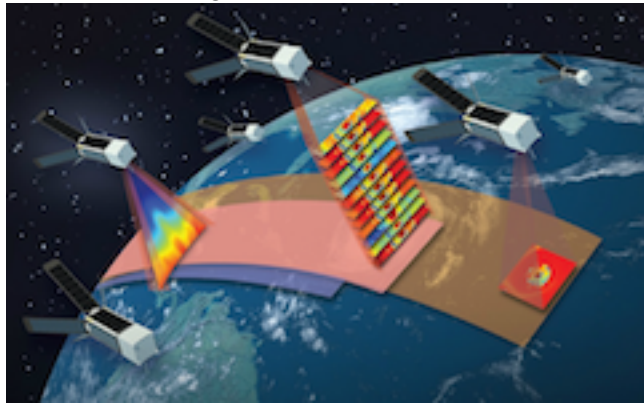
10 March, 2016 – NASA has selected two proposals for new Earth science investigations with new

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instruments to track harmful particulate air pollutants and study the development of tropical cyclones.

Observations of small atmospheric aerosols from the Multi-Angle Imager for Aerosols (MAIA) will be combined with health information to determine the toxicity of different particulate matter types in airborne pollutants over the world's major cities. David Diner of NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California, is the principal investigator.



The Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS) investigation, 12 CubeSats c1 foot long each, will study the development of tropical cyclones by taking measurements of temperature, precipitation & cloud properties every 21 minutes.##

## NASA Gets Down to Earth This Year With Globe-Spanning Expeditions

[www.nasa.gov/press-release/nasa-gets-down-to-earth-this-year-with-globe-spanning-expeditions](http://www.nasa.gov/press-release/nasa-gets-down-to-earth-this-year-with-globe-spanning-expeditions)

24 March, 2016 – NASA is sending scientists around the world in 2016 – from the edge of the Greenland ice sheet to the coral reefs of the South Pacific – to understand about how our planet is changing and the impacts humans are having on it, **combining long-term global views from space with detailed measurements from field experiments** as a powerful way of deciphering what's happening on Earth.

NASA uses Earth science field data with satellite data and computer models to tackle many environmental challenges to advance knowledge of how Earth works as a complex, integrated system.

- An examination of the extent to which the oceans around Greenland are melting the edges of the ice sheet from below, **the Oceans Melting Greenland (OMG)** team is now conducting its first airborne survey of the ice edge around the entire coast of Greenland. They will also measure coastal water temperatures by dropping sensors in the sea from a plane.
- Air quality is the focus of the **Korea U.S.–Air Quality (KORUS–AQ)** campaign in South Korea will advance our ability to monitor air pollution from space, with coordinated observations from aircraft, ground sites, ships and satellites.
- The **North Atlantic Aerosols and Marine Ecosystems Study (NAAMES)** will study how the world's largest plankton bloom gives rise to small organic particles that influence clouds and climate.
- Teams of scientists working on the **Arctic Boreal Vulnerability Experiment (ABOVE)** will be in the tundra and forests of Alaska and northwestern Canada investigating the role of climate in wildfires, thawing permafrost, wildlife migration habits and insect outbreaks.
- **The Coral Reef Airborne Laboratory (CORAL)** project team will begin testing airborne and in-water instruments in Hawaii to assess the condition of threatened coral-based ecosystems. CORAL's next stop will be Australia's Great Barrier Reef.
- Three airborne research campaigns will take to the skies over the Pacific and Atlantic this summer, focusing on critical climate-related components of the atmosphere. The **Atmospheric Tomography (ATom) mission** will gather measurements on more than 200 different chemical species from the ocean surface up to 11000 m (c, 7,000 ft.) in the atmosphere to understand how the movement and transformation of short-lived greenhouse gases, (e.g, ozone & methane, contribute to climate change.
- Focusing on the skies over the eastern half of the United States, The **Atmospheric Carbon and Transport – America (ACT–America)** research team will track the movement of atmospheric

carbon over the eastern half of the U.S. to better understand the sources and sinks of greenhouse gases.

- The **Observations of Clouds above Aerosols and their Interactions (ORACLES)** study will use airborne instruments to probe the impact on climate and rainfall of interaction between clouds over the southeastern Atlantic Ocean and smoke from massive vegetation burning in southern Africa. ##

## Microbial Mats Offer Clues to Life on Early Earth

25 March, 2016 - [www.space.com/32377-microbes-give-clues-about-ancient-life.html](http://www.space.com/32377-microbes-give-clues-about-ancient-life.html)

To follow all the NASA Earth Expeditions, visit: [www.nasa.gov/earthexpeditions](http://www.nasa.gov/earthexpeditions)

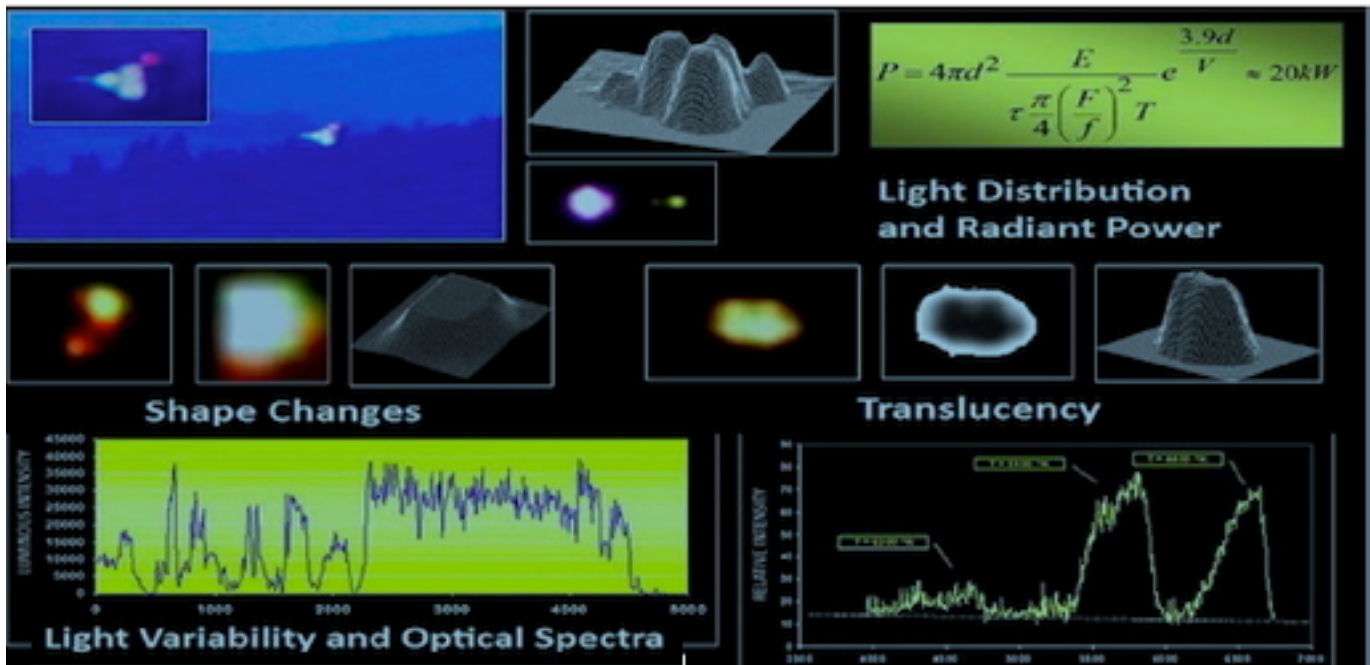


Ancient clusters of rock that preserve some of the oldest microbes on Earth occasionally possess mysterious branch-like formations. Scientists think they know what might have caused this enigmatic branching — changes in microbial activity in the shallow lakes and seas where life first evolved. ##

## ON THE WILD SIDE

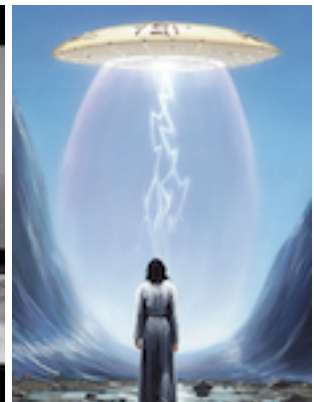
### What are UFOs? New Study Aims to Find Out

30 December, 2015 - [www.space.com/31067-what-are-ufos-new-study.html](http://www.space.com/31067-what-are-ufos-new-study.html)



A new science project has been launched in 2015 with a lofty goal: to record data on reported sightings of "Unidentified Flying Objects" (or UFOs) in the hopes of identifying what they are.

The group is called "UFODATA" – short for **UFO Detection And TrAcKing** – and is based on building a network of automated surveillance stations with high-tech sensors for gathering scientific data on sightings of alleged UFOs



**Editor** - They were called "flying saucers" in my day. I was 9+ during the 1947 sightings hysteria and I wanted so bad for one to land across the fence and take me away to see their planet, I even went to the Milwaukee Public Library and found a **Sanskrit-to-English Dictionary**, and learned how to read the Sanskrit lalphabet, so I could verify whether or not "Vimana" - a word from the Sanskrit epic poem Ramayana - c. 1,500 B.C. really meant a "celestial vehicle shaped like a saucer" etc. - it did!

### **Sightings of alleged UFOs.**

The aim of this new project is to move toward a scientific solution to the UFO reports by implementing an effort to gather systematic **instrumented observations**.

**Editor:** Despite my childhood enthusiasm and overactive imagination, I must say "Bah Humbug!" "Nonsense", but fun. We DO believe "they" are out there, somewhere, but that contact is extremely unlikely. ##

## **The Truth Is Out There: CIA Publishes UFO Investigation Tips**

3 February, 2016 - [www.space.com/31809-cia-ufo-investigation-tips.html](http://www.space.com/31809-cia-ufo-investigation-tips.html)  
[www.livescience.com/16184-ufo-sightings-aliens-states-infographic.html](http://www.livescience.com/16184-ufo-sightings-aliens-states-infographic.html)

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### Tips that the CIA learned from "flying saucer intelligence"

- 1 Create a group to find and evaluate the sightings. After the 1947 incident, Project SAUCER was established to obtain all possible information about these sightings. (The premise was that the sightings were not necessarily UFOs, but could be foreign craft.) The group was renamed Project SIGN and then Project BLUE BOOK.
- 2 Figure out your investigation's goals. Project BLUE BOOK aimed to find out if **UFOs were a threat to U.S. Security, determine if UFOs have technology that could be used by the U.S.**, and explain which stimuli cause a person to report a UFO.
- 3 Consult with experts. Project BLUE BOOK's outside experts included astrophysicists, federal aviation officials, pilots, academics, and people at the U.S. Weather Bureau, local weather stations, the National Center for Atmospheric Research and NASA, among other organizations.
- 4 Organize cases in a reporting system. BLUE BOOK's categories included astronomical, aircraft, balloons, satellites, other (such as reflections or mirages), insufficient data and unidentified.
- 5 Eliminate false positives. Examples included misidentified aircraft (particularly the U2, A12m and SR71 spy planes, hoaxes and mass hysteria.
- 6 Develop methodology to identify common aircraft (or other phenomena) mistook as UFOs.
- 7 Examine witness documentation.
- 8 Conduct controlled experiments, such as photographing certain types of balloons from different distances under similar weather conditions.
- 9 Gather and test physical and forensic evidence. The Zamora investigation included using Geiger counters to look for radiation, and sending soil samples off for expert analysis.
- 10 Discourage false reporting. In the 1950s, during the Cold War, there were concerns the Soviet Union could deploy fake "UFOs" to incite panic in the U.S. So officials countered that by teaching the public how to look for similar phenomena, such as astronomical objects (meteors) or illuminated objects (balloons). ##

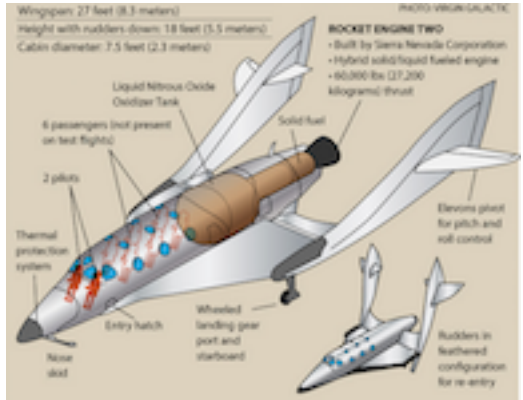




**SPACE TOURISM**

**Virgin Galactic's Second SpaceShipTwo Spaceliner in Pictures**

6 January, 2016 - [www.space.com/31520-virgin-galactic-second-spaceshiptwo-pictures.html](http://www.space.com/31520-virgin-galactic-second-spaceshiptwo-pictures.html)



Virgin Galactic is scheduled to roll out and christen its second SpaceShipTwo on Feb. 19, 15 months after its first suborbital spacecraft was lost during a test flight.



**Stephen Hawking Wants to Ride Virgin Galactic's New Passenger Spaceship**

[www.space.com/31993-stephen-hawking-virgin-galactic-spaceshiptwo-unity.html](http://www.space.com/31993-stephen-hawking-virgin-galactic-spaceshiptwo-unity.html)



20 February, 2016 – Famed cosmologist and physicist Stephen Hawking revealed the name of the new SpaceShipTwo suborbital craft — “**Virgin SpaceShip Unity**” or “**VSS Unity**” — during its unveiling ceremony Feb. 19 at Virgin's manufacturing facility at the Mojave Air & Space Port.

"We are entering a new space age, and I hope this will help to create a new unity. Space exploration has already been a great unifier — **we seem able to cooperate between nations in space in a way we can only envy on Earth.**"

SpaceShipTwo is designed to carry six passengers on brief journeys to suborbital space, for \$250,000 US per seat. Customers will get to see the curvature of the Earth against the blackness of space and experience a few minutes of weightlessness during the trip.

VSS Unity is the 2nd SpaceShipTwo. The first, VSS Enterprise, broke apart during its 4<sup>th</sup> rocket powered test flight Oct. 31, 2014, killing co-pilot Michael Alsbury and injuring pilot Peter Siebold. ##

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## Building a robust commercial market in low Earth orbit

[www.spacedaily.com/reports/Building\\_a\\_Robust\\_Commercial\\_Market\\_in\\_Low\\_Earth\\_Orbit\\_999.html](http://www.spacedaily.com/reports/Building_a_Robust_Commercial_Market_in_Low_Earth_Orbit_999.html)

15 January, 2016 – “Few would have imagined back in 2010 when President Barack Obama pledged that NASA would work “with a growing array of private companies competing to make getting to space easier and more affordable,” that less than six years later we’d be able to say commercial carriers have transported 35,000 of pounds of space cargo (and counting!) to the International Space Station (ISS) – or that we’d be so firmly on track to return launches of American astronauts to the ISS from American soil on American commercial carriers.

“But that is exactly what is happening. Across the board, about 80% of NASA's activities are carried out by our partners in industry and at America's academic institutions. We develop more than 1,600 new technologies a year and work with business partners to transfer thousands of products, services and processes into the market for job creation and economic growth. More venture capital was invested in America's space industry in 2015 than in all the previous 15 years combined.”

## Space: The here-and-now frontier

22 January, 2016 – [www.spacedaily.com/reports/Space\\_The\\_here\\_and\\_now\\_frontier\\_999.html](http://www.spacedaily.com/reports/Space_The_here_and_now_frontier_999.html)

Students in AeroAstro don't have to wait 30 years for the next Boeing aircraft to come out, or for NASA to send humans to Mars. They see opportunities to do things today.

**The public can now** fly commercially—available drones, access real-time satellite weather and navigation technologiesL purchase tickets for a future Virgin Galactic suborbital flight.

**Today innovators can** start their own companies, create their own aviation designs, build their own rockets, and make an impact outside of government facilities and large aerospace firms.

## New "Spaceport" in Tucson for World View Edge of Space Balloon Rides

1 February, 2016 - <http://www.thespacereview.com/article/2914/1> - <http://worldviewexperience.com>



**Spaceport Tucson** is intended to be the home base for World View, the company developing high-altitude balloons designed to carry experiments and, eventually, people to altitudes of about 30 kilometers. That's far short of any traditional definition of space, as above the 100-km line, but the company boasts it will give people a spaceflight-like experience, for much less money.

## Airbus "Spaceplane" Suborbital Vehicle for Space Tourism & Science

24 March, 2016 - <http://www.space.com/32373-spaceplane.html>

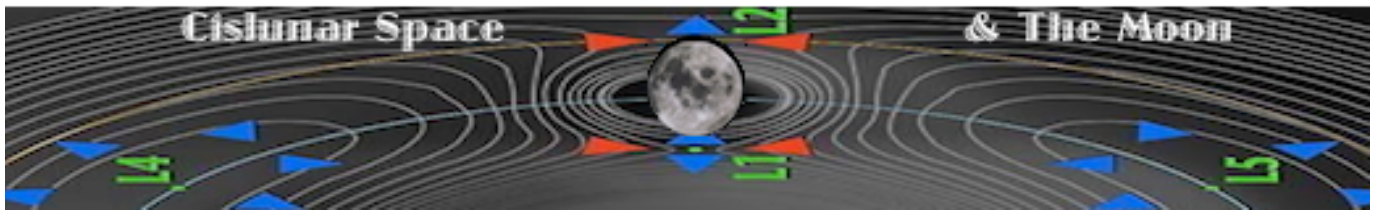


The "Spaceplane" is a European vision to bring cargo or paying passengers into suborbital space, for science or operational reasons. Being developed by Airbus, Europe's biggest aerospace manufacturer, it is intended to carry **four passengers** as high as 100 km (62 mi) by **taking off and landing at a conventional airport**. It will operate in between the usual altitude of airplanes and satellites.

The spaceplane could be used as a **"point-to-point" transfer service** or do experiments and work in an area of space not heavily occupied by other vehicles. ##



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We insist on capitalizing “Moon” when it refers to Earth’s satellite.  
 Read why: <http://www.moonsociety.org/info/capital-M-for-Moon.html>

## ANALOG STATIONS & ACTIVITIES

### Magnetic MoonWalker Shoes Ditch Gravity

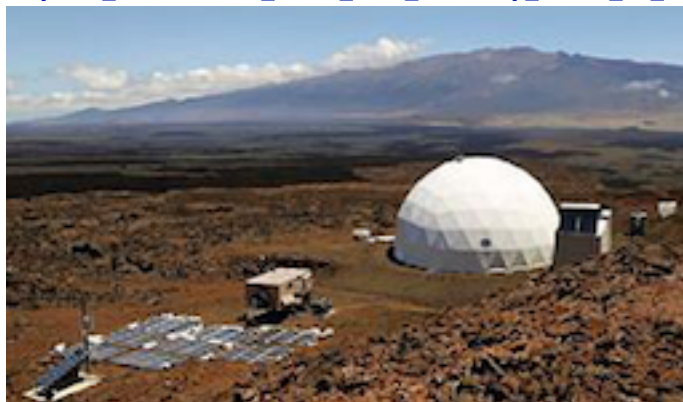
12 January, 2016 – [www.space.com/31600-magnetic-moonwalker-shoes-ditch-gravity.html](http://www.space.com/31600-magnetic-moonwalker-shoes-ditch-gravity.html)  
<http://news.discovery.com/tech/gear-and-gadgets/high-tech-shoes-step-into-the-future-140228.htm>



A New York-based startup wants to send you to the Moon, replicating low-gravity environments with their smart, super-magnetic sneakers. the startup **Moonshine Crea** <http://www.moonshinecrea.com/> lets wearers bounce around like Neil Armstrong. Each shoe contains N45 magnets — a fairly high grade of powerful rare-earth magnet — placed so their north poles face each other, creating a repellant force that “leaves you light on your feet and happy as an astronaut,” ##

### Space simulation crew hits halfway mark til August re-entry

[www.marsdaily.com/reports/Space\\_simulation\\_crew\\_hits\\_halfway\\_mark\\_til\\_August\\_re\\_entry\\_999.html](http://www.marsdaily.com/reports/Space_simulation_crew_hits_halfway_mark_til_August_re_entry_999.html)



4 March, 2016 – Six crew members of the 4th Hawaii Space Exploration Analog and Simulation, HI-SEAS, spent more than six months of their 12-month mission in a solar-powered dome on the slopes of Mauna Loa. The crew has been living in isolation as part of a University of Hawaii at Manoa research project simulating long-duration space travel. This fourth mission is the longest in HI-SEAS history. As with the previous two missions in the NASA funded study, the current mission is focused on crewmember cohesion and performance. NASA awarded HI-SEAS a 3rd grant through 2019. ##

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## MOON SCIENCE

**South Korea to launch Lunar Exploration in 2016, land by 2020**

[www.space-travel.com/reports/South\\_Korea\\_to\\_launch\\_lunar\\_exploration\\_in\\_2016\\_land\\_by\\_2020\\_999.html](http://www.space-travel.com/reports/South_Korea_to_launch_lunar_exploration_in_2016_land_by_2020_999.html)

31 December – The project's first 2016–2018 stage envisions sending an **independently developed orbiter** to the Moon, followed by a landing vessel with an also independently developed launch vehicle and ground control station under the second phase.

Seoul plans to cooperate with foreign agencies including the US National Aeronautics and Space Administration (NASA) to develop **payloads**. ##

**Russia Postpones Plans on Extensive Moon Exploration Until 2025**

[www.space-travel.com/reports/Russia\\_Postpones\\_Plans\\_on\\_Extensive\\_Moon\\_Exploration\\_Until\\_2025\\_999.html](http://www.space-travel.com/reports/Russia_Postpones_Plans_on_Extensive_Moon_Exploration_Until_2025_999.html)

[www.space-travel.com/reports/Death\\_rumors\\_of\\_Russian\\_lunar\\_program\\_greatly\\_exaggerated\\_Deputy\\_PM\\_999.html](http://www.space-travel.com/reports/Death_rumors_of_Russian_lunar_program_greatly_exaggerated_Deputy_PM_999.html)

30 December, 2015 – **Roscosmos will give up on manned flights to the Moon and related activities at least until 2025.**

This includes:

- a lunar **landing complex**
- a lunar **orbital station**
- a lunar **space suit**
- a system of **robotic software** for Moon flights.

**Chang'e-3 landing site named "Guang Han Gong"**

[www.space-travel.com/reports/Change\\_3\\_landing\\_site\\_named\\_Guang\\_Han\\_Gong\\_999.html](http://www.space-travel.com/reports/Change_3_landing_site_named_Guang_Han_Gong_999.html)



A total of 22 lunar features have been given Chinese names.

6 January, 2016 – The landing site of China's first Moon lander Chang'e-3 has been named "**Guang Han Gong**" or "Moon Palace", more than two years after the spacecraft made a successful soft-landing on the Moon in December 2013. Together with three nearby impact craters, the name was approved by the International Astronomical Union (IAU), ##

**China's Moon Rover Finds New Kind of Basaltic Lunar Rock**

7 January, 2016 – [www.space.com/31544-china-moon-rover-lunar-rock-discovery.html](http://www.space.com/31544-china-moon-rover-lunar-rock-discovery.html)

A new type of basaltic rock was discovered at a fresh crater named Zi Wei. Measurements of the rock composition indicate that the basalt contains a **high enrichment of titanium dioxide** and **olivine**.

The area surveyed was covered in a late-stage magma ocean during the Moon's development around three billion years ago, whereas rock samples from the U.S. Apollo and former Soviet Union Luna missions mainly date back from earlier-stage magma oceans between 3 and 4 billion years ago. ##

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

## China's manned Moon mission moves a step closer

12 January, 2016 – [www.space-travel.com/reports/Lunar\\_mission\\_moves\\_a\\_step\\_closer\\_999.html](http://www.space-travel.com/reports/Lunar_mission_moves_a_step_closer_999.html)



The China Academy of Launch Vehicle Technology, working with other Chinese institutes, has developed a super-large **one-piece interstage ring** to be used to connect stages of the rocket, now called the **Long March 9**. It may take up to five years to design and develop a **liquid oxygen/kerosene engine with 460 metric tons of thrust** and an **oxygen/liquid hydrogen engine with 220 tons of thrust**. The rocket will have a launch weight of 3,000 tons and make its maiden flight around 2030. ##

## China shoots for first landing on far side of the Moon

15 January, 2016 – <http://phys.org/news/2016-01-china-dark-side-moon.html>

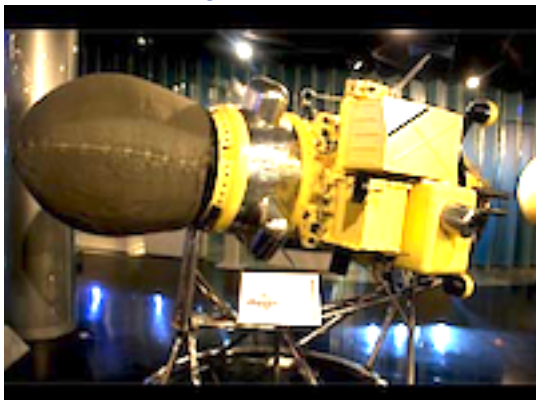
China will launch a mission to land on the far side of the Moon in two years' time, state media reported, in what will be a first for humanity. The Moon's far hemisphere is never directly visible from Earth and while it has been photographed from orbit, the first images in 1959, but no probe has landed there. China's **Chang'e-4** probe—named for the goddess of the Moon in Chinese mythology—will be sent to it in 2018. The lander and rover will make a soft landing, and will carry out in-place and patrolling surveys,

## European Governments Disagree with their Space Agency on Moon vs. Mars

25 January, 2016 – [www.space.com/31559-europe-woerner-moon-awakens-push.html](http://www.space.com/31559-europe-woerner-moon-awakens-push.html)

## Forgotten Moon landing that paved the way for today's adventures

[www.space-travel.com/reports/The\\_forgotten\\_moon\\_landing\\_that\\_paved\\_the\\_way\\_for\\_todays\\_space\\_adventures\\_999.html](http://www.space-travel.com/reports/The_forgotten_moon_landing_that_paved_the_way_for_todays_space_adventures_999.html) – <http://nssdc.gsfc.nasa.gov/nmc/spacecraftDisplay.do?id=1966-006A>  
[https://en.wikipedia.org/wiki/Luna\\_9](https://en.wikipedia.org/wiki/Luna_9) – [www.zarya.info/Diaries/Luna/Luna09.php](http://www.zarya.info/Diaries/Luna/Luna09.php)



**Left:** A replica of Luna 9 on display in Moscow – **Right:** the lander itself

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

7 February, 2016 – Fifty years ago, the Soviet Union managed to soft land on the Moon with an unmanned craft, **Luna 9** on **February 3 1966**. It was a technological triumph at the time and of lasting importance. **Until this successful landing, no one knew for sure whether or not "astronauts would sink in the thick lunar dust.**

#### Luna 9 Statistics:

**Launch Vehicle:** Molniya

**Launching Technique:** Low orbit around the Earth and then a direct landing trajectory

**Mass:** 1,583 kilogrammes fully fuelled (including 84 kg lander)

**Length:** 2.5 metres (including lander)

**Maximum Diameter:** 1.0 metre

### NASA chooses ASU to design and operate special satellite over the Moon

[www.space-travel.com/reports/NASA\\_chooses\\_ASU\\_to\\_design\\_and\\_operate\\_special\\_satellite\\_999.html](http://www.space-travel.com/reports/NASA_chooses_ASU_to_design_and_operate_special_satellite_999.html)

17 February, 2016 – Arizona State University's School of Earth and Space Exploration's craft is called **LunaH-Map**, short for the **Lunar Polar Hydrogen Mapper**, and it seeks to map **the Moon's water deposits, especially at the southern pole**, Hannah Kerner, a SESE graduate student and lead systems and software engineer on the LunaH-Map project, said.

The satellite will fly low above the surface of the Moon, using neutron detectors to count the amount of neutrons dislodged into space by cosmic rays. Different counts and energies of the neutrons that escape from the Moon are characteristic of different elements being present, she said. Kerner said the application for ASU to work on this project was not a simple one. ##

### Chinese scientists invent leak detection system for Moon exploration

[www.space-travel.com/reports/Chinese\\_scientists\\_invent\\_leak\\_detection\\_system\\_for\\_moon\\_exploration\\_999.html](http://www.space-travel.com/reports/Chinese_scientists_invent_leak_detection_system_for_moon_exploration_999.html)

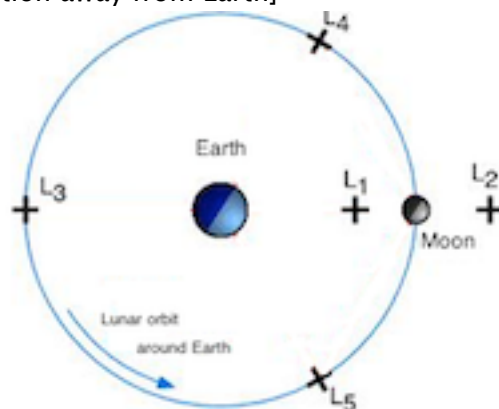
17 February, 2016 – Chinese scientists have developed a system to measure the leak rate for a vacuum environment which will be used in the country's third step Moon exploration program.

The measurement system will help scientists figure out a better way to preserve samples from the Moon, which are stored in a vacuum capsule, increasing the accuracy of research. ##

### China to use data relay satellite to explore farside of Moon

[www.space-travel.com/reports/China\\_to\\_use\\_data\\_relay\\_satellite\\_to\\_explore\\_dark\\_side\\_of\\_moon\\_999.html](http://www.space-travel.com/reports/China_to_use_data_relay_satellite_to_explore_dark_side_of_moon_999.html)

4 March, 2016 – China will launch a data relay satellite to ensure communication between Earth and the lunar probe during an expedition to the far side of the Moon. Earth can contact Chang'e-4 with the help of a "communication station" on the Lagrange point L2 of the Earth-moon system, 80,000 kilometers away from the Moon [in the direction away from Earth]



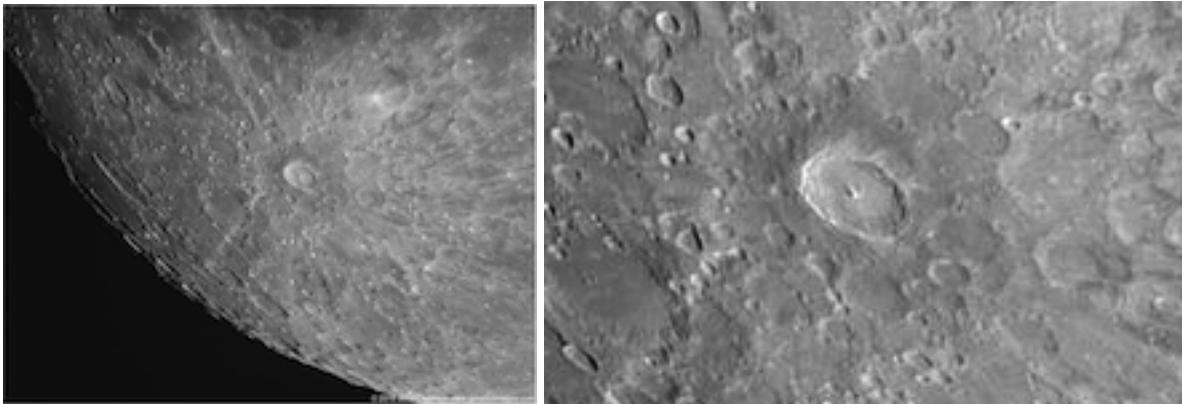
**Editor:** The original title of this article written by space.com "staff writers" uses the term "dark side" of the Moon. The misnomer is repeated once in the body of the article as well, going on to say "Due to Due to

**gravitational forces**, this part of the moon is not visible to Earth and has never been explored by humans, this part of the moon is not visible to Earth and has never been explored by humans" "Gravitational forces" have nothing to do with it.

That the Moon rotates on its axis once every orbit around Earth is the cause of this phenomenon. There is no such thing as a dark side of the Moon. The side that we never see from Earth, is properly called the "far" side and the sun rises and sets there just as it does on the side that always faces Earth. Hey, editor! How come no one on the staff caught this? How embarrassing! One has to wonder how many other "inaccuracies" and "whoops" mistakes are in Space.com articles! ## PK

## Moon's Young Crater (Tycho) Seen in Close-Up View (Photo)

21 March, 2016 - [www.space.com/32237-amazing-moon-photo-tycho-crater.html](http://www.space.com/32237-amazing-moon-photo-tycho-crater.html)

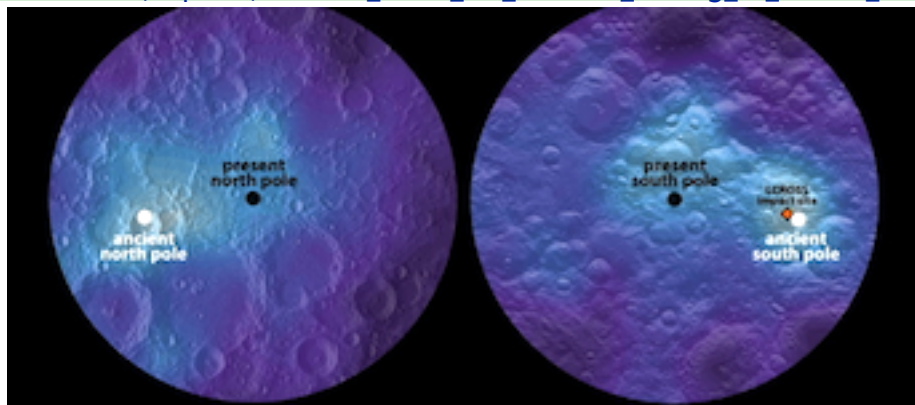


## How the Moon Moved: Lunar Poles Have Wandered

23 March, 2016 - [www.space.com/32354-moon-polar-shift-water-ice.html](http://www.space.com/32354-moon-polar-shift-water-ice.html)

[www.space.com/32353-moon-s-axis-shifted-6-over-1-billion-years-video.html](http://www.space.com/32353-moon-s-axis-shifted-6-over-1-billion-years-video.html)

[www.space-travel.com/reports/Ancient Polar Ice Reveals Tilting of Earths Moon\\_999.html](http://www.space-travel.com/reports/Ancient Polar Ice Reveals Tilting of Earths Moon_999.html)



Black dots present N&S pole positions - White dots, original positions of poles

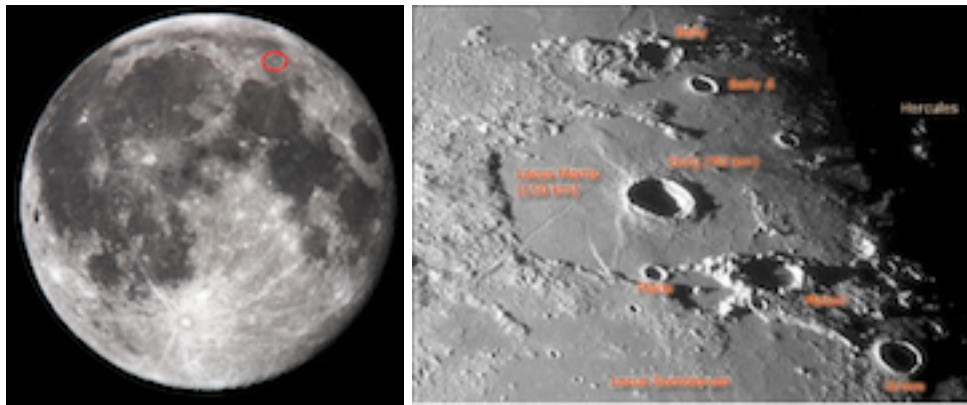
A new study suggests that **the Moon's poles have shifted over the eons**, likely as a result of geological activity beneath the lunar crust.

This finding — based on an analysis of the distribution of water ice near the lunar north and south poles — sheds light on the Moon's structure and evolution, and also provides **clues about where Earth's water came from**. The ice has to be really old, and therefore may record the ancient delivery of ice to the inner solar system. ##

## GOOGLE LUNAR X-PRIZE

## Interview with Astrobotics

[www.youtube.com/watch?v=cJcJGH3BSxk](http://www.youtube.com/watch?v=cJcJGH3BSxk) - [www.Astrobotics.com](http://www.Astrobotics.com)



Location of chosen landing site in Lacu Mortis (Mare Frigoris to the North, Mare Serenitatis to the South)

**Editor:** this is a very interesting and informative interview. Astrobotics' chosen landing site is on the rim of a lava tube "pit" where a meteor or asteroid fragment hit the surface right over a hidden lavatube, creating a sink hole that gives access to the tube below, which they hope to explore. This is the team that I personally am rooting for, because of their site choice and its discovery potential which could redirect scientists' current preoccupation with the Moon's poles to real development and colonization. ##

## Audi joins Google Lunar XPrize competition

15 January, 2016: [www.space-travel.com/reports/Audi\\_joins\\_Google\\_Lunar\\_XPrize\\_competition\\_999.html](http://www.space-travel.com/reports/Audi_joins_Google_Lunar_XPrize_competition_999.html)  
<http://lunar.xprize.org/teams/part-time-scientists>

Audi is lending its engineering talents to a team of scientists in the Google Lunar XPrize competition. Together, the German auto makers and the "Part-Time Scientists" are optimizing a Moon rover called the "Audi lunar quattro."

Audi engineers are helping the team outfit the rover with the company's patented technologies, including **quattro all-wheel drive, lightweight construction, electric mobility and piloted driving.**



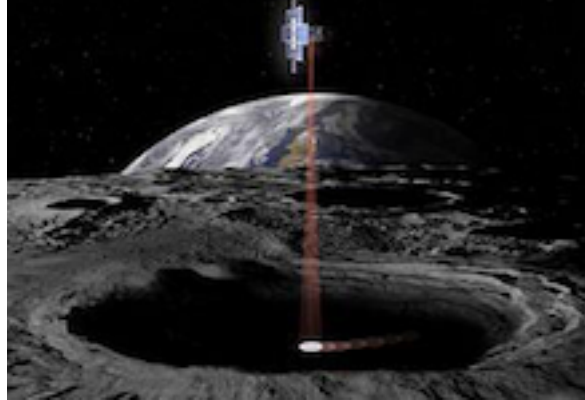
The Part-Time Scientists have been working on the rover since 2008 -- testing prototypes in the extreme terrain of the Alps. The team includes scientists and engineers from both Germany and Austria. They plan to launch their rover in 2017. Currently 16 other teams vying for the competition's main prize.

Google's Lunar XPrize competition promises \$30 million to the first team whose rover first lands on the Moon, travels 500 meters and then beams back high-definition images and video. ##

## Lunar Flashlight to fly as 2ndary payload on Exploration Mission-1

[www.space-travel.com/reports/Lunar Flashlight Selected to Fly as Secondary Payload on Explorati on Mission 1\\_999.html](http://www.space-travel.com/reports/Lunar_Flashlight_Selected_to_Fly_as_Secondary_Payload_on_Explorati_on_Mission_1_999.html) – [www.space.com/31806-nasa-cubesats-giant-rocket-test-flight.html](http://www.space.com/31806-nasa-cubesats-giant-rocket-test-flight.html)  
[www.space.com/31814-cubesats-will-swarm-nasa-s-sls-first-flight-video.html](http://www.space.com/31814-cubesats-will-swarm-nasa-s-sls-first-flight-video.html)

3 February, 2016 – NASA's Advanced Exploration Systems Division has selected the Lunar Flashlight CubeSat as a 2ndary payload aboard the Space Launch System's Exploration Mission-1 (EM-1) flight.



Lunar Flashlight in a position over the south pole of the Moon

Lunar Flashlight will **map the lunar south pole for volatiles** and demonstrate several technological firsts, including being the **first CubeSat to reach the Moon**, the **first planetary CubeSat mission to use green propulsion**, and the **first mission to use lasers to look for water ice**. ##

## X Prize Planning for Next Space Competition

2 March, 2016 – [www.space.com/32110-x-prize-next-space-competition.html](http://www.space.com/32110-x-prize-next-space-competition.html)

With its current flagship space competition set to end next year, the X Prize Foundation is starting the planning for its next space-related challenge. The foundation has a road-mapping approach for developing new prizes that it plans to apply to a new space prize. That involves identifying desired future states of the space industry and working backwards, or "backcasting," to the present day to identify key technical challenges that could be solved through the use of a prize. ##

## 'Moon Shot': Web Series About Private Moon Race Coming Soon

[www.space.com/32135-moon-shot-google-lunar-xprize-documentary-video.html](http://www.space.com/32135-moon-shot-google-lunar-xprize-documentary-video.html)

"Moon Shot" is a new nine-part documentary web series about the Google Lunar X Prize (GLXP). The \$30 million private race to the Moon is about to hit computer and smartphone screens world-wide.

## HISTORY OF MEN ON THE MOON – THE APOLLO YEARS

### Eugene Cernan, “Last Man on the Moon”, tells his story

<http://thelastmanonthemoon.com/trailer/> <http://thelastmanonthemoon.com>



Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

## FUTURE HUMAN OUTPOSTS ON THE MOON

### Lunar Leap: Europe Is Reaching for a Moon Base by the 2030s

30 December, 2015 - [www.space.com/31488-european-moon-base-2030s.html](http://www.space.com/31488-european-moon-base-2030s.html)

<http://phys.org/news/2016-02-colony-alien-world.html>

#### "Comeback to the Moon"

There is growing interest in Europe to prioritize the Moon as humanity's next deep-space destination, and to serve as a springboard to push the human exploration of the solar system, with Mars as the horizon goal. Seeing the strategic significance of the Moon, Europe is pushing forward lunar exploration missions that would involve both humans and robots.



European space planners envision a series of human missions to the lunar vicinity starting in the early 2020s. They would include coordination between astronauts and robotic systems on the lunar surface. Robots would land first, paving the way for human explorers to set foot on the Moon. ##

### Momentum builds for creation of 'Moon villages'

[www.space-travel.com/reports/Momentum\\_builds\\_for\\_creation\\_of\\_moon\\_villages\\_999.html](http://www.space-travel.com/reports/Momentum_builds_for_creation_of_moon_villages_999.html)

8 January, 2016 - Villages on the Moon, constructed through cooperation between astronauts and robotic systems on the lunar surface, could become a reality as early as 2030. That's the consensus of a recent international conference of scientists, engineers and industry experts.

The **European Space Agency** (ESA) hosted a symposium in the Netherlands, titled "Moon 2020-2030 - A New Era of Coordinated Human and Robotic Exploration"

The ESA's vision is that the Moon villages could serve as a potential springboard for future human missions to Mars and potentially other destinations.

#### Near term goals:

- Ground truth verification of deposit size, composition, form and homogeneity through a coordinated prospecting program
- Demonstration of extraction techniques followed by refinement of products into usable commodities. #

### Russia postpones manned Lunar mission to 2035

[www.space-travel.com/reports/Russia\\_postpones\\_manned\\_Lunar\\_mission\\_to\\_2035\\_999.html](http://www.space-travel.com/reports/Russia_postpones_manned_Lunar_mission_to_2035_999.html)

21 January, 2016 - Russia initially planned to launch a manned aircraft to the moon atop an Angara heavy rocket carrier from its Vostochny space port in 2025. The earlier version of the state space program - worth some 2 trillion rubles (\$25 billion) - specified that the creation of a heavy carrier rocket would allow for a manned lunar landing by 2030.

But the new edition, which had its budget trimmed down to 1.4 trillion rubles, plans to start setting aside funds to put a man on the moon after 2035. ##

## How ESA is preparing astronauts for missions to the Moon

[www.esa.int/About\\_Us/EAC/Highlights/Spaceship\\_EAC](http://www.esa.int/About_Us/EAC/Highlights/Spaceship_EAC)

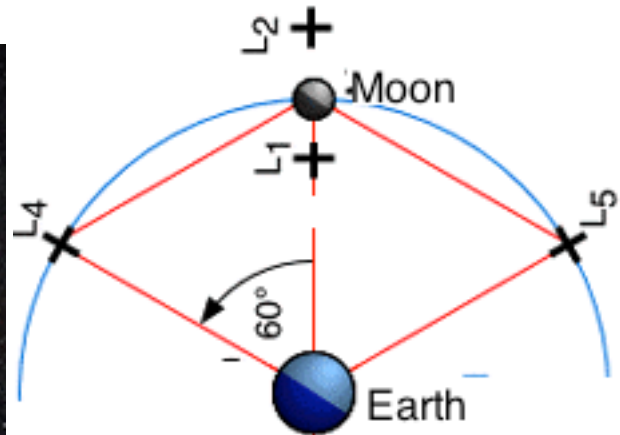
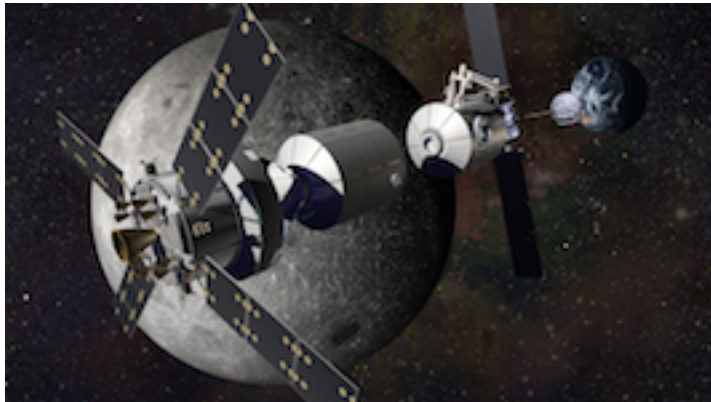
> Do watch this very interesting VIDEO <

For many of us Moon Firsters, this video is very encouraging

ESA is planning its beachhead on the Moon for the 2020s, just around the corner.

## Plans Being Devised for Human Outpost “Near” the Moon

23 February, 2016 – [www.space.com/32014-human-outpost-near-moon-cislunar-space.html](http://www.space.com/32014-human-outpost-near-moon-cislunar-space.html)



**Left:** An approach to cislunar habitats is one that is both modular and flexible, adding elements over time. NASA's Orion spacecraft is capable of transporting habitat elements to an orbiting outpost around the Moon. Credit: Lockheed Martin **Right:** Two near Moon locations under consideration. L1 and L3 are closest to the Moon, roughly 97,000 km (60,000 mi) in front of and behind the Moon, Two other locations, L4 & L5 are as far from the Moon as Earth but provide views of portions of the Moon's farside.

Under NASA's Next Space Technologies for Exploration Partnerships (NextSTEP) Projects, scientists and engineers are examining how best to utilize NASA's Orion deep-space crew capsule and future human habitats to set up a cislunar outpost. Under a NextSTEP award, Lockheed Martin's space systems division is studying the **augmentation of the Orion capsule to initially sustain a crew of four for up to 60 days in cislunar space.**

The cislunar outpost is envisioned as **a place from which to operate robots on the Moon** and perhaps even serve as **a receiving node for lunar samples on their way to Earth**, and as a life-sciences test bed as well. The cislunar outpost would be outside Earth's protective magnetic field, so planners are focused on ways to limit crewmembers' radiation exposure.

Researchers are also looking at the possibility of scaling up this concept to provide in-space habitation for future crewed Mars missions. ##

## NASA releases strange 'music' heard by 1969 astronauts while over Farside

[www.space-travel.com/reports/NASA\\_releases\\_strange\\_music\\_heard\\_by\\_1969\\_astronauts\\_999.html](http://www.space-travel.com/reports/NASA_releases_strange_music_heard_by_1969_astronauts_999.html)  
<http://phys.org/news/2016-02-nasa-strange-music-heard-astronauts.html>

22 February, 2016 – NASA has made public a recording of strange "music" that astronauts reported hearing in **1969 while on the far side of the Moon**, out of radio contact with the Earth.

The story behind these unusual whistling noises was showcased Sunday night in a show on the cable channel Discovery, as part of a series called "NASA's Unexplained Files."

The noises reportedly were heard in May 1969 by the **Apollo 10** astronauts as they circled the Moon, months before the first astronauts stepped foot on the lunar surface on July 21 that same year (Thomas Stafford, John Young and Eugene Cernan).

The sound lasted about an hour, and were recorded and transmitted to mission control in Houston. A transcript of the text was released in 2008.



The actual audio has only just been made public. ##

## NASA May Return to Moon, But Only After Cutting Off ISS

[www.space-travel.com/reports/NASA\\_May\\_Return\\_to\\_Moon\\_But\\_Only\\_After\\_Cutting\\_Off\\_ISS\\_999.html](http://www.space-travel.com/reports/NASA_May_Return_to_Moon_But_Only_After_Cutting_Off_ISS_999.html)

29 February, 2016 – the future of NASA's Space policy will be decided by the next US President. The main issue would be whether to return to the Moon first, or immediately begin deep space exploration with a manned mission to Mars.

**“Only after government support for the International Space Station, will there be an adequate budget for the robust exploration program.” ##**

## Permanent Lunar Colony Possible in 10 Years

[www.space-travel.com/reports/Permanent\\_Lunar\\_Colony\\_Possible\\_in\\_10\\_Years\\_999.html](http://www.space-travel.com/reports/Permanent_Lunar_Colony_Possible_in_10_Years_999.html)

15 March, 2016 – Scientific papers released after a 2014 high-profile astronomical workshop suggest that a fully operational base could be constructed by 2022. The base would open the pathway for the commercial development of space.

Putting humans on the moon would cost less than \$10 billion, a surprisingly low amount considering the expense of space exploration in the past. The Apollo space program, for instance, was completed for some \$150 billion, adjusted for inflation to today's dollars.

Chris McKay, a NASA astrobiologist and one of the organizers of the workshop, explained that price cuts are now possible due to the rapid development of new technologies, ending highly specialized and expensive development in the logistics of space exploration.

**“New technologies, some of which have nothing to do with space – like self-driving cars and waste-recycling toilets – are going to be incredibly useful in space, and are driving down the cost of a moon base to the point where it might be easy to do.” ##**

## International 'Moon Village' Way To Go – European Space Agency | Video

[www.space.com/32375-international-moon-village-is-way-to-go-according-to-european-space-agency-video.html](http://www.space.com/32375-international-moon-village-is-way-to-go-according-to-european-space-agency-video.html)

## Moon Mission: A Blueprint for the Red Planet

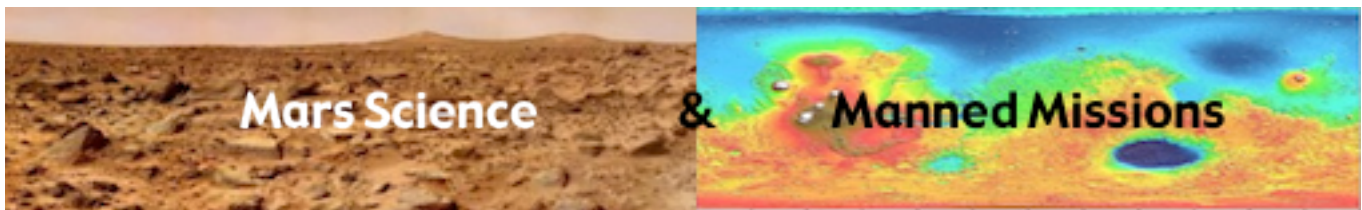
[www.space-travel.com/reports/Moon\\_Mission\\_A\\_Blueprint\\_for\\_the\\_Red\\_Planet\\_999.html](http://www.space-travel.com/reports/Moon_Mission_A_Blueprint_for_the_Red_Planet_999.html)

30 March, 2016 – The Apollo program that led to the first humans landing on the Moon in 1969 cost US\$25 billion (US\$150 billion by today's standards) and up until now, another mission to the Moon seemed out of the question, since the majority of NASA's budget was taken by Mars.

But according to NASA scientists, sending a bunch of astronauts to the Moon to set up a Lunar base camp would be much cheaper now. A team of space experts say they could establish a human colony on the Moon by 2022 – at a cost of US\$10 billion, **a fraction of what it used to cost** with results from the Moon mission feeding into future research of the colonization of Mars. ##



]



## MARS ANALOG EXERCISES

### Mars Society Announces Precursor Mission for MA365

7 September, 2015 - <http://fmars.marssociety.org>

The Mars Society intends to advance planning for its “one-year” **Mars Arctic 365** program at FMARS on **Devon Island** in Northern Canada by down-selecting to a single crew that will first be “put to the test” as part of an 80-day mission at the organization’s **Mars Desert Research Station** in fall 2016.

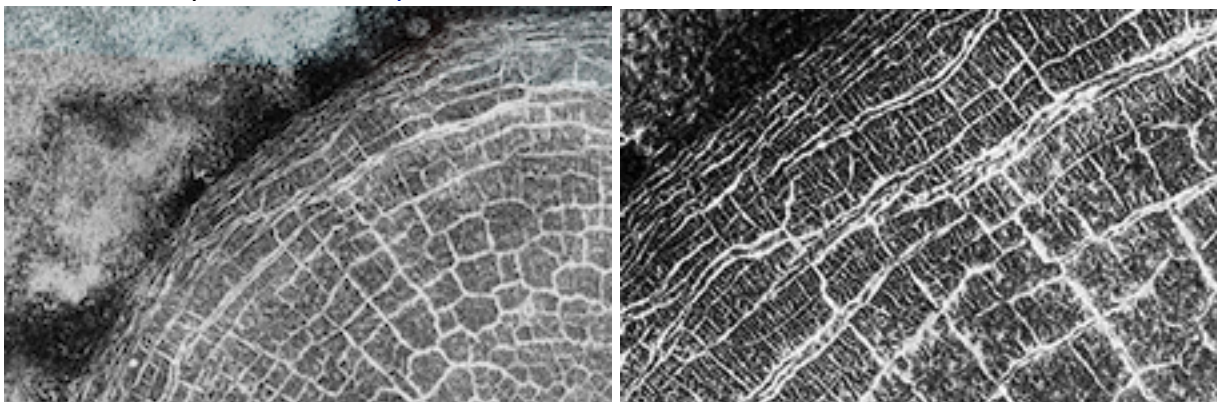
The crew, including alternates, of Mars Awakening 80 (MA80), as the mission is being called, will consist of nine individuals drawn from the U.S., France, Canada, Germany and Russia who previously made the cut of 21 finalists chosen from an initial pool of over 200 volunteers. ##



## MARS SCIENCE & MISSIONS

### Mars Reconnaissance Orbiter Catches a Crater Full of Cracks

1 January 2016 - [www.space.com/31500-mars-orbiter-crater-full-cracks.html](http://www.space.com/31500-mars-orbiter-crater-full-cracks.html)



**Left:** MRO HiRISE photo shows the northwest quadrant of a fracture-filled crater on Mars. **Right:** detail) A lacy web of bright frost-filled fractures fills a crater near the north pole of Mars in this image, acquired Sept. 20, 2015 with the HiRISE camera aboard NASA’s Mars Reconnaissance Orbiter (MRO)

**This crater is 5 km (3 mi) across and its ancient interior has undergone countless millennia of freeze/thaw cycles that have broken the surface into polygonal shapes.**

This process is common on Mars and can even be found on Earth. ##

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

## CNES To Get to the Bottom of Leaks that Forced Mars InSight Delay

4 January, 2016 – [www.space.com/31508-mars-insight-lander-launch-delay-investigation.html](http://www.space.com/31508-mars-insight-lander-launch-delay-investigation.html)

The French space agency, CNES, on Jan. 4 created an outside board of inquiry to examine the circumstances surrounding the discovery of multiple leaks in an instrument intended to launch on NASA's Mars InSight lander — leaks that appeared so late in the instrument's development that NASA and CNES were forced to scrap a planned March launch.

Because Mars and Earth align favorably just once every 26 months, the InSight lander now must wait until mid-2018 to begin its mission to characterize Mars' interior in unprecedented detail. ##

## Curiosity Rover Rounds Martian Dune to Get to the Other Side

[www.marsdaily.com/reports/Rover\\_Rounds\\_Martian\\_Dune\\_to\\_Get\\_to\\_the\\_Other\\_Side\\_999.html](http://www.marsdaily.com/reports/Rover_Rounds_Martian_Dune_to_Get_to_the_Other_Side_999.html)

6 January, 2016 – Partway through the first up-close study ever conducted of extraterrestrial sand dunes, the rover is providing dramatic views of a dune's steep face, where cascading sand has sculpted very different textures than the wavy ripples visible on the dune's windward slope.

Curiosity is examining examples of the Bagnold Dunes, a band of dark sand dunes lining the northwestern flank of Mt. Sharp, the layered mountain the rover is climbing.



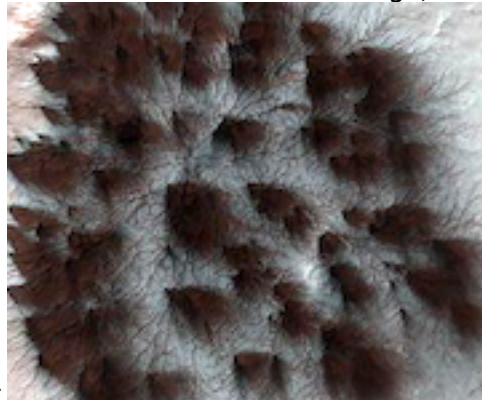
This Dec. 18, 2015, view of the downwind face of "Namib Dune" on Mars covers 360 degrees, including a portion of Mount Sharp on the horizon ##

## A Starburst Spider On Mars

12 January, 2016 – [www.marsdaily.com/reports/A\\_Starburst\\_Spider\\_On\\_Mars\\_999.html](http://www.marsdaily.com/reports/A_Starburst_Spider_On_Mars_999.html)

[www.space.com/31583-spider-mars-veins-dry-ice-photo.html](http://www.space.com/31583-spider-mars-veins-dry-ice-photo.html)

Mars' seasonal cap of carbon dioxide ice has eroded many beautiful terrains as it sublimates directly from ice to vapor every spring. Where on Mars the High Resolution Imaging Science Experiment (HiRISE) camera on Mars Reconnaissance Orbiter took this image, we see troughs in a starburst pattern.



Light/dark contrast

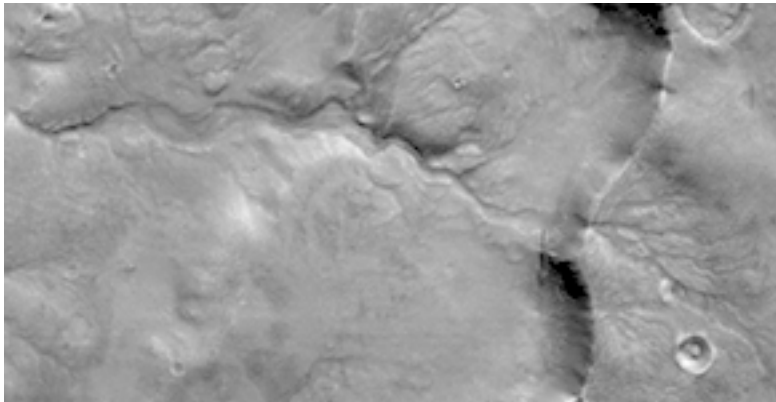
exaggerated by editor

Here the pattern looks more dendritic as channels branch out numerous times as they get further from the center. The troughs are believed to be formed by gas flowing beneath the seasonal ice to openings where the gas escapes, carrying along dust from the surface below. The dust falls to the surface of the ice in fan-shaped deposits, covering an area about 1 km (0.6 m across, at 81.8°S, 76.2°

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

## An Ancient Meandering River ... On Mars

14 January, 2016 – [www.space.com/31613-ancient-river-on-mars-photo.html](http://www.space.com/31613-ancient-river-on-mars-photo.html)



There are few more potent reminders that Mars used to be a wet world than ancient, dried up river beds etched into its surface. Although this particular example has been weathered by hundreds of thousands or even millions of years in a region dominated by a plain north of the Martian equator.

This river apparently flowed from right to left, down the slope of a crater rim and into the crater itself. This image was captured by the prolific High-Resolution Imaging Science Experiment (HiRISE) camera on NASA's Mars Reconnaissance Orbiter (MRO) on Sept. 25, 2015. ##

## India to Cooperate With France on Next Mission to Mars

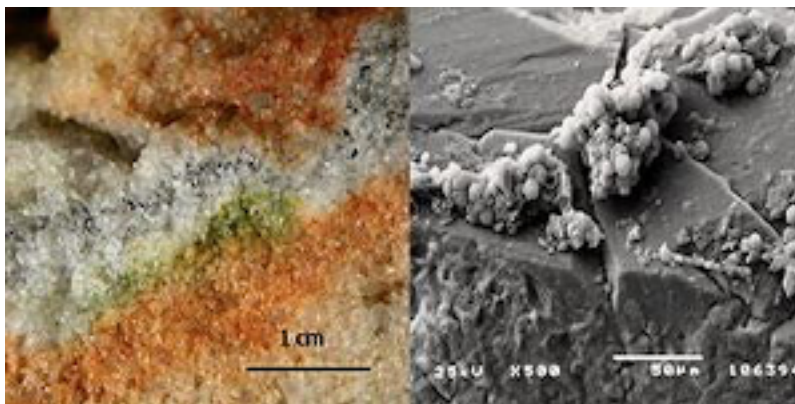
[www.marsdaily.com/reports/India\\_to\\_Cooperate\\_With\\_France\\_on\\_Next\\_Mission\\_to\\_Mars\\_999.html](http://www.marsdaily.com/reports/India_to_Cooperate_With_France_on_Next_Mission_to_Mars_999.html)

26 January, 2016 – France will become India's partner in the next Indian mission to Mars. No details.

## Antarctic fungi survive Martian conditions on the Space Station

[www.spacedaily.com/reports/Antarctic\\_fungi\\_survive\\_Martian\\_conditions\\_on\\_the\\_International\\_Space\\_Station\\_999.html](http://www.spacedaily.com/reports/Antarctic_fungi_survive_Martian_conditions_on_the_International_Space_Station_999.html) [www.space.com/31772-fungi-survive-mars-conditions-space-station.html](http://www.space.com/31772-fungi-survive-mars-conditions-space-station.html)

29 January, 2016 – The McMurdo Dry Valleys in Antarctica, are considered to be the most similar earthly equivalent to Mars. They make up one of the driest and most hostile environments on our planet, where strong winds scour away even snow and ice. Only so-called cryptoendolithic microorganisms, capable of surviving in cracks in rocks, and certain lichens can withstand such harsh climatological conditions.



<http://www.eurekalert.org/multimedia/pub/107710.php>

Section of rock colonized by cryptoendolithic microorganisms and the *Cryomyces* fungi in quartz crystals under an electron microscope.

European scientists gathered tiny fungi that take shelter in Antarctic rocks and sent them to the International Space Station. After 18 months on board in conditions similar to those on Mars, more than 60% of their cells remained intact, with stable DNA. The results provide new information for the search for life on the red planet. Lichens from the Sierra de Gredos (Spain) and the Alps (Austria) also travelled into space for the same experiment. ##

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## The ExoMars 2016 Schiaparelli module unwrapped in Baikonur

[www.esa.int/spaceinimages/Images/2016/01/The\\_ExoMars\\_2016\\_Schiaparelli\\_module\\_in\\_Baikonur](http://www.esa.int/spaceinimages/Images/2016/01/The_ExoMars_2016_Schiaparelli_module_in_Baikonur)

5 January, 2015 – On 14 March, the launch window opens for ExoMars 2016, ESA's next mission to Mars, composed of the **Trace Gas Orbiter** and **Schiaparelli**.

In December the two spacecraft left Thales Alenia Space in Cannes, France, where they had been for the final few months of assembly and testing, and headed towards the Baikonur cosmodrome in Kazakhstan.

With both now in Baikonur, preparations are under way for the launch on a Russian Proton rocket during a window that remains open until 25 March.



The 600 kg Schiaparelli – pictured here being unpacked in a cleanroom in the cosmodrome – will ride to Mars on the Trace Gas Orbiter. Three days before they reach the Red Planet, Schiaparelli will separate from the orbiter, which will then enter orbit for a five-year mission of studying atmospheric gases potentially linked to present-day biological or geological activity.

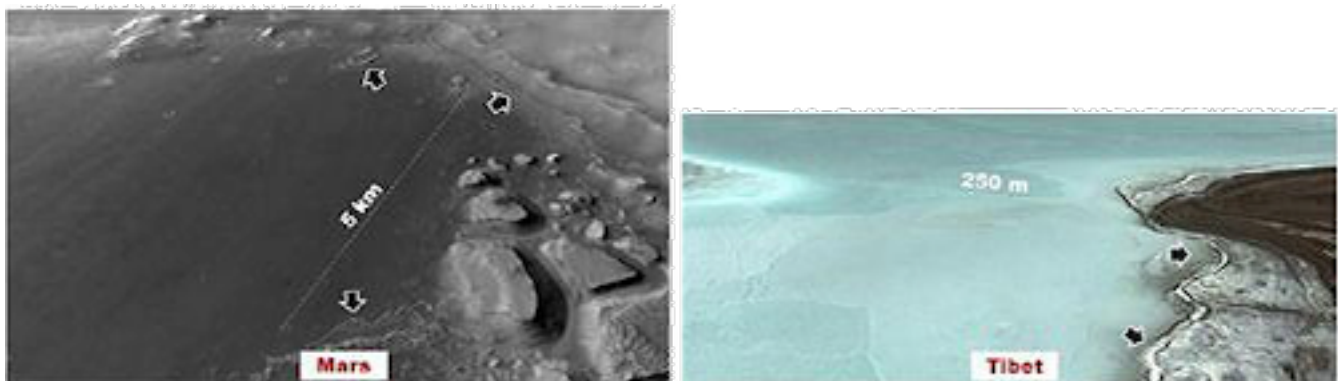
Schiaparelli will enter the atmosphere at 21 000 km/h and slow by aerobraking in the upper layers, then deploying a parachute, followed by liquid-propellant thrusters that will brake it to less than 5 km/h about 2 m above the surface. At that moment, the thrusters will be switched off and it will drop to the ground, where the impact will be cushioned by its crushable structure in a region known as Meridiani Planum. ##

## Site of Martian lakes linked to ancient habitable environment

[www.marsdaily.com/reports/Site\\_of\\_Martian\\_lakes\\_linked\\_to\\_ancient\\_habitable\\_environment\\_999.html](http://www.marsdaily.com/reports/Site_of_Martian_lakes_linked_to_ancient_habitable_environment_999.html)

10 February, 2016 – "Groundwater Flow Induced Collapse and Flooding in Noctis Labyrinthus, Mars"

Groundwater circulation beneath a massive tectonic rift zone located along the flanks of some of the solar system's largest volcanic plateaus resulted in the formation more than 3 billion years ago of some of the deepest basins on Mars. These basins could have been episodically covered, perhaps during hundreds of millions of years, by lava and water lakes discharged from subsurface pressurized sources.



**IMAGE:** Perspective views of (left) the floor of a basin on **Mars** where shallow lakes could have formed within the last few tens of millions of years, and (right) the floor of a proposed Martian analog high mountain lake in the **Tibetan** plateau, where a field investigation is set for this coming summer.

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

The arrows in both panels identify similar ridges that surround the basin's floor. In the Tibetan lake case, the ridges are thought to form as sediments are pushed outwards by the freezing waters. These types of ridges might be diagnostic shoreline feature of lakes that formed under extremely cold and dry Martian conditions. A key objective of the planned field expedition is to investigate these bizarre shoreline features and characterize their astrobiological potential. For a larger version of this image please go to <http://www.psi.edu/news/alexisimage>.

## Follow the Salt: Search for Mars Life May Focus on Driest Regions

[www.space.com/31936-mars-life-search-salty-dry-regions.html](http://www.space.com/31936-mars-life-search-salty-dry-regions.html)

If life ever existed on Mars, its last outposts near the Red Planet's surface might have been in very salty environments, new [research](#) shows. This premise might help guide where future rovers land to look for signs of past or present Mars.

The idea that Mars may have once hosted life is rooted in plentiful evidence suggesting that rivers, lakes and seas covered the Red Planet billions of years ago. Because there is life virtually everywhere there is liquid water on Earth, some researchers have suggested that life might have evolved on Mars when it was wet, and that life could perhaps survive on the planet even now. ##

## Video: ESA 2016 Launch of EXO-Mars to Mars

[www.esa.int/spaceinvideos/Videos/2016/02/ExoMars\\_2016\\_launch\\_to\\_Mars](http://www.esa.int/spaceinvideos/Videos/2016/02/ExoMars_2016_launch_to_Mars)

[www.space.com/32250-exomars-mars-mission-science.html](http://www.space.com/32250-exomars-mars-mission-science.html)

[www.space.com/32254-exomars-mars-mission-launches-orbiter-lander.html](http://www.space.com/32254-exomars-mars-mission-launches-orbiter-lander.html)

[www.marsdaily.com/reports/Rocket\\_blasts\\_off\\_on\\_Russia-Europe\\_mission\\_seeking\\_life\\_on\\_Mars\\_999.html](http://www.marsdaily.com/reports/Rocket_blasts_off_on_Russia-Europe_mission_seeking_life_on_Mars_999.html)

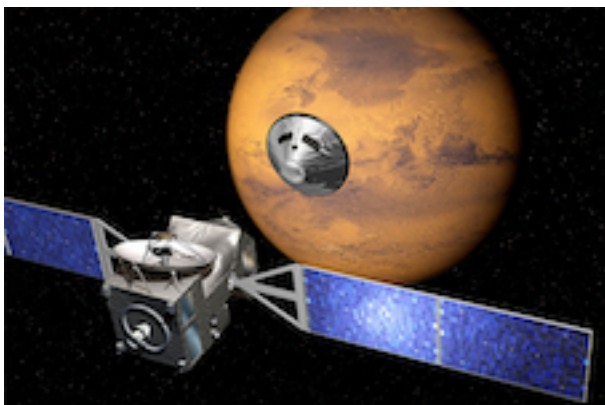
[www.space.com/32205-exomars-mars-orbiter-rover-missions-explained-infographic.html](http://www.space.com/32205-exomars-mars-orbiter-rover-missions-explained-infographic.html)

[www.space.com/32243-exomars-mars-lander-schiaparelli-wild-ride.html](http://www.space.com/32243-exomars-mars-lander-schiaparelli-wild-ride.html)

14 March, 2016 – Two robotic spacecraft began a seven-month journey to the Red Planet today (March 14), blasting off together atop a Russian Proton-M rocket from Baikonur Cosmodrome in Kazakhstan.

The spacecraft — the **Trace Gas Orbiter (TGO)** and a **lander** called **Schiaparelli** — constitute the first part of the two-phase ExoMars program, a European-Russian project to hunt for signs of life on the Red Planet. The second phase will launch a deep-drilling rover in 2018, if current schedules hold.

If all goes according to plan, TGO and Schiaparelli will separate from each other on October 16, as the duo are approaching Mars. Its chief task is to hunt for methane and its degradation products in Mars' air. The vast majority of methane in Earth's atmosphere is produced by microbes and other living organisms, so the gas is viewed as a possible sign of Mars. ##



<http://exploration.esa.int/mars/57517-exomars-2016-spacecraft-encapsulated-within-launcher-fairing/>  
[www.marsdaily.com/reports/ExoMars\\_2016\\_The\\_heat\\_is\\_on\\_999.html](http://www.marsdaily.com/reports/ExoMars_2016_The_heat_is_on_999.html)

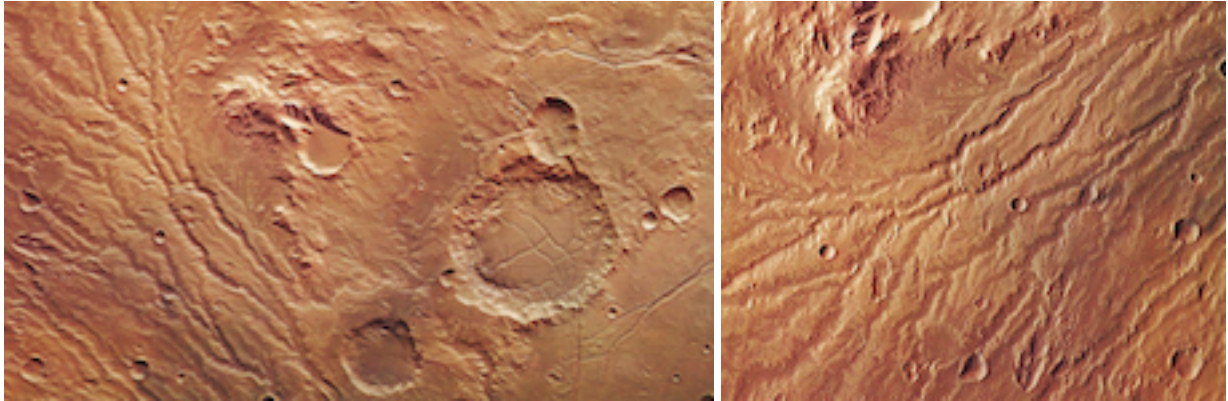
## How the ExoMars mission could sniff out life on Mars

[www.marsdaily.com/reports/How\\_the\\_ExoMars\\_mission\\_could\\_sniff\\_out\\_life\\_on\\_Mars\\_999.html](http://www.marsdaily.com/reports/How_the_ExoMars_mission_could_sniff_out_life_on_Mars_999.html)

16 March, 2016 – Scientists believe that some kind of past or present microbial lifeform on Mars could have produced the methane recently confirmed in Mars' atmosphere. But it could also be caused by cosmic dust or geological processes. A special mission, Exo-Mars, is on its way there to find out. ##

## Footprints of a Martian Flood

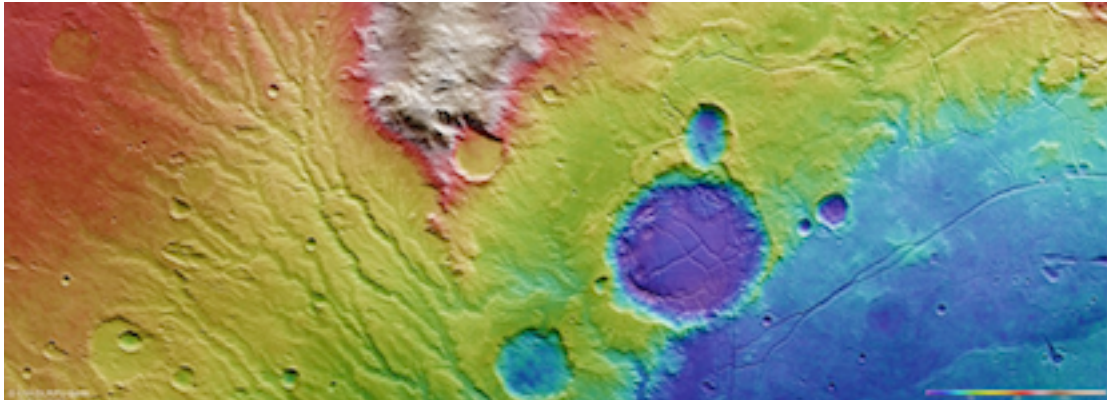
18 February, 2016 – [www.esa.int/Our\\_Activities/Space\\_Science/Mars\\_Express/Footprints\\_of\\_a\\_martian\\_flood](http://www.esa.int/Our_Activities/Space_Science/Mars_Express/Footprints_of_a_martian_flood)



The region lies on the western rim of an ancient large impact basin, as seen in the context map. The image shows the western part of the Arda Valles, a dendritic drainage system 260 km north of Holden Crater and close to Ladon Valles.

Vast volumes of water once flowed from the southern highlands, carving Ladon Valles and ponding in the large Ladon Basin seen in the image below.

The plan views show the striking dendritic drainage pattern of the valleys (left). Many contributing streams merge into tributaries of the main channels before flowing down into the smooth-floored impact basin (blue) towards the right.



Arda Valles topography – orange is high elevation, blue lowest, showing direction of flow. ##

## Jarosite found in the Noctis Labyrinthus Region of Mars

[www.marsdaily.com/reports/Jarosite\\_in\\_the\\_Noctis\\_Labyrinthus\\_Region\\_of\\_Mars\\_999.html](http://www.marsdaily.com/reports/Jarosite_in_the_Noctis_Labyrinthus_Region_of_Mars_999.html)

[https://en.wikipedia.org/wiki/Noctis\\_Labyrinthus](https://en.wikipedia.org/wiki/Noctis_Labyrinthus)

22 February, 2016 – Along the pit's upper wall is a light-toned layered deposit. Spectra extracted from that deposit by the spacecraft's Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) instrument are consistent with the mineral jarosite, which is a **potassium and iron hydrous sulfate**.

On Earth, jarosite can form in ore deposits or from alteration near volcanic vents, and indicates an oxidizing and acidic environment. The jarosite-bearing deposit observed here could indicate acidic aqueous conditions within a volcanic system in Noctis Labyrinthus. ##

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**Left:** the western side of an elongated pit depression in the eastern Noctis Labyrinthus region of Mars.

**Right:** Noctus Labyrinthus lies between Mons Pavonis and the Western end of Valles Marineris

## NASA Tests Life-Detection Drill in Earth's Driest Place

[www.spacedaily.com/reports/NASA\\_Tests\\_Life\\_Detection\\_Drill\\_in\\_Earths\\_Driest\\_Place\\_999.html](http://www.spacedaily.com/reports/NASA_Tests_Life_Detection_Drill_in_Earths_Driest_Place_999.html)

28 February, 2016 – In a harsh environment with very little water and intense ultraviolet radiation, most life **in the extreme Atacama Desert in Northern Chile** exists as microbial colonies underground or inside rocks. Researchers at NASA hypothesize that the same may be true if life exists on Mars.

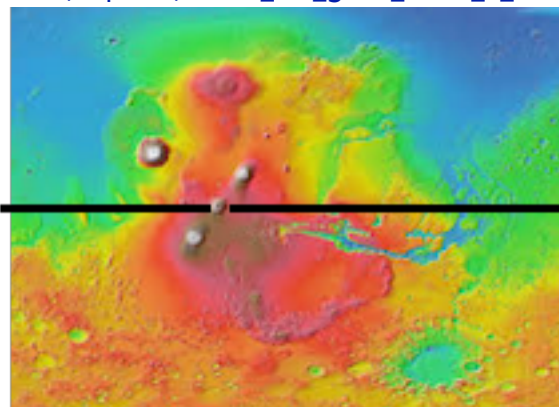


Carefully examining ground obtained from the 2.2 meter depth science excavation pit

## Monster volcano gave Mars extreme makeover

[www.marsdaily.com/reports/Monster\\_volcano\\_gave\\_Mars\\_extreme\\_makeover\\_study\\_999.html](http://www.marsdaily.com/reports/Monster_volcano_gave_Mars_extreme_makeover_study_999.html)

[www.marsdaily.com/reports/Great\\_tilt\\_gave\\_Mars\\_a\\_new\\_face\\_999.html](http://www.marsdaily.com/reports/Great_tilt_gave_Mars_a_new_face_999.html)



Above: The Tharsis Plateau: Pavonis Mons is on the equator  
Olympus Mons is to the NW.

**2 March, 2016** – A volcano on Mars half the size of France spewed so much lava 3.5 billion years ago that the weight displaced the Red Planet's outer layers. **Mars' original north and south poles, in other words, are no longer where they once were.**

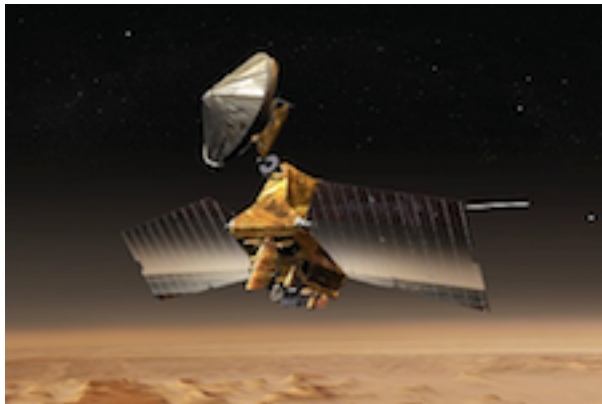
The findings explain the unexpected location of dry river beds and underground reservoirs of water ice, as well as other Martian mysteries that have long perplexed scientists. The volcanic upheaval, which lasted a couple of hundred million years, tilted the surface of Mars 20–25° and created the Tharsis dome plateau more than 5,000 km<sup>2</sup> (2,000 sq mi) wide and 12 km (7.5 mi) thick. A theoretical study showed that if the Tharsis dome were removed from Mars, the planet would shift on its axis.

Scientists couldn't figure out why the dry riverbeds we see today -- are where they are. But if we take into account the shift in the surface, they all line up on the same tropical band. Likewise the huge underground reservoirs of frozen water ice that should be closer to the poles, were once upon a time.

The new theory also explains why the Tharsis dome is situated on the "new" equator, exactly where it would need to be for the planet to regain its equilibrium. ##

## Indian Scientists get a peek into the Martian Exosphere

[www.bangaloremirror.com/bangalore/others/Scientists-get-a-peekinto-Martian-exosphere/articleshow/51271897.cms](http://www.bangaloremirror.com/bangalore/others/Scientists-get-a-peekinto-Martian-exosphere/articleshow/51271897.cms) - [https://en.wikipedia.org/wiki/Mars\\_Orbiter\\_Mission](https://en.wikipedia.org/wiki/Mars_Orbiter_Mission)



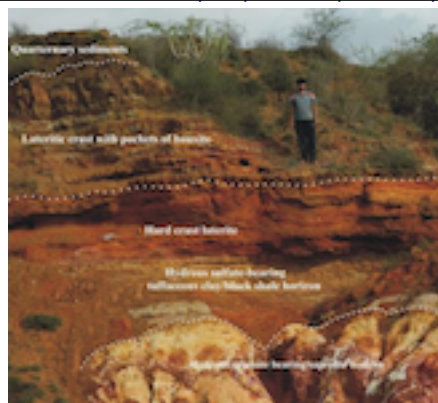
**6 March, 2016** – Years of hard work by Indian space scientists is beginning to yield results. Data from India's first interplanetary mission to planet Mars — the Mars Orbiter Mission (MOM) "**Mangalyaan**" — shows that around dusk time in the Martian exosphere (a thin, atmosphere-like layer surrounding a planetary body), **the density of carbon dioxide and atomic oxygen show "remarkable variability"**

The probe was launched on 5 November 2013 by the Indian Space Research Organization (ISRO)

These observations are significant in understanding what is physically happening in the Martian exosphere. The findings — the first significant ones since MOM was launched — will now be fed into models of how the atmosphere really behaves in the 'dusk sector' (evening) vis-a-vis the noon sector. Prior to this, no observations were available for this period. ##

## Indian Scientists find geological clone of Mars in Gujarat state, India

28 March, 2016 – [www.natureasia.com/en/nindia/article/10.1038/nindia.2016.44](http://www.natureasia.com/en/nindia/article/10.1038/nindia.2016.44)



Researchers report that Matanumadh, situated around 86 km (55 mi) northwest of Bhuj, is actually a terrestrial clone of Mars. In other words, experiments to understand the geology of the Martian surface can be conducted in this "analog locality" in India instead of sending robots to the red planet. ##

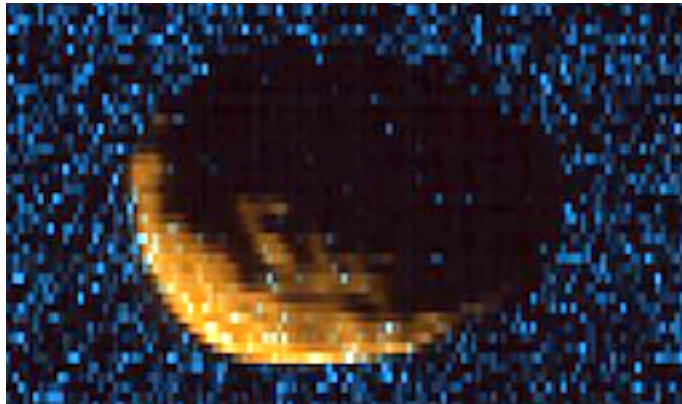
## MARS' MOONLETS – PHOBOS & DEIMOS

### MAVEN Observes Mars Moon Phobos in the Mid- and Far-Ultraviolet

[www.marsdaily.com/reports/MAVEN\\_Observes\\_Mars\\_Moon\\_Phobos\\_in\\_the\\_Mid\\_and\\_Far\\_Ultraviolet\\_999.html](http://www.marsdaily.com/reports/MAVEN_Observes_Mars_Moon_Phobos_in_the_Mid_and_Far_Ultraviolet_999.html)

1 March, 2016 – NASA scientists are closer to solving the mystery of how Phobos formed. In late November and early December 2015, NASA's Mars Atmosphere and Volatile Evolution (MAVEN) mission made a series of close approaches to tPhobos, collecting data from within 500 km (300 mi) of the moon.

Included were spectral images of Phobos in the ultraviolet which will allow MAVEN scientists to better assess the composition of this enigmatic object, whose origin is unknown.



Phobos as observed by MAVEN's Imaging Ultraviolet Spectrograph. **Orange** shows mid-ultraviolet (MUV) sunlight reflected from the surface of Phobos, exposing the moon's irregular shape and many craters. **Blue** shows far ultraviolet light detected at 121.6 nm, which is scattered off of hydrogen gas in the extended upper atmosphere of Mars.

Comparing MAVEN's images and spectra of the surface of Phobos to similar data from asteroids and meteorites will help planetary scientists understand the moon's origin – whether it is a captured asteroid or was formed in orbit around Mars.

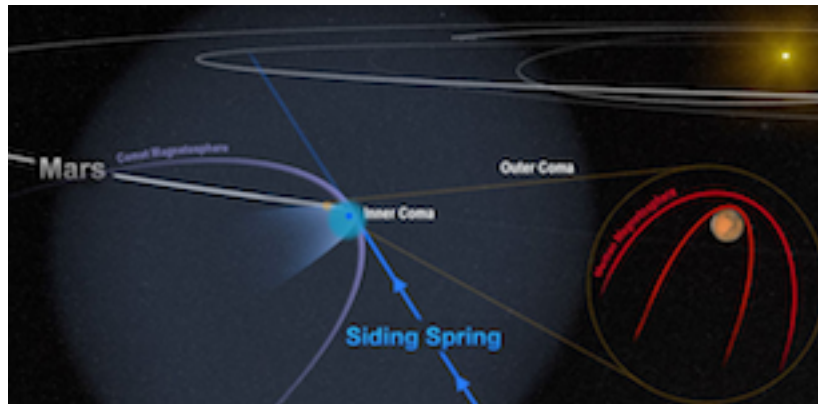
The MAVEN data should also help scientists look for organic molecules on the surface. Evidence for such molecules has been reported by previous measurements from the ultraviolet spectrograph on the Mars Express spacecraft. ##

**Editor:** a lot is at stake. If Phobos (and//or Deimos) turn out to be captured carbonaceous chondrite asteroids, rich in carbon and nitrogen, these two moonlets could become major suppliers of these elements (shipped as liquid methane (CH<sub>4</sub>) and ammonia (NH<sub>3</sub>) to the Moon where these elements are very scarce.

If this is not the case, Phobos and Deimos could compete with the Moon in supplying building materials to GeoSynchronous orbit around Earth. In either case, Phobos and Deimos should prove an economic asset in developing Mars as a human frontier.##

## Chaotic Comet Flyby Blew Away Some of Mars' Atmosphere

16 March, 2016 – [www.space.com/32281-comet-flyby-mars-magnetic-field.html](http://www.space.com/32281-comet-flyby-mars-magnetic-field.html)



The magnetic fields of Mars and Comet Siding Springs merged during the comet's October 2014 flyby, with Mars coming off the worse for it. A stream of invisible charged particles from the comet's coma flooded the planet, with many of the particles reaching or nearly reaching the surface.

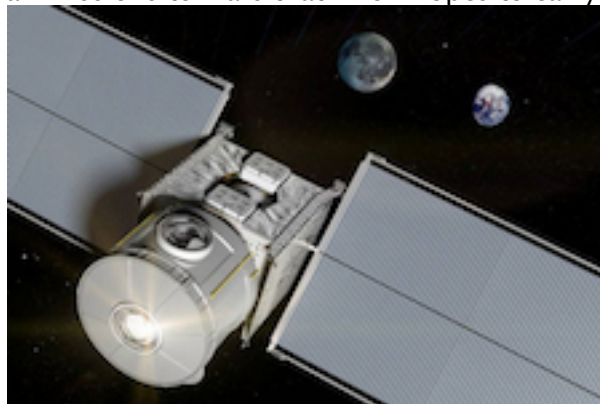
The comet zoomed within 140,000 km (87,000 mi) of the Martian surface. During this highly anticipated flyby, the comet's magnetic field interacted with and overwhelmed the Red Planet's own weak magnetic field, sending a portion of Mars' outer atmosphere into space. ##

## HUMANS TO MARS

### Spending Bill To Accelerate NASA Deep Space Habitation Module Work

30 December, 2015 = [www.space.com/31486-nasa-habitation-module-work-accelerates.html](http://www.space.com/31486-nasa-habitation-module-work-accelerates.html)

“NASA shall develop a **prototype deep space habitation module** within the advanced exploration systems program **no later than 2018**,” This module could be tested in cislunar space in the 2020s, then be used for human missions to Mars that NASA hopes to carry out some time in the 2030s.



Boeing is one of four companies with NASA contracts to study **habitation module concepts**. Funding provided in the 2016 omnibus spending bill could accelerate that work. ##

### Russia's “Monkeys-to-Mars” Mission Draws PETA Protest

1 January, 2016 – [www.space.com/31350-russian-monkeys-mars-mission-peta-protest.html](http://www.space.com/31350-russian-monkeys-mars-mission-peta-protest.html)

A few months ago, it was reported that researchers from the Russian Academy of Science were busy training **four macaque monkeys** to make a long-distance trek to the Red Planet. Educating the animals includes **joystick training** and tapping into the cognitive thinking and learning skills of the animals. Those opposed to this use of primates suggest high tech robotics instead. ##

**Editor:** I love animals, and I'd sign up in a heartbeat to go along with them, even if return to Earth was not an option. Dying without having been helpful is far far worse, and is the fate of too many humans.

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

## Zinnias from space – Gardening for Morale

20 January, 2016 – [www.spacedaily.com/reports/Zinnias\\_from\\_space\\_999.html](http://www.spacedaily.com/reports/Zinnias_from_space_999.html)

“One of the most triumphant moments in the book and recent movie **The Martian** comes when lead character, Mark Watney, successfully grows a potato crop on Mars. It's more than food for survival; he's also nourishing his spirit. In space, there is no scent of baking bread, no wind on your face, no sound of raindrops hitting the roof, no favorite kitten to curl up in your lap.”

“Over time, being deprived of these common earthbound sense stimulations takes a toll. Having limited access to stimuli to the senses is identified as a significant risk by NASA's Behavioral Health and Performance team.” (The story is about growing Zinnias on the International Space Station.)

## Getting real – on Mars

28 January, 2016 – [www.marsdaily.com/reports/Getting\\_real\\_on\\_Mars\\_999.html](http://www.marsdaily.com/reports/Getting_real_on_Mars_999.html)

NASA wants you to know that it's only a matter of months before you can wake up in a Martian habitat, grab some breakfast, jump into your spacesuit, and head out for a stroll across the Red Planet's surface. Granted, **the experience will be virtual**, but it promises be the most realistic vision of human Mars habitation that a team comprising NASA engineers, a digital media developer, and MIT Department of Aeronautics and Astronautics doctoral candidate Sydney Do can generate.

"Mars 2030" is a multiplatform virtual reality (VR) product that features a Mars surface expedition based on actual NASA concepts. To create as authentic an experience as possible, VR developer FUSION partnered with NASA in creating the narrative, user interface, and 3-D assets.



An grad student peers from the front window of NASA's drivable Mars rover prototype at the Johnson Space Center in Houston. ##

## 4 people to live in an HERA habitat for 30 days at JSC

[www.marsdaily.com/reports/4\\_people\\_to\\_live\\_in\\_an\\_HERA\\_habitat\\_for\\_30\\_days\\_at\\_JSC\\_999.html](http://www.marsdaily.com/reports/4_people_to_live_in_an_HERA_habitat_for_30_days_at_JSC_999.html)

**31 January, 2016** – This 30 day mission will help our researchers learn how isolation and close quarters affect individual and group behavior. This study at our Johnson Space Center prepares us for long duration space missions, like a trip to an asteroid or even to Mars.



The **Human Research Exploration Analog (HERA)** that the crew members will be living in is one compact, science-making house. But unlike in a normal house, these inhabitants won't go outside for 30 days. Their communication with the rest of planet Earth will also be very limited, and they won't have any access to internet. So no checking social media kids!

- + The crew follows a timeline that is similar to one used for the ISS crew.
- + They work 16 hours a day, Monday through Friday, including daily planning, conferences, meals and exercises.
- + They will grow and taking care of plants and brine shrimp, which they will analyze and document. ##

## Russia Plans Nuclear Engine for Deep Space Exploration

<http://marsforthemany.com/news/technology/russia-plans-nuclear-rocket-engine-for-deep-space-exploration/>

<http://www.dailytech.com/Russia+is+Developing+Nuclear+Fission+Spaceship+to+Reach+the+Red+Planet/article16662.htm>



**Right:** current project    **LEFT:** Abandoned Soviet Nuclear rocket project of 1960s

18 January, 2016 – Roscosmos, the Russian Federal Space Agency, recently presented its ten-year development plan to the Russian government -- the 2016–2025 Federal Space Program. The plan included the construction of a prototype nuclear rocket engine using a reactor to propel it into deep space. Work on the construction of the atomic engine is ongoing, in accordance with planned timescales.

Nuclear rocket engines are not new. NASA's worked on the concept for over two decades in the 1950's and '60's as part of the NERVA (Nuclear Engine for Rocket Vehicle Application) program.



**Editor; Note,** NASA has also realized the need to shorten the time it takes for Mars-bound crews to make the journey: less time exposed to radiation in space and less time for the body to weaken in weightlessness, and the need for crews to reach Mars in good shape to begin exploration, construction, etc.

To this end, NASA has recently decided to fund development of the **Vasimir engine** (illustration above) which could get crews to Mars in 6 weeks instead of 6 months, i.e. one quarter of the time.

[http://www.huffingtonpost.com/2015/04/06/vasimr-rocket-mars\\_n\\_7009118.html](http://www.huffingtonpost.com/2015/04/06/vasimr-rocket-mars_n_7009118.html)

[https://en.wikipedia.org/wiki/Variable\\_Specific\\_Impulse\\_Magnetoplasma\\_Rocket](https://en.wikipedia.org/wiki/Variable_Specific_Impulse_Magnetoplasma_Rocket) [schematic] ##

## Powerful Laser Could Blast Spacecraft to Mars in 3 Days (Video)

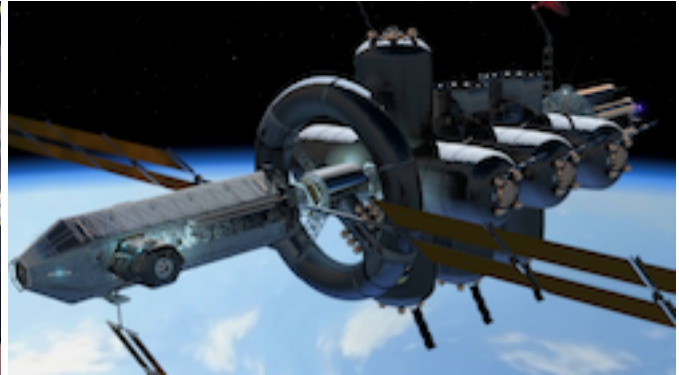
23 February, 2016 – [www.space.com/32026-photon-propulsion-mars-three-days.html](http://www.space.com/32026-photon-propulsion-mars-three-days.html)

“Mars in 3 days? Photonic Propulsion Technology could bridge the Gap”

“Photon propulsion, which would use a powerful laser to accelerate spacecraft to relativistic speeds. Recent advances which take this from science fiction to science reality.”

## !0 Must Have Technologies for Settling Mars

<http://marsforthemany.com/news/mars/10-must-have-technologies-for-settling-mars/>



1. Reusable Launch Vehicles
2. Commercial Space Station
3. Radiation Protection
4. Closed Loop Life Support
5. Artificial Gravity
6. Earth–Mars Orbital Transfer Station
7. Aerocapture
8. Mars Orbital Station
9. Landers
10. Ascent Vehicles ##

## New Bedrest Venture adds Artificial Gravity

[www.esa.int/Our\\_Activities/Human\\_Spaceflight/Bedrest\\_studies/New\\_bedrest\\_adventure\\_adds\\_artificial\\_gravity](http://www.esa.int/Our_Activities/Human_Spaceflight/Bedrest_studies/New_bedrest_adventure_adds_artificial_gravity)



2 February, 2016 – The human body is made for living on Earth – take away the constant pull of gravity and muscles and bones begin to waste away. Living in space is hard on astronauts and ways must be found to keep them fit and safe. ESA and NASA are planning to confine human subjects to bed for 60 days in 2017 in Cologne, Germany to probe the effects of spaceflight, with periods in a centrifuge to test if artificial gravity can keep them healthy. Bedrest studies offer a way of testing measures to counter some of the negative aspects of living in space. Volunteers are kept in beds with the head end tilted 6° below the horizontal. ##

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

## Mars or the Moon (Where is the money?)

7 February, 2016 – [www.spacedaily.com/reports/Mars\\_or\\_the\\_Moon\\_999.html](http://www.spacedaily.com/reports/Mars_or_the_Moon_999.html)

A panel of space experts has revealed that NASA is capable of developing only one major human spaceflight mission at a time, and must make a tough choice between projected flights to Mars and the moon. The announcement was made during a Congressional hearing.

### Points made:

- A mission to Mars is particularly at risk today because of its expense.
- Astronauts could put their boots on Mars 20 to 40 years in the future at best, adding that it would cost up to \$500 billion. The US allocates only \$9 billion on its human spaceflight program annually, making the realization of the mission unlikely.
- Astronauts could put their boots on Mars 20 to 40 years in the future at best, adding that it would cost up to \$500 billion.
- The US allocates only \$9 billion on its human spaceflight program annually, making the realization of the mission unlikely.”
- Replacing humans with robots, a "much more cost effective" solution. ##

**Editor:** There is a middle ground, developing technologies useful on both worlds.

- NASA should continue to develop faster rockets, like Vasimir, that would cut trip times to Mars to a fraction, so that the explorers do not arrive too weak to do anything useful.
- Technologies useful in opening the Moon to permanent human occupation will be useful in opening Mars, when that becomes financially doable.
- Developing lunar Thorium-233 as a nuclear fuel could cut travel times to Mars to a fraction.
- Determining if Phobos and/or Deimos have ores that would facilitate opening Mars surface and/or could be mined for products made on the Moon
- In the meantime, there is much to learn about Mars:
  - Where on Mars is sub-surface water available
  - Developing plants that will grow in Mars' atmosphere in higher pressure
  - Learning how to fly on Mars, at low elevations where the pressure is greatest.. ##

## Homesteading in Space: White House Science Office Seeks Sci-Fi Inspiration

[www.space.com/32001-homesteading-space-white-house-science-office-vision.html](http://www.space.com/32001-homesteading-space-white-house-science-office-vision.html)

22 February, 2016 – The White House Office of Science and Technology Policy (OSTP) co-sponsored a look at humanity's future in space under a program called: "Homesteading in Space – Inspiring the Nation through Science Fiction." ##

## First tomatoes, peas harvested from mock Martian farm

[www.spacedaily.com/reports/First\\_tomatoes\\_peas\\_harvested\\_from\\_mock\\_Martian\\_farm\\_999.html](http://www.spacedaily.com/reports/First_tomatoes_peas_harvested_from_mock_Martian_farm_999.html)

8 March, 2016 – Round two of the Martian farming experiment at Wageningen University and Research Centre in the Netherlands has proven more successful than the last.

Researchers announced a bountiful harvest from soil designed to mimic the makeup of Martian soil. Harvested crops included tomatoes, peas, rye, garden rocket, radish and garden cress. Lessons learned during round one allowed for greater success during the second iteration of the experiment.

Trays were used instead of small pots, along with added organic material (fresh cut grass) to the Mars and moon soil simulant.

the Mars soil simulant generated biomass on par with the Earth control soil, and was equally productive when properly prepped and watered.

### On the Moon?

Scientists also tested soil made to simulate lunar soil. Moon soil simulant produced much less biomass and was only able to support spinach. ##

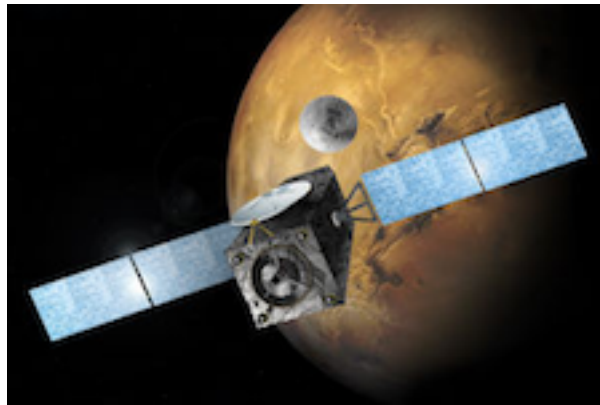
Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)



## With ExoMars, Europe and Russia Aim to Kickstart Mars Exploration

11 March, 2016 - [www.space.com/32231-exomars-europe-russia-mars-exploration.html](http://www.space.com/32231-exomars-europe-russia-mars-exploration.html)

On March 14, a Russian Proton rocket boosted the Europe's Trace Gas Orbiter (TGO) and a small lander named Schiaparelli on a 7-month journey to Mars. TGO will hunt for methane (possible sign of life) from orbit, while Schiaparelli heads to Mars' surface, to test out entry, descent and landing technologies for the second part of the **ExoMars** mission — a life-hunting rover that will lift off in 2018.



Europe's ExoMars Trace Gas Orbiter releasing the Schiaparelli landing demonstrator near Mars.

## Mars Radiation Risk: How Would 'The Martian' Hero Fare?

16 March, 2016 - [www.space.com/32273-the-martian-movie-astronaut-radiation-risk.html](http://www.space.com/32273-the-martian-movie-astronaut-radiation-risk.html)



"The Martian" hero Mark Watney survived all that the Red Planet threw at him, including frigid temperatures, unbreathable air and relatively high radiation levels. This last danger wasn't explicitly addressed in hit 2015 movie or in the best-selling book it was based on, ##

## Robot-Built Landing Pad Could Pave the Way for Construction on Mars

17 March, 2016 - [www.space.com/32293-pisces-robot-builds-launch-landing-pad.html](http://www.space.com/32293-pisces-robot-builds-launch-landing-pad.html)



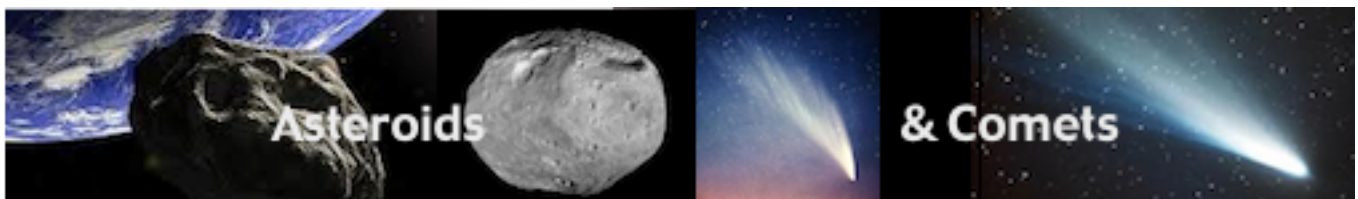
The Helelani rover, pictured above, built a prototype launch-and-landing pad on Hawaii's Big Island in late 2015, putting together 100 pavers made of locally available material in an effort to prove out technology that could do similar work in space. in the PISCES project [The Pacific Islands Schools, Connectivity, Education, and Solar] ##

## Viva 'Mars World': Las Vegas May Get Red Planet Experience

28 March, 2016 – [www.space.com/32390-mars-world-las-vegas.html](http://www.space.com/32390-mars-world-las-vegas.html)



A consortium that includes a renowned space designer wants to build an immersive experience called "Mars World" near the famed Las Vegas Strip by 2021 on yet-to-be purchased land somewhere between the I-15 freeway and Las Vegas Boulevard. ##tts



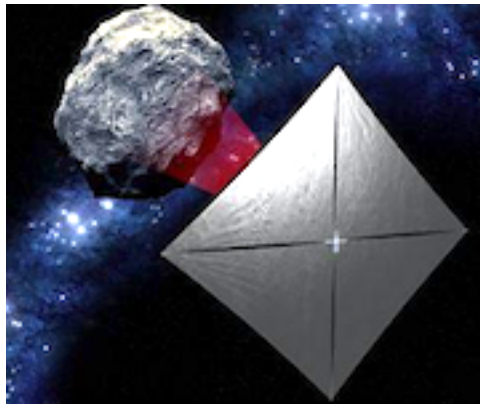
### ASTEROID SCIENCE

## NASA tests solar sail deployment for asteroid-surveying CubeSat NEA Scout

[www.spacedaily.com/reports/NASA\\_Tests\\_Solar\\_Sail\\_Deployment\\_for\\_Asteroid\\_Surveying\\_CubeSat\\_NEA\\_Scout\\_999.html](http://www.spacedaily.com/reports/NASA_Tests_Solar_Sail_Deployment_for_Asteroid_Surveying_CubeSat_NEA_Scout_999.html)

3 February, 2016 – The CubeSat Sail will perform a reconnaissance flyby of an asteroid with Near-Earth Asteroid Scout, or NEA Scout which will launch as a secondary payload on the inaugural flight of NASA's Space Launch System (SLS), scheduled to launch in 2018.

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)



NEA Scout's flight solar sail will be 86 square meters, approximately the length of a full-size school bus. Engineers at NASA's Marshall Space Flight Center in Huntsville, Alabama, recently conducted a series of tests with a sail roughly half that size – 36 square meters to verify the folding and deployment of the sail in deep space.

NEA Scout's second mission objective will be to develop and verify a low-cost reconnaissance platform capable of carrying a wide range of research spacecraft to many destinations using a solar sail to harness solar pressure to propel the spacecraft. ##

### Puzzling asteroid observation clues & destruction of asteroids close to Sun

[www.spacedaily.com/reports/Puzzling\\_asteroid\\_observations\\_explained\\_by\\_destruction\\_of\\_asteroids\\_close\\_to\\_Sun\\_999.html](http://www.spacedaily.com/reports/Puzzling_asteroid_observations_explained_by_destruction_of_asteroids_close_to_Sun_999.html)

18 February, 2016 – An international team from **Finland, France, the United States** and the **Czech Republic** set out to construct a state-of-the-art model of the NEO population that is needed for planning future asteroid surveys and spacecraft missions. The model describes the NEOs' orbit distribution and estimates the number of NEOs of different sizes.

The vast majority of NEOs originate in the doughnut-shaped main asteroid belt between the orbits of Mars and Jupiter. **The orbit of a main-belt asteroid slowly changes as it is pushed by the uneven release of excess solar heat from the asteroid's surface.** The asteroid's orbit eventually interacts with the orbital motions of Jupiter and Saturn changing the trajectory to bring the asteroid close to the Earth. **An asteroid is classified as an NEO when its smallest distance from the Sun during an orbit is less than 1.3 times the average Earth-Sun distance.**



✓ The actual mechanism causing asteroids to disrupt is still unknown but some obvious scenarios such as tidal forces caused by the Sun and direct sublimation of silicates have been ruled out. ✓ One of the remaining scenarios is that volatiles inside the asteroid sublimate at moderate temperatures and create enough pressure to blow up the body. A similar process on a smaller scale called spalling can also break up surface rocks. ##

## Ancient Impacts Mysteriously Erased From Asteroid Vesta

19 February, 2015 – [www.space.com/31978-ancient-impacts-erased-asteroid-vesta.html](http://www.space.com/31978-ancient-impacts-erased-asteroid-vesta.html)

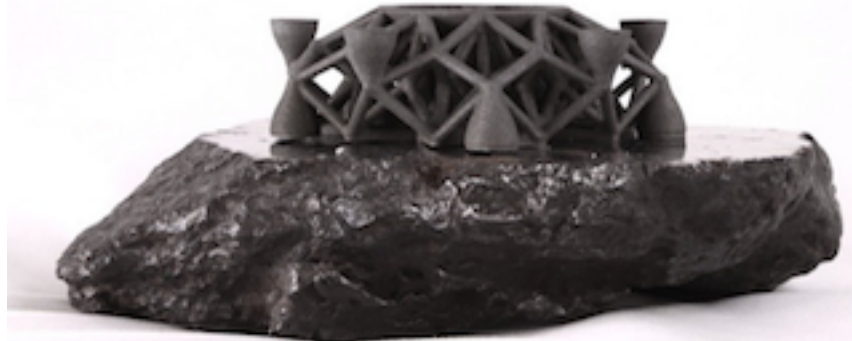
A little less than four billion years ago, as the theory goes, the inner solar system was pummeled by space rocks. It caused craters on the Moon and likely left a few marks on the skin of our own planet, which erased over time due to erosion. Called **the Late Heavy Bombardment** (LHB), a leading theory for why it happened was the outer planets (such as Jupiter and Saturn) adjusting their orbits.

Vesta — an airless, large asteroid that orbits in the belt between Mars and Jupiter — doesn't have much evidence of the LHB. We know this photos taken in 2011–12 from the Dawn Spacecraft which visited Vesta up close. But why? A new simulation suggests that despite its airless surface, there have been enough rocks pummeling the surface in the last four billion years to erase most of the evidence. ##

## ASTEROID MINING

### Asteroid-Mining Company 3D-Prints Object from Space Rock Metals

[www.space.com/31553-asteroid-metal-3d-printing-test-planetary-resources.html](http://www.space.com/31553-asteroid-metal-3d-printing-test-planetary-resources.html)



8 January, 2016 – Planetary Resources, which aims to extract water and other useful materials from asteroids, has 3D-printed an object using metal powder gleaned from a space rock.

It has a design that could originate from a 3D printer in the zero-gravity environment of space “about 2.5 cm (1”) tall by 8.7 cm (3.4”) wide and weighs 250 g (8.8 oz).

The asteroid (meteorite) used for the print materials was sourced from the Campo Del Cielo impact near Argentina, and composed of iron, nickel and cobalt — similar to refinery-grade steel.

## NASA counting on humanoid robots in deep space exploration

[www.spacedaily.com/reports/NASA\\_counting\\_on\\_humanoid\\_robots\\_in\\_deep\\_space\\_exploration\\_999.html](http://www.spacedaily.com/reports/NASA_counting_on_humanoid_robots_in_deep_space_exploration_999.html)

25 January, 2016 – As we continue to explore space, we should prepare for risky and extremely hazardous endeavors such as manned missions to Mars and asteroids. Having fully operational robotic help ready to **assist in every dangerous task** would be of the utmost importance during long-lasting journeys beyond Earth. NASA is seriously considering this subject matter, ushering new humanoid robots, expected to be space pioneers that could offer astronauts a helping hand in future expeditions.”



**Left:** 2.1 m (6 ft) tall humanoid robot “R5”, previously known as Valkyrie. About 130 kg (290 lbs) initially designed to complete disaster-relief maneuvers. **Right:** Other “Humanoid” designs;

**Editor:** *Humans will do what only they can do that cannot be done remotely with long time lags.* ##

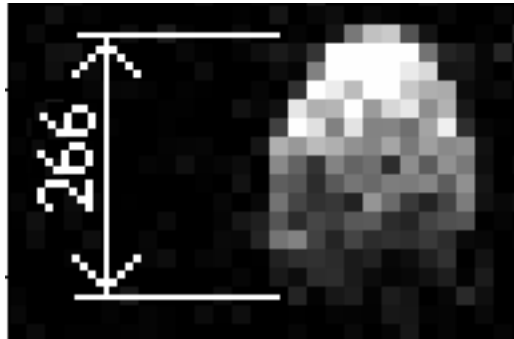
## NASA Invites Public to Send Artwork to an Asteroid

[www.nasa.gov/press-release/nasa-invites-public-to-send-artwork-to-an-asteroid](http://www.nasa.gov/press-release/nasa-invites-public-to-send-artwork-to-an-asteroid)

19 February, 2016 – Enthusiasts are invited to send their artistic endeavors on board NASA’s Origins, Spectral Interpretation, Resource Identification, Security–Regolith Explorer (OSIRIS–REx) spacecraft.

[www.nasa.gov/osiris-rex](http://www.nasa.gov/osiris-rex) = <http://www.asteroidmission.org/WeTheExplorers>

This will be the 1st U.S. mission to collect a sample of an asteroid and return it to Earth for study. OSIRIS–REx is scheduled to launch in September and travel to the asteroid **Bennu**.



Bennu orbits the sun in 436+days and crosses Earth’s orbit

[https://en.wikipedia.org/wiki/101955\\_Bennu](https://en.wikipedia.org/wiki/101955_Bennu) – 101955 Bennu has a mean diameter of approximately 492 m (1,614 ft; 0.306 mi) and has been observed extensively with the Arecibo Observatory Planetary Radar (Puerto Rico) and the Goldstone Deep Space Network (California.)

Bennu is a potential Earth impactor listed on the Sentry Risk Table with the third highest rating on the Palermo Technical Impact Hazard Scale.

[https://en.wikipedia.org/wiki/Sentry\\_\(monitoring\\_system\)](https://en.wikipedia.org/wiki/Sentry_(monitoring_system))

[https://en.wikipedia.org/wiki/Palermo\\_Technical\\_Impact\\_Hazard\\_Scale](https://en.wikipedia.org/wiki/Palermo_Technical_Impact_Hazard_Scale)

The #WeTheExplorers campaign invites the public to take part in this mission by **expressing, through art, how the mission’s spirit of exploration is reflected in their own lives**. Submitted works of art will be saved on a chip on the spacecraft. The spacecraft already carries a chip with more than 442,000 names submitted through the 2014 “Messages to Bennu” campaign.

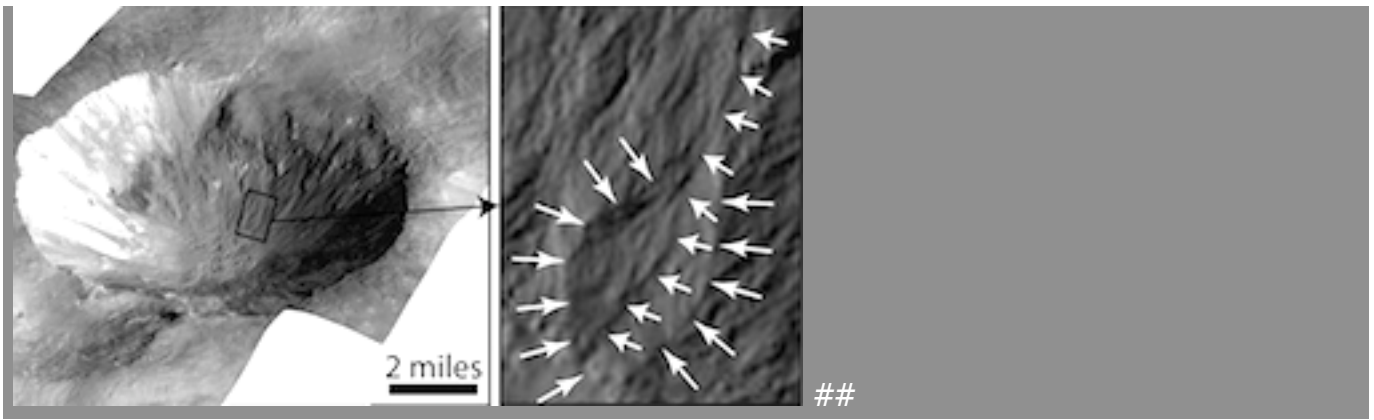
## ASTEROID THREATS

### NASA Opens Planetary Defense Office to Protect Earth from Asteroids

8 January, 2016 – [www.space.com/31551-nasa-planetary-defense-office-launched.html](http://www.space.com/31551-nasa-planetary-defense-office-launched.html)

A major step has been taken to coordinate U.S. agencies and intergovernmental efforts to respond to future near–Earth objects that threaten Earth.

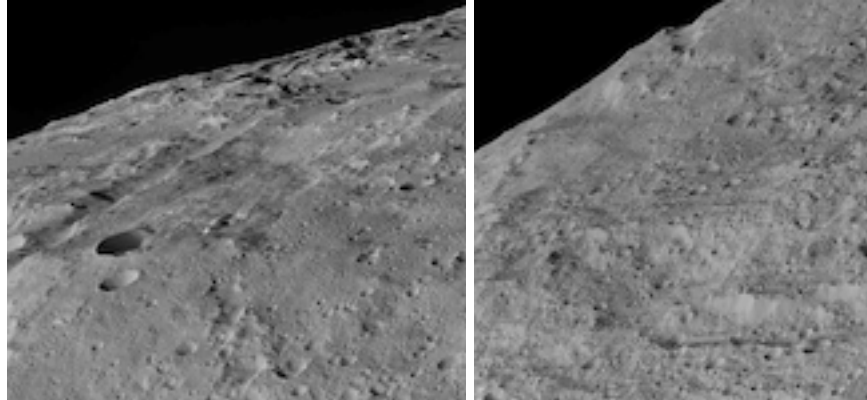
NASA has announced the creation of a Planetary Defense Coordination Office (PDCO) within NASA’s Planetary Science Division, in the agency’s Science Mission Directorate in Washington, D.C. See article on “**Centaurs**” just below in the **COMETS** section



## CERES

## Ceres' Stretched-Out Surface Revealed in New Photos

28 December, 2015 - [www.space.com/31469-dwarf-planet-ceres-stretched-surface-photos.html](http://www.space.com/31469-dwarf-planet-ceres-stretched-surface-photos.html)



The surface of Ceres, taken by NASA's Dawn spacecraft on December 10, shows an area in the southern mid-latitudes, around a crater chain called Gerber Catena.

NASA's Dawn probe took a series of stunning new images of Ceres' chain of craters called **Gerber Catana**, from an altitude of just 385 km (240 mi)- the closest the spacecraft has ever come to Ceres.

Among the major science findings from the close-up view is the discovery that Ceres, despite its diminutive size (only about 590 miles wide, or 950 km), displays internal stresses similar to what you would find on a larger body, such as Mars. Grooves and troughs on the surface of Ceres were mostly created after meteorite impacts, but some are shaped in a way that suggests tectonic forces. ##

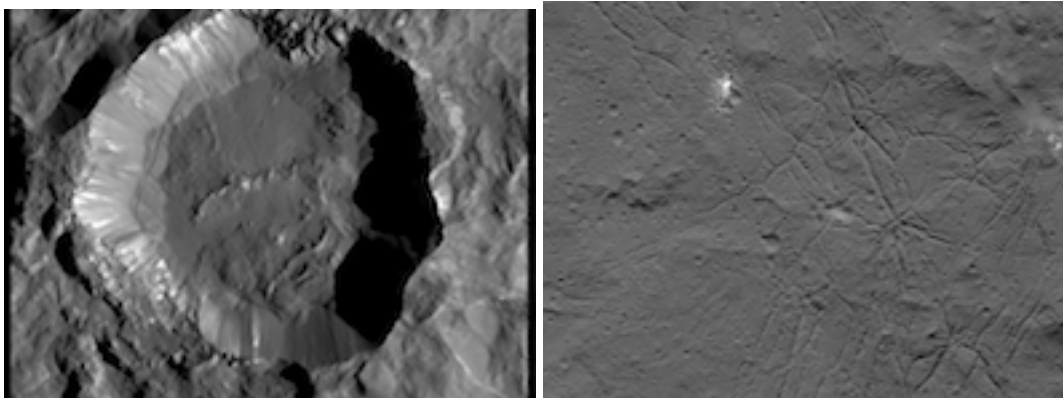
## Take a Cinematic Flyover Tour of Dwarf Planet Ceres (Video)

1 February, 2016 - [www.space.com/31797-flyover-tour-dwarf-planet-ceres-video.html](http://www.space.com/31797-flyover-tour-dwarf-planet-ceres-video.html)

## Craters on Dwarf Planet Ceres Shine in Stunning New Up-Close Photos

13 January, 2016 - [www.space.com/31604-dwarf-planet-ceres-crater-photos-dawn.html](http://www.space.com/31604-dwarf-planet-ceres-crater-photos-dawn.html)

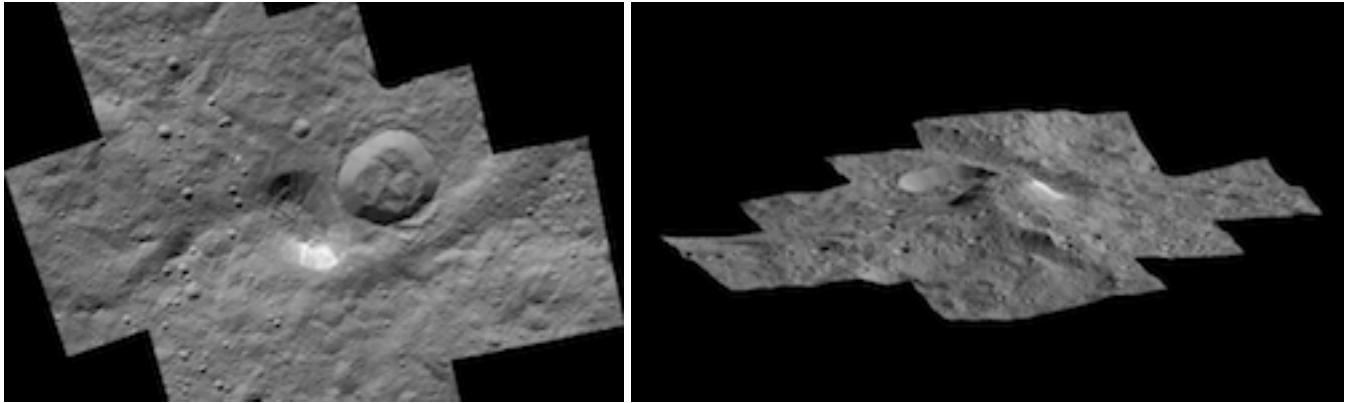
New up-close photos of Ceres show some of the dwarf planet's many craters in sharp and intriguing detail. The images were captured last month by the Dawn spacecraft from a distance of just 385 km (240 mi) — the final and closest of a series of orbits while circling Ceres since March 2015. ##



**Left:** Dawn captured this image of the 26 km (16-m) wide Kupalo Crater on the Ceres Dec. 21, 2015.  
**Right:** The floor of Ceres' Dantu Crater is highlighted in this image, from a distance of 385 km (240 mi).

## One Year at Ceres: NASA Probe Hits Milestone at a Dwarf Planet

7 March, 2016 - [www.space.com/32175-ceres-one-year-anniversary-dawn-spacecraft.html](http://www.space.com/32175-ceres-one-year-anniversary-dawn-spacecraft.html)  
[www.spacedaily.com/reports/Dawns\\_First\\_Year\\_at\\_Ceres\\_A\\_Mountain\\_Emerges\\_999.html](http://www.spacedaily.com/reports/Dawns_First_Year_at_Ceres_A_Mountain_Emerges_999.html)



**L:** Mosaic showing mountain Ahuna Mons on Ceres

**R:** another view of Ahuna Mons

Chief among the mysteries are Ceres' intriguing bright spots, and a 3-mile-high (5 kilometers) mountain known as Ahuna Mons.

Ceres' bright patches lie at the bottom of craters — most famously, a 56-mile-wide (90 km) hole in the ground called Occator.

For a while, mission scientists debated whether these reflective spots are composed of water ice or salts; the current thinking leans heavily towards salts, in particular hydrated magnesium sulfates akin to our Epsom salt. ##

## Are Ceres' Weird Bright Spots Changing? What Ground-Based Telescopes Show

[www.space.com/32282-ceres-bright-spots-changes-ground-telescopes-views.html](http://www.space.com/32282-ceres-bright-spots-changes-ground-telescopes-views.html)

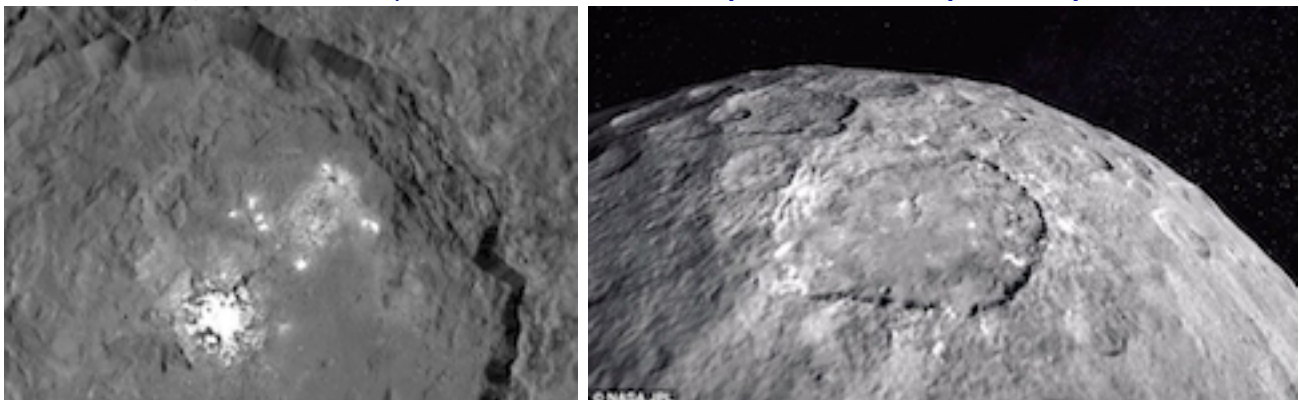
[www.space.com/32275-dwarf-planet-ceres-bright-spots-put-into-motion-video.html](http://www.space.com/32275-dwarf-planet-ceres-bright-spots-put-into-motion-video.html)

**16 March, 2016** - In 2015, NASA's Dawn space probe sent back the first images that directly revealed the presence of mysterious, bright spots on the surface of Ceres.

Now, a group of scientists is using an Earth-based telescope to study the spots on Ceres and other variations on the dwarf planet's surface. Their results seem to support the idea that sunlight may regularly turn ice into vapor in the Occator crater (where the spots are located) ##

## Ceres' Puzzling Bright Spots, Giant Mountain seen in New Close-Up Photos

24 March, 2016 - [www.space.com/32358-dwarf-planet-ceres-mysteries-photos.html](http://www.space.com/32358-dwarf-planet-ceres-mysteries-photos.html)





## COMETS

## Giant Comets – “Centaur” – Periodically Smash Earth

28 December, 2015 – [www.space.com/31466-giant-comets-smash-earth.html](http://www.space.com/31466-giant-comets-smash-earth.html)



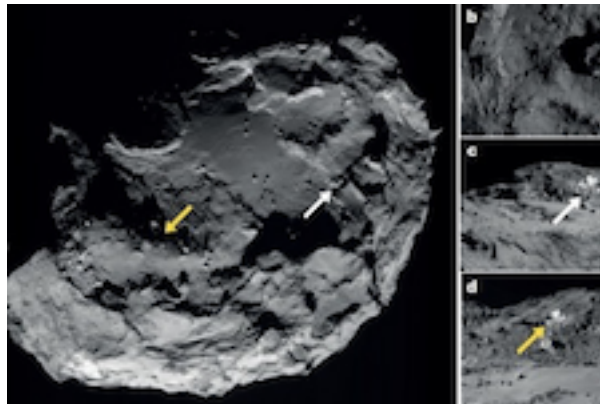
In the last two decades, scientists have discovered hundreds of giant comets (known as “centaurs”) in the region near Jupiter, Saturn, Uranus and Neptune.

**Apparently, these giant comets** that originate in the planetary fringes of the solar system pose a greater threat of colliding with Earth than do smaller bodies in the asteroid belt between the orbits of Mars and Jupiter. ##

## Water ice on Comet Reveals Clues About Its Evolution

13 January, 2016 – [www.space.com/31607-water-ice-comet-rosetta-mission.html](http://www.space.com/31607-water-ice-comet-rosetta-mission.html)

[www.esa.int/Our\\_Activities/Space\\_Science/Rosetta/Exposed\\_ice\\_on\\_Rosetta\\_s\\_comet\\_confirmed\\_as\\_water](http://www.esa.int/Our_Activities/Space_Science/Rosetta/Exposed_ice_on_Rosetta_s_comet_confirmed_as_water)



Images of Comet 67P/Churyumov-Gerasimenko captured by the Rosetta spacecraft's navigation camera showing two patches of exposed water ice (which are seen close up).

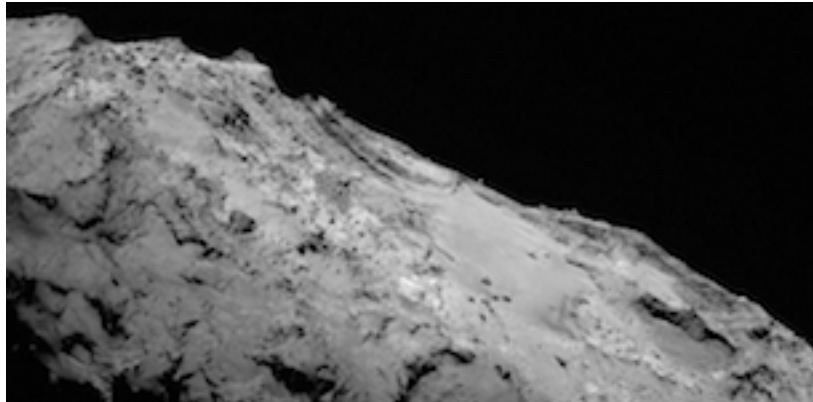
The European Space Agency's Rosetta spacecraft detected relatively large grains of water ice in two different places on the surface of Comdg 67/P/Churyumov-Gersimenko, which the probe has been orbiting since August 2014.

These big grains may have formed after heat from the Sun sublimated (or vaporized) buried water ice, which then recondensed and was redeposited in subsurface layers, never leaving Comet 67P,

Observations of Comet 67P made by Rosetta's Visual and Infrared Thermal Imaging Spectrometer (VIRTIS) instrument. VIRTIS detected surface water ice in two separate, 1 meter (3.3-ft) areas within a region of the comet dubbed Imhotep, ##

## Exploring Imhotep – image of Comet explored by OSIRIS camera

25 January, 2016 – [www.esa.int/spaceinimages/Images/2016/01/Exploring\\_Imhotep](http://www.esa.int/spaceinimages/Images/2016/01/Exploring_Imhotep)  
[https://en.wikipedia.org/wiki/Rosetta\\_\(spacecraft\)](https://en.wikipedia.org/wiki/Rosetta_(spacecraft))



This beautiful landscape feels within arm's reach in this stunning view across the Imhotep region on **Comet 67P/Churyumov-Gerasimenko**. The view was captured by **Rosetta's** OSIRIS narrow-angle camera on 17 January 2016, from a distance of 86.8 km. Measuring 3.2 km across, it captures one of the most geologically diverse areas of the comet.

**Wikipedia:** **Rosetta** is a probe of the European Space Agency launched on 2 March 2004. Along with **Philae**, its lander module, Rosetta is performing a detailed study of comet 67P/Churyumov-Gerasimenko (67P). On 6 August 2014, the spacecraft reached the comet and performed a series of manoeuvres to be captured in its orbit. On 12 November, the lander module performed the first successful landing on a comet. ##

## Rosetta's Philae Comet Lander Faces Eternal Hibernation

[www.esa.int/Our\\_Activities/Space\\_Science/Rosetta/Rosetta\\_s\\_lander\\_faces\\_eternal\\_hibernation](http://www.esa.int/Our_Activities/Space_Science/Rosetta/Rosetta_s_lander_faces_eternal_hibernation)

12 February, 2016 = Silent since its last call to mothership Rosetta seven months ago, the **Philae lander** is facing conditions on **Comet 67P/Churyumov-Gerasimenko** from which it is unlikely to recover.



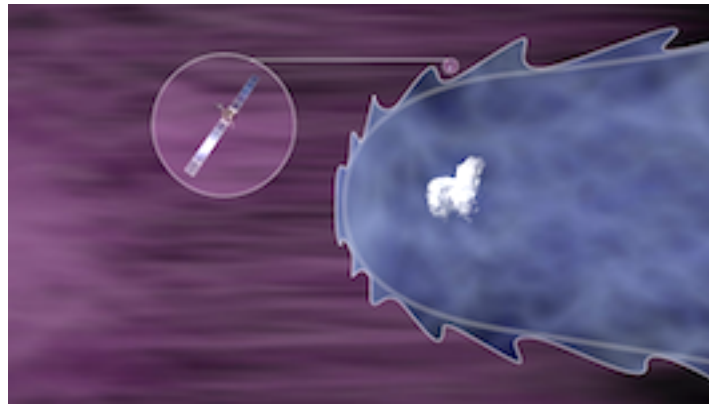
While Rosetta might continue its scientific investigations at the comet until September before its own comet-landing finale, it has, in recent months, been balancing science observations with flying dedicated trajectories optimised to listen out for Philae. But it has remained silent since 9 July 2015. ##

## Rosetta finds magnetic field-free bubble at comet

[www.esa.int/Our\\_Activities/Space\\_Science/Rosetta/Rosetta\\_finds\\_magnetic\\_field-free\\_bubble\\_at\\_comet](http://www.esa.int/Our_Activities/Space_Science/Rosetta/Rosetta_finds_magnetic_field-free_bubble_at_comet)

11 March, 2016 – When ESA's Giotto flew past Comet Halley three decades ago, it found a vast magnetic-free region extending more than 4000 km from the nucleus. This was the first observation of something that scientists had until then only thought about but had never seen. Interplanetary space is pervaded by the solar wind, electrically charged particles streaming from the Sun. carries its magnetic field across the Solar System. A comet pouring lots of gas into space obstructs the solar wind.

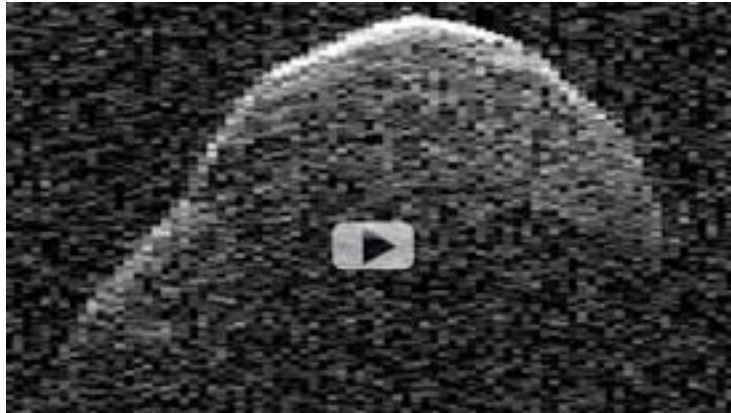
Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)



Magnetic field-free cavity at comet

### Radar Pegs 3rd Closest Comet At 3000ft-Wide | Video

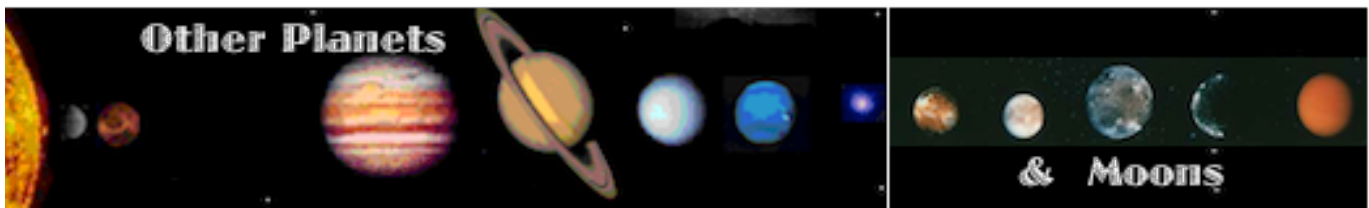
[www.space.com/32382-3rd-closest-comet-fly-by-radar-pinged-and-imaged-video.html](http://www.space.com/32382-3rd-closest-comet-fly-by-radar-pinged-and-imaged-video.html)



NASA's Deep Space Network's Goldstone Solar System Radar in California watched comet P/2016 BA14 for 3 days (March 21–23, 2016). The comet, about 1,000 meters wide, was between 2.5 and 2.2 million mi (4.1 and 3.6 million km) away. The imagery reveals that the comet spins once every 35–40 hours.

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## MERCURY

(News we missed in the last TTSIQ)

### Mercury's Movements Give Scientists Peek Inside the Planet

[www.spacedaily.com/reports/Mercurys\\_Movements\\_Give\\_Scientists\\_Peek\\_Inside\\_the\\_Planet\\_999.html](http://www.spacedaily.com/reports/Mercurys_Movements_Give_Scientists_Peek_Inside_the_Planet_999.html)

10 September, 2016 – The first measurements of Mercury's movements from a spacecraft orbiting the planet reveal new insights about the makeup of the solar system's innermost world and its interactions with other planetary bodies.

Mercury does not rotate on its axis smoothly, like a record, but experiences regular fluctuations in speed over an 88-day “year.” These oscillations, or librations, are caused by the planet's interactions with the Sun as it moves around the star. The Sun's gravitational pull speeds up or slows down Mercury's rotation depending on where the oblong-shaped planet is on its elliptical orbit.

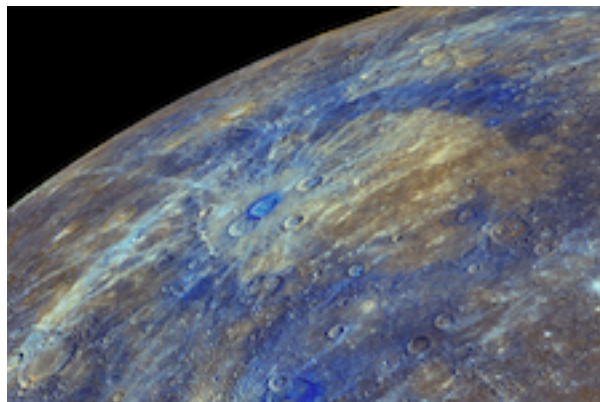
Scientists can use measurements of Mercury's rotation and its librations to infer information about the interior of the planet. The new measurements provide a new way to measure the planet's oscillations, showing that Mercury is spinning on its axis about 9 seconds faster than calculated –not a huge difference, parts per million, but it unexpected.

Mercury rotates three times on its axis for every two revolutions around the Sun, indicating that the Sun is influencing Mercury's spin. But Mercury has a more complex rotational behavior. The difference in rotational speed could come **from Jupiter's large gravity field tugging on Mercury's orbit**, changing the planet's distance to the Sun and the star's influence on its spin.

The authors of the new study propose that Jupiter, which travels around the Sun roughly once every 12 years, has **superimposed a 12-year, long-term libration on top of Mercury's 88-day libration**. This long-term libration could be causing the slight increase in speed observed during the time period of the new study and also cause a slow-down in Mercury's spin at other times. ##

### Mercury's Carbon-Rich Crust is Surprisingly Ancient

8 March, 2016 – [www.space.com/32179-mercury-carbon-rich-crust-surprisingly-ancient.html](http://www.space.com/32179-mercury-carbon-rich-crust-surprisingly-ancient.html)



**Above:** Enhanced color image highlights Mercury's low-reflectance material, which appears blue in this image, and its association with impact-excavated material. The young rayed crater Degas appears near the center, and to the far left is the crater Akutagawa, whose extensive low-reflectance (dark blue) material was studied by MESSENGER and found to be carbon rich.

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

In its final orbits, MESSENGER not only confirmed that Mercury's dark hue is due to carbon, but also revealed that the carbon wasn't deposited by impacting comets, as some researchers suspected.

Instead, scientists now believe they are seeing remnants of the planet's primordial crust, which likely formed when a global ocean of super-heated magma cooled, allowing minerals to solidify. Computer simulations and experiments show that most of these crystallized minerals would sink — with one key exception. Graphite, the studies show, would float. ##

## VENUS

## JUPITER & ITS MOONS

### Lab discovery gives glimpse of conditions found on gas giant planets

[www.spacedaily.com/reports/Lab\\_discovery\\_gives\\_glimpse\\_of\\_conditions\\_found\\_on\\_other\\_planets\\_999.html](http://www.spacedaily.com/reports/Lab_discovery_gives_glimpse_of_conditions_found_on_other_planets_999.html)

7 January, 2016 = Scientists have recreated an elusive metallic form of hydrogen, the material that makes up much of the interiors of **Jupiter** and **Saturn**, and the **Sun** and that exists only at extremely high pressures – more than 3 million times that of Earth's atmosphere. Scientists had tried to confirm this in lab experiments spanning the past four decades, without success.

Scientists found that at pressures equivalent to 3.25 million times that of Earth's atmosphere, hydrogen entered a new solid phase – named phase V – and started to show some interesting and unusual properties. Its molecules began to separate into single atoms, while the atoms' electrons began to behave like those of a metal.##

### Life on Earth Can Thank Its Lucky Stars for Jupiter and Saturn

12 January, 2016 – [www.space.com/31577-earth-life-jupiter-saturn-giant-impacts.html](http://www.space.com/31577-earth-life-jupiter-saturn-giant-impacts.html)

Without Jupiter and Saturn orbiting out past Earth, life may not have been able to gain a foothold on our planet. The two gas giants likely helped stabilize the solar system, protecting Earth and other inner system rocky planets from frequent run-ins with big, fast-moving objects, such as the one in which a sizable early planet dubbed “Theia” collided with the proto-Earth, resulting in the formation of the Moon. If such impacts continued to happen, early Earth (once it had settled down after the Moon-forming event) could have lost its atmosphere and primeval oceans. Without the influence of giant planets, the fragments formed a large, dangerous cloud orbiting close within the system that took much longer to disperse.

First, the researchers took into account the fragmenting that occurs when objects ram into one another, rather than assuming they combine perfectly. And second, they ran hundreds of simulations to see all the possible ways the chaotic formation process could play out. ##

### Ancient Astronomy: Babylonians Used Surprising Math Leap to Track Jupiter

28 January, 2016 – [www.space.com/31765-ancient-babylonians-tracked-jupiter-with-math.html](http://www.space.com/31765-ancient-babylonians-tracked-jupiter-with-math.html)



Text B (BM 34757)

Ancient Babylonian tablets like this 5cm wide sample one show that calculating the distance Jupiter travels in the sky over time can be done by finding the area of a trapezoid, showing the creators understood a concept essential to modern calculus 1500 years earlier than historians have ever seen. ##

## NASA Juno Probe Fine-Tunes Path to Jupiter

4 February, 2016 – [www.space.com/31831-juno-jupiter-spacecraft-engine-burn.html](http://www.space.com/31831-juno-jupiter-spacecraft-engine-burn.html)



NASA's solar-powered Juno probe performed an engine burn Wednesday (Feb. 3), consuming 0.6 kg (1.3 lb) of fuel to change its speed by about 1.1 km/h (0.7 mph). Juno was roughly 82 million km (51 million mi) from Jupiter when it conducted the maneuver. This is the first of two trajectory adjustments that fine-tune Juno's orbit around the Sun, perfecting our rendezvous with Jupiter on July 4.

The \$1.1 billion Juno mission launched in August 2011. Its main goal involves mapping Jupiter's gravitational and magnetic fields in precise detail, to shed light on the gas giant's structure, formation and evolution.

Juno will perform its science work from orbit. The nominal mission plan calls for the 4-ton spacecraft to zip around Jupiter 33 times, coming within just 5,000 km (3,100 mi) of the planet's cloud tops every 14 days,

## New study challenges Jupiter's role as planetary shield, protecting Earth from comet impacts

[www.spacedaily.com/reports/New\\_study\\_challenges\\_Jupiters\\_role\\_as\\_planetary\\_shield\\_protecting\\_Earth\\_from\\_comet\\_impacts\\_999.html](http://www.spacedaily.com/reports/New_study_challenges_Jupiters_role_as_planetary_shield_protecting_Earth_from_comet_impacts_999.html)

5 February, 2016 – “Not only is the “Jupiter as shield” concept, implying that the planet shields Earth from comet impacts, not true, but perhaps Jupiter's most important role in fostering the development of life on Earth was just the opposite – delivering the volatile materials from the outer Solar System needed for life to form.”

## NASA Europa Mission May Not Launch Until Late 2020s

10 February, 2016 – [www.space.com/31887-nasa-europa-mission-launch-late-2020s.html](http://www.space.com/31887-nasa-europa-mission-launch-late-2020s.html)

Last year, the US Congress granted NASA \$175 million to continue developing its Europa mission, which would perform dozens of flybys to gauge the life-hosting potential of the icy moon's huge subsurface ocean.

That allocation required NASA to have the Europa mission ready to launch by 2022.

But NASA's fiscal year 2017 budget request, which was released February 9, 2016, includes just \$49.6 million for the Europa effort — a level that, when combined with predicted funding in the coming years, “supports a Europa mission launch in the late 2020s.

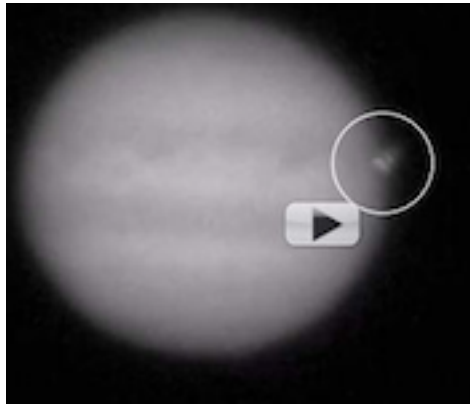
**Editot:** totally unacceptable! The Europa mission's importance trumps almost anything else!

Further, flyby science is not enough. Landers on some of Europa's ruddy cracks in the ice crust could look for organic material, which if found, would indicate life below. ##

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## Jupiter Just Got Hit by a Comet or Asteroid ... Again (Video)

17 March, 2016 - [www.space.com/32411-jupiter-hit-by-comet-asteroid-video.html](http://www.space.com/32411-jupiter-hit-by-comet-asteroid-video.html)



## SATURN & ITS MOONS

### Saturn's Moons and Rings May Be Younger Than the Dinosaurs

25 March, 2016 - [www.space.com/32378-saturn-rings-and-moons-younger-than-dinosaurs.html](http://www.space.com/32378-saturn-rings-and-moons-younger-than-dinosaurs.html)

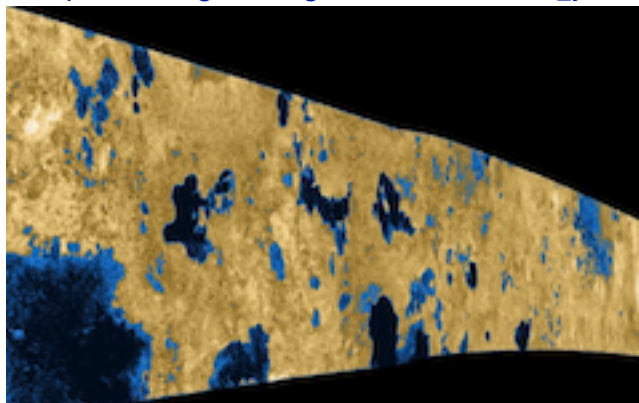
Some of Saturn's icy moons may have been formed after many dinosaurs roamed the Earth. New computer modeling of the Saturnian system suggests the rings and moons may be **no more than 100 million years old**.

Saturn hosts 62 known moons. All of them are influenced not only by the gravity of the planet, but also by each other's gravities.

A new computer model suggests that the Saturnian moons **Tethys**, **Dione** and **Rhea** haven't seen the kinds of changes in their orbital tilts that are typical for moons that have lived in the system and interacted with other moons over long periods of time. In other words, these appear to be very young moons, most likely born during the most recent 2% of the planet's history. ##

### Dark Pools of Liquid Methane on Titan

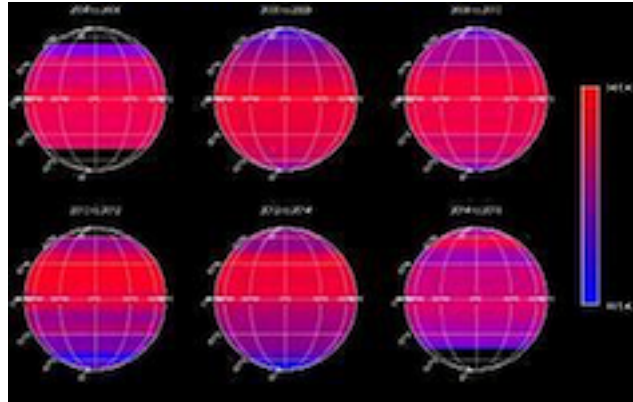
[www.esa.int/spaceinimages/Images/2016/01/Dark\\_pools\\_on\\_Titan](http://www.esa.int/spaceinimages/Images/2016/01/Dark_pools_on_Titan)



This radar image from the Cassini orbiter shows a thin strip of surface on Saturn's moon Titan. The yellow-hued terrain appears to be peppered with blue-tinted lakes and seas, filled with liquid methane. Titan is the only Solar System body other than Earth known to have liquid lakes and seas on its surface.

## Titan Temperature Lag Maps and Animation

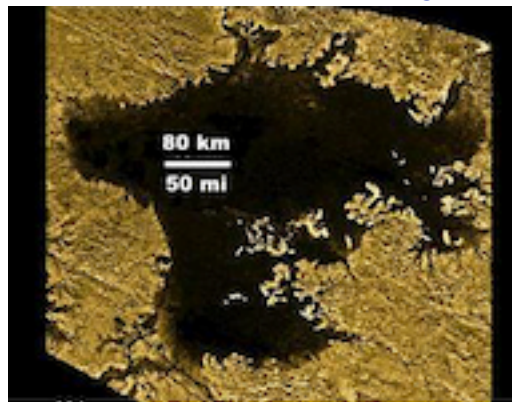
23 February, 2016 [www.spacedaily.com/reports/Titan\\_Temperature\\_Lag\\_Maps\\_and\\_Animation\\_999.html](http://www.spacedaily.com/reports/Titan_Temperature_Lag_Maps_and_Animation_999.html)  
[www.space.com/32044-doctor-cassini-takes-titans-temperature.html](http://www.space.com/32044-doctor-cassini-takes-titans-temperature.html)



This sequence of maps shows varying surface temperatures on Saturn's moon Titan at two-year intervals, from 2004 to 2016. The measurements were made by the Composite Infrared Spectrometer (CIRS) instrument on NASA's Cassini spacecraft.

## New photos show 'magic island' on Titan

[www.spacedaily.com/reports/New\\_photos\\_show\\_magic\\_island\\_on Saturns\\_moon\\_999.html](http://www.spacedaily.com/reports/New_photos_show_magic_island_on_Saturns_moon_999.html)



file photo

3 March, 2016 – New images from the Cassini probe showcase the shifting shape of a geological feature on Titan known informally as "magic island." The brightly colored, pinwheel-shaped island is a transient feature in Titan's Ligeia Mare, a hydrocarbon sea located in the moon's north polar region. Scientists think a series of cresting waves is the most likely explanation. Bubbles or solids on/beneath the surface could also explain the feature, while tides, sea level and seafloor changes are unlikely causes. ##

## How Friendly Is Enceladus' Ocean To Life?

4 February, 2016 – <http://phys.org/news/2016-02-friendly-enceladus-ocean-life.html>

Enceladus is one of the icy moons, including Europa (Jupiter) and Titan (Saturn). These moons receive tidal energy from the gas giants they orbit and contain liquid water.

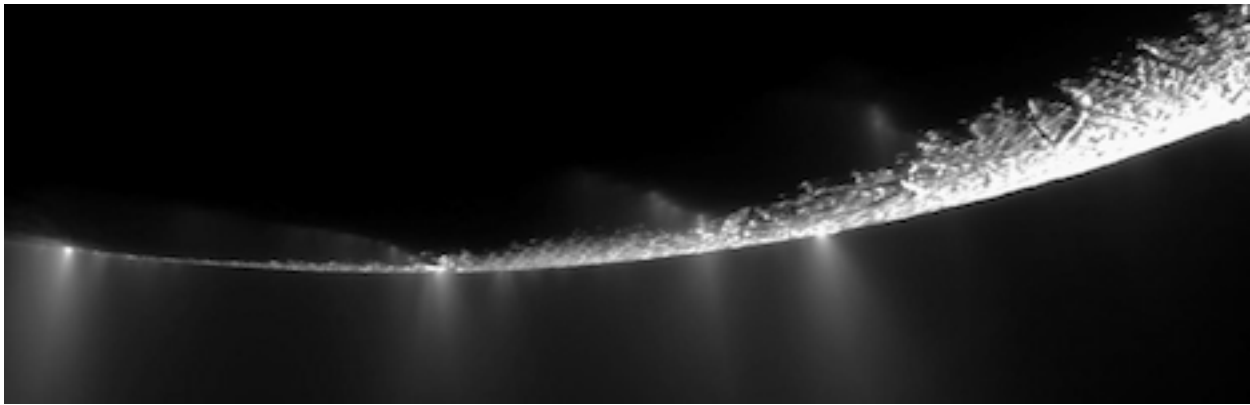
The Cassini probe has been taking regular measurements of geyser-spouting Enceladus for more than a decade to evaluate its environment. How acidic is the ocean under the ice crust of Enceladus? This is a key to understanding if this moon could support life.

On Earth, it's possible for life to exist near the extremes of the pH scale that ranges from 0 (battery acid) to 14 (drain cleaner). Knowing the pH can help us to identify geochemical reactions that affect the habitability of an environment, because many reactions cause predictable changes in pH.

We can't stick a strip of pH paper into the ocean water on Enceladus to measure the pH directly, But we can estimate it from the molecules in its plumes that change form in response to pH changes. ##

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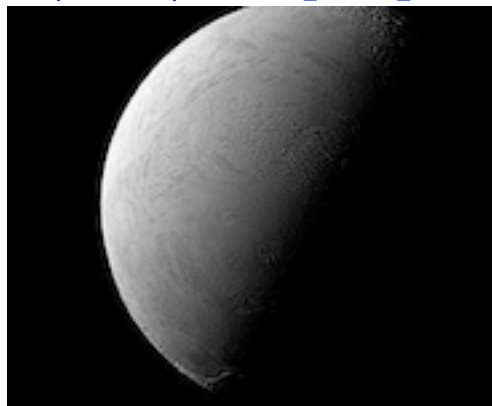




Plumes erupting off the surface of Enceladus, an icy moon of Saturn

## The Tilted Terminator Of Enceladus

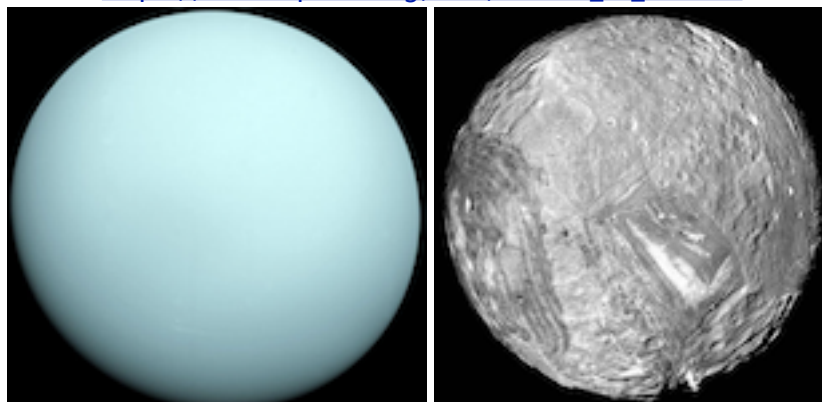
17 March, 2016 - [www.spacedaily.com/reports/The\\_Tilted\\_Terminator\\_Of\\_Enceladus\\_999.html](http://www.spacedaily.com/reports/The_Tilted_Terminator_Of_Enceladus_999.html)



NASA's Cassini spacecraft captured this view of Saturn's moon Enceladus showing wrinkled plains remarkably youthful in appearance, being generally free of large impact craters. ##

## 30 Years After Uranus Flyby, Voyager 2 Sails On

28 January, 2016 = [www.space.com/31761-nasa-voyager-2-uranus-30-years.html](http://www.space.com/31761-nasa-voyager-2-uranus-30-years.html)  
[https://en.wikipedia.org/wiki/Moons\\_of\\_Uranus](https://en.wikipedia.org/wiki/Moons_of_Uranus)



**Uranus Right:** a bluish orb with extremely subtle features. Haze layer hides most cloud features.

**Miranda Left:** Miranda wowed scientists during 1986 encounter with its dramatically fractured landscapes with huge canyons that could be 12 times as deep as Arizona's Grand Canyon.

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)



Uranus (L) and its six largest moons left to right: Puck, **Miranda**, Ariel, Umbriel, Titania, and Oberon. Voyager 2 is the only probe ever to see Uranus up close, but more discoveries about the ice giant — which is about four times wider than Earth — keep coming, thanks to telescope observations.

The Keck II telescope in Hawaii saw weather activity on Uranus ramp up in August 2014, 7 years after its closest approach to the Sun. The reasons for this puzzling delay are still being investigated. ##

## Top 5 Weird facts about Uranus

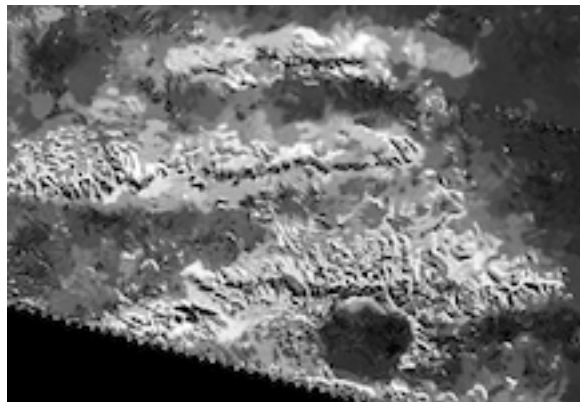
[www.space.com/32272-top-5-weird-facts-about-mysterious-uranus-photos.html](http://www.space.com/32272-top-5-weird-facts-about-mysterious-uranus-photos.html)

15 March, 2016 – To celebrate the 235th anniversary of Uranus' discovery, here are some of the most mind-blowing things discovered about the blue planet. It's only been visited once, by Voyager 2 in 1986, but we also study it from afar with powerful modern telescopes, such as the Hubble Space Telescope. Imagine what discoveries we'll find with the next time we send a probe that far out in the solar system.

1. Something big might have crashed into Uranus in the past, because the planet is rotating on its side. Its magnetic north and south are also way different than its polar north and south. All told, this causes some bizarre seasonal effects. Imagine a world where, for example, the south pole is pointed at the sun while the north pole is shrouded in darkness.
2. When Uranus got to its closest approach to the sun in 2007, there were more storms marring its normally calm surface. The stormy activity actually extended at least as long as 2014.
3. There are now more than a dozen known rings found around the planet.
4. Uranus isn't the farthest planet, but it's the coldest.
5. One of Uranus' moons, Miranda, looks like an abstract painting.

## Tallest Peak on Saturn's Huge Moon Titan Identified (Photo)

25 March, 2016 – [www.space.com/32370-saturn-moon-titan-tallest-mountain-photo.html](http://www.space.com/32370-saturn-moon-titan-tallest-mountain-photo.html)



Images and radar data taken by Cassini peg a 3,337 m (10,948-ft) tall mountain in an equatorial range with three ridges called **Mithrim Montes** as Titan's likely loftiest peak. A number of other peaks in that size stud Titan's surface, mostly in spots close to the equator. Their existence suggests that tectonic forces could be shaping the 5,150 km (3,200-mi) wide moon's landscapes today. ##

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## Fog Detected on Surface of Titan

28 March, 2016 – [www.space.com/32380-fog-detected-on-saturn-moon-titan.html](http://www.space.com/32380-fog-detected-on-saturn-moon-titan.html)

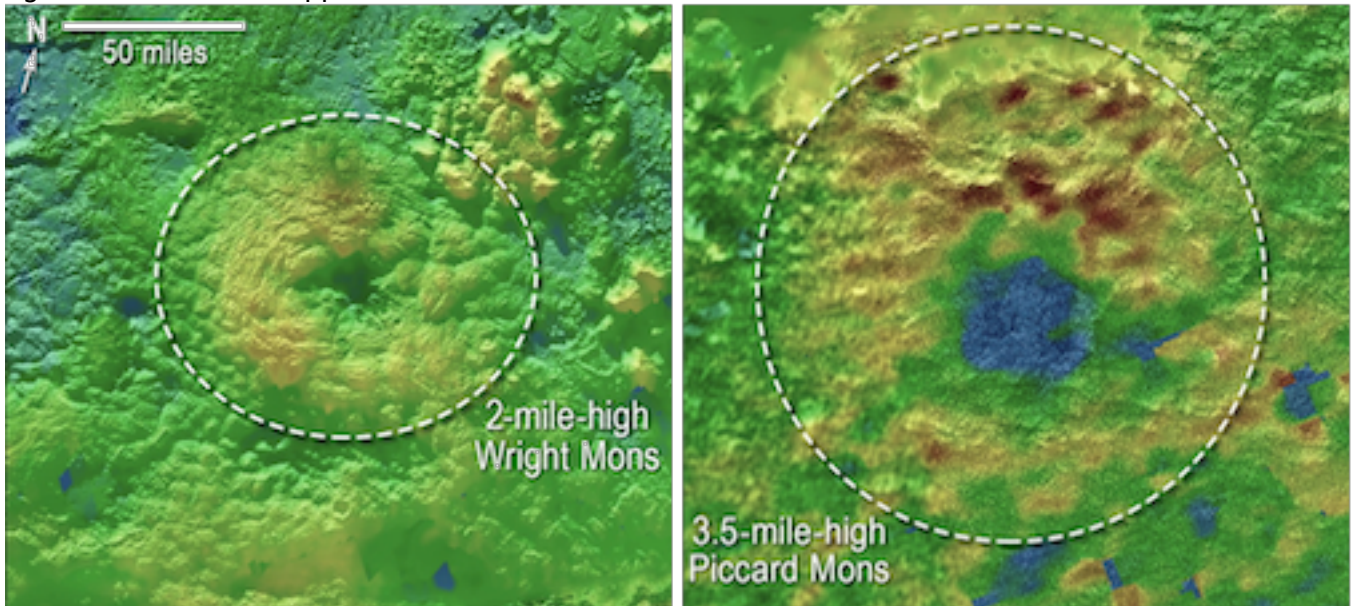
Ground fog on Titan has been seen before from orbit so it's not unexpected to find fog on the surface. But it hadn't been detected from the surface before.

## PLUTO-CHARON

### A New Pluto Wonder? Possible Ice Volcanoes Spotted (Video)

7 January, 2016 – [www.space.com/31549-pluto-ice-volcanoes-new-horizons.html](http://www.space.com/31549-pluto-ice-volcanoes-new-horizons.html)

Two of the towering mountains observed by NASA's New Horizons spacecraft during its historic July 14 flyby of Pluto — the 3,960 m (13,000 ft) high **Wright Mons** and the roughly (5,500 m (18,000 ft) high **Piccard Mons** — appear to be “ice volcanoes.”

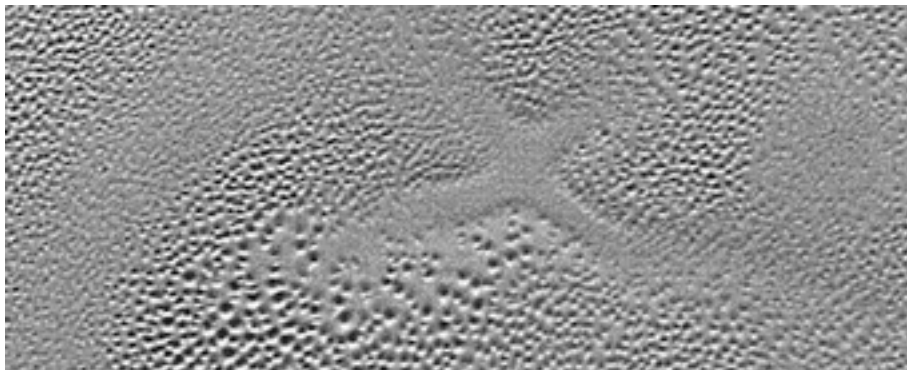


The two peaks both feature large holes in their summits, which likely formed when material erupted from underneath, causing the mountaintops to collapse. In addition, the flanks of Wright Mons and Piccard Mons sport an odd "hummocky" texture that could be the residue of past volcanic flows.

How Pluto has managed to stay geologically active more than 4.5 billion years after its formation is a mystery that mission scientists are still trying to solve. ##

### On Pluto, 'X' Marks the Spot (Photo)

8 January, 2016 – [www.space.com/31555-pluto-x-marks-the-spot-new-horizons-photo.html](http://www.space.com/31555-pluto-x-marks-the-spot-new-horizons-photo.html)



NASA's New Horizons spacecraft captured this image of an intriguing "X" on Pluto's icy Sputnik Planum region; the X probably marks a spot where four separate “cells” of nitrogen ice came together.

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

## How NASA's Flying Observatory Revealed Secrets About Pluto

14 January, 2016 – [www.space.com/31605-how-sofia-flight-revealed-pluto-secrets.html](http://www.space.com/31605-how-sofia-flight-revealed-pluto-secrets.html)

On June 29, 2015, an airplane was already flying off the southwest coast of New Zealand when a group of astronomers in Chile phoned a group of scientists in Massachusetts, who then called the scientist aboard the aircraft, who told the navigator they had to change course.

The airplane was not a typical passenger jet or cargo aircraft but a mobile scientific observatory called SOFIA, (Stratospheric Observatory for Infrared Astronomy) was chasing a moving target in the sky: the shadow of the dwarf planet Pluto. For about 2 minutes, the icy world would be passing in front of a star — an occultation. Observing this event held incredible promise for Pluto scientists, but it meant getting SOFIA in exactly the right spot for them to see it.



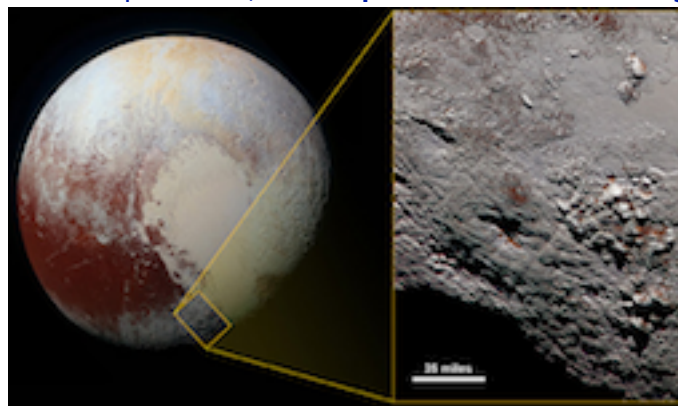
When such an occultation happens with Pluto, we can watch the interaction between the light from the star and Pluto's atmosphere, and learn about the atmosphere from Earth-based measurements, without having to actually go out there and see what's going on.

Scientists have been studying Pluto occultations for several decades, but the one on June 29 had the potential to affect all subsequent studies of the dwarf planet's atmosphere from Earth, because two weeks after SOFIA's flight, the New Horizons probe was set to become the very first space probe to make a close encounter with Pluto. After having traveled through the solar system for 10 years, New Horizons would come within 7,800 miles (12,500 kilometers) of Pluto's surface.

If scientists on Earth could observe Pluto passing in front of a star, and compare it to what New Horizons could see from a few million miles away, they could compare the observations in order to better understand what they were seeing from Earth. ##

## A 'Wright Mons-ter': Pluto's Ice Volcano Is Huge

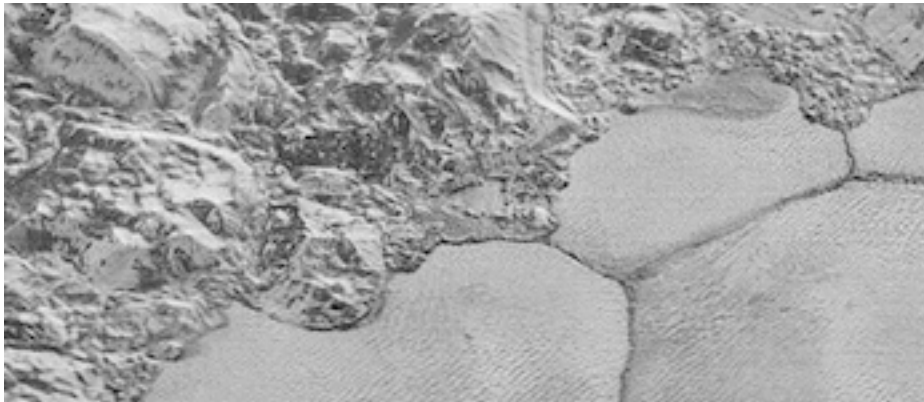
16 January, 2016 – [www.space.com/31639-pluto-ice-volcano-wright-monster.html](http://www.space.com/31639-pluto-ice-volcano-wright-monster.html)



This observation shows the candidate cryovolcano Wright Mons taken by New Horizons Long Range Reconnaissance Imager (LORRI) July 14, 2015. Color enhanced by data from the Ralph/Multispectral Visible Imaging Camera (MVIC), from a range of 21,000 miles (34,000 kilometers) and at a resolution of about 2,100 feet (650 meters) per pixel. The entire scene is (230 km (140 mi) across. ##

## Young at Heart: Pluto's Ice Only 10 Million Years Old

22 January, 2016 - [www.space.com/31708-young-at-heart-plutos-ice-only-10-million-years-old.html](http://www.space.com/31708-young-at-heart-plutos-ice-only-10-million-years-old.html)



A spot along the “shoreline” of Sputnik Planum

Pictures are still filtering back from NASA’s New Horizons close-up of Pluto last year and one of the biggest surprises so far comes from the region informally known as Sputnik Planum. There’s a lack of craters on its surface, making it a unique area on Pluto and a rare spot in the solar system.

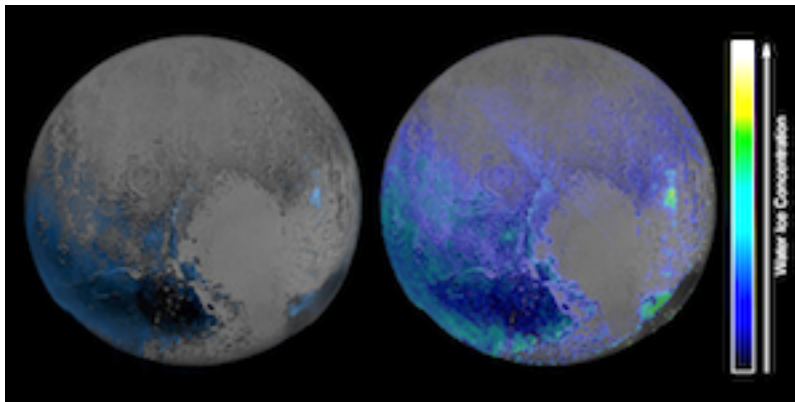
So far, scientists have come up with **three ways the resurfacing could take place:**

- 1 Nitrogen ice on the surface could be “relaxing” if it is viscous, getting rid of any craters created by meteoroids.
- 2 Ice on the bottom could be rising up and replacing ice at the top (like a lava lamp)
- 3 The ice could be partially melted at its bottom and from time to time, erupt on to the surface as cryo-lava.

Pluto is in a zone filled with smaller Kuiper Belt objects. From time to time, these small bodies crash into Pluto. Trilling’s math shows that this happens roughly every 10 million years, which would explain why Sputnik Planum appears so young. ##

## Pluto's Surface Has a Surprising Amount of Water Ice (Photo)

29 January, 2016 = [www.space.com/31775-pluto-water-ice-maps-new-horizons.html](http://www.space.com/31775-pluto-water-ice-maps-new-horizons.html)

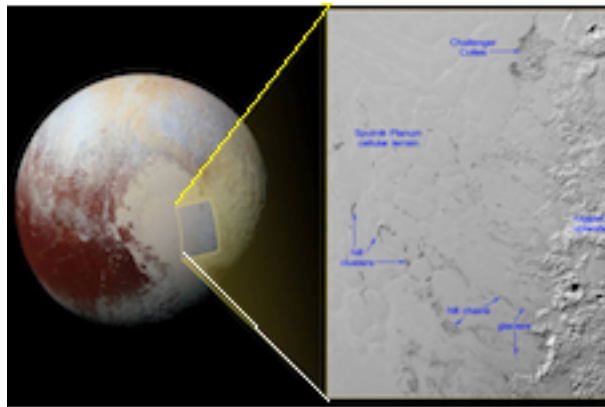


These maps of water ice on Pluto's surface were created using data captured by NASA's New Horizons spacecraft during its flyby of the dwarf planet on July 14, 2015. The **map at left** is an early effort; the **one at right** used modeling techniques to achieve greater sensitivity. The new map is more sensitive than an earlier version also produced using flyby observations, and thus shows more water ice — Pluto's bedrock material — cropping up across its surface than had been seen previously. ##

## The 'Floating Hills' of Pluto (Pho

5 February, 2016 - [www.space.com/31841-pluto-floating-hills-photo-new-horizons.html](http://www.space.com/31841-pluto-floating-hills-photo-new-horizons.html)

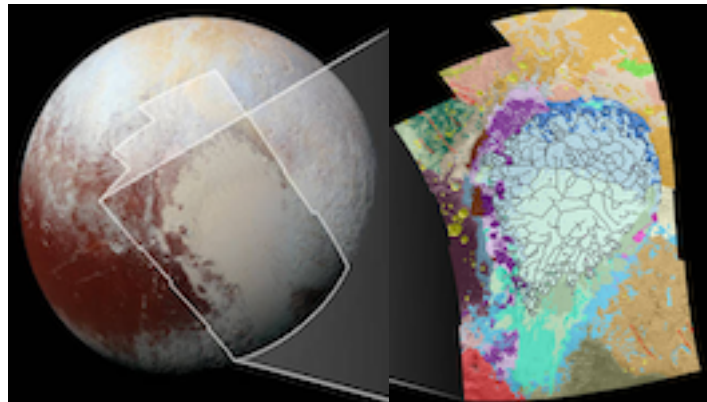
Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)



Hills of water ice on Pluto 'float' in a sea of frozen nitrogen and move over time like icebergs in Earth's Arctic Ocean — another example of Pluto's fascinating geological activity.

## NASA Maps Geology of Pluto's 'Heart'

15 February, 2016 – [www.space.com/31930-pluto-geology-map-new-horizons.html](http://www.space.com/31930-pluto-geology-map-new-horizons.html)



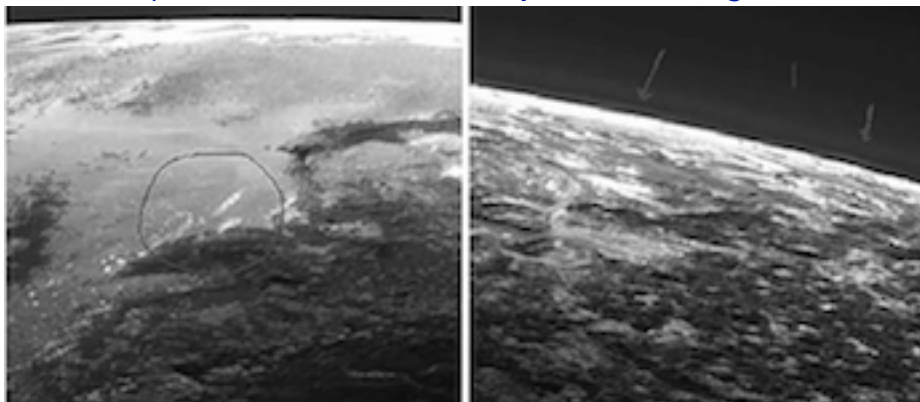
This map of the left side of Pluto's heart-shaped feature uses colors to represent Pluto's varied terrains, which helps scientists understand the complex geological processes at work

For geochemical color code to the image on the right, see:

[www.space.com/images/i/000/053/231/i02/nh-geomorphologicalmapping\\_smaller-alignedkey-v2.jpg](http://www.space.com/images/i/000/053/231/i02/nh-geomorphologicalmapping_smaller-alignedkey-v2.jpg)

## Cloudgate: Rumors Spread of Nitrogen Clouds on Pluto

7 March, 2016 – [www.space.com/32161-rumors-spread-of-nitrogen-clouds-on-pluto.html](http://www.space.com/32161-rumors-spread-of-nitrogen-clouds-on-pluto.html)

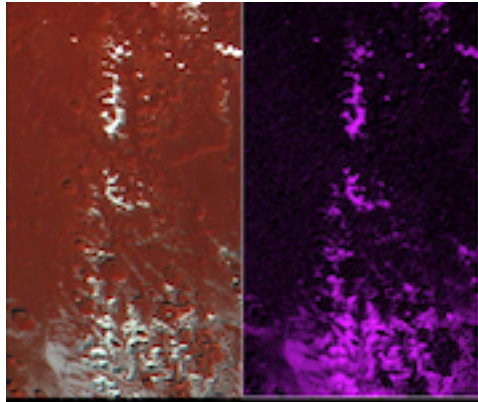


Highlighted structures in Pluto's atmosphere thought to be clouds

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## Pluto's Mountains Capped by Methane Ice (Photo)

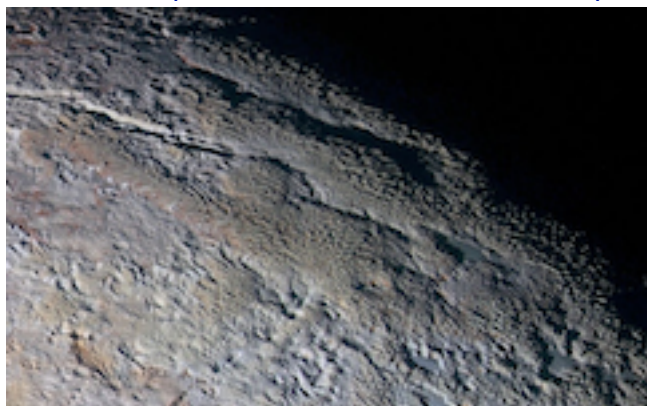
11 March, 2016 - [www.space.com/32227-pluto-methane-snow-new-horizons-photo.html](http://www.space.com/32227-pluto-methane-snow-new-horizons-photo.html)



Bright material coating the tops of Cthulu's reddish mountains;  
the inset at right shows the distribution of methane ice in the area (light purple).

## Are Pluto's Pebbled 'Snakeskin' Slopes Made of Ancient Stuff?

[www.space.com/32269-pluto-snakeskin-terrain-solar-system-birth.html](http://www.space.com/32269-pluto-snakeskin-terrain-solar-system-birth.html)



Pluto's intriguing "snakeskin" terrain, which New Horizons mission team members have informally named Tartarus Dorsa.

15 March, 2016 - Pluto's mysterious "snakeskin" terrain may be made of stuff that predates the solar system's birth. NASA's New Horizons spacecraft spotted the strange pebbly and scaly landscape on the eastern side of Pluto's famous "heart." The "scales" - informally named Tartarus Dorsa - are actually tightly packed minimountains about 1,650 feet (500 meters) tall. Their relative spacing of about 3-5 kilometers [1.9 to 3.1 miles] makes them some of the steepest features seen on Pluto.

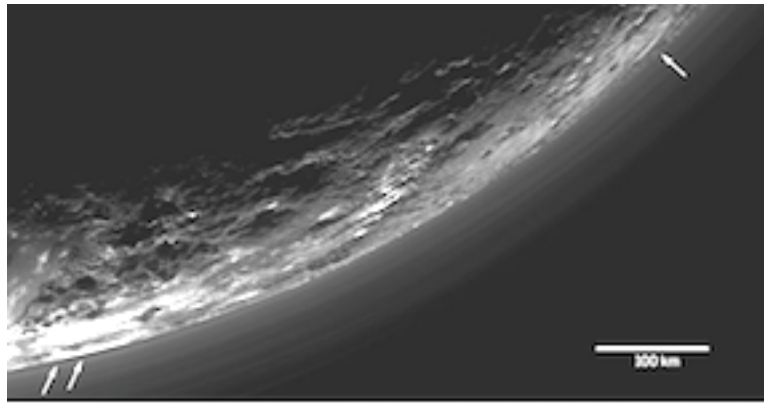
Measurements show that the area is dominated by methane, with some water thrown in for good measure. So the scaly peaks could be composed of pure methane ice, or, perhaps, of methane clathrate ice - methane molecules surrounded by a "cage" of water molecules.

One study found that pure methane would be too mushy, while the other suggested it could be stout enough, if the individual methane crystals were big enough.

## Pluto's 'Unprecedented' Ice Provinces and Other Surprises

17 March, 2016 - [www.space.com/32301-pluto-surprising-discoveries-new-horizons.html](http://www.space.com/32301-pluto-surprising-discoveries-new-horizons.html)

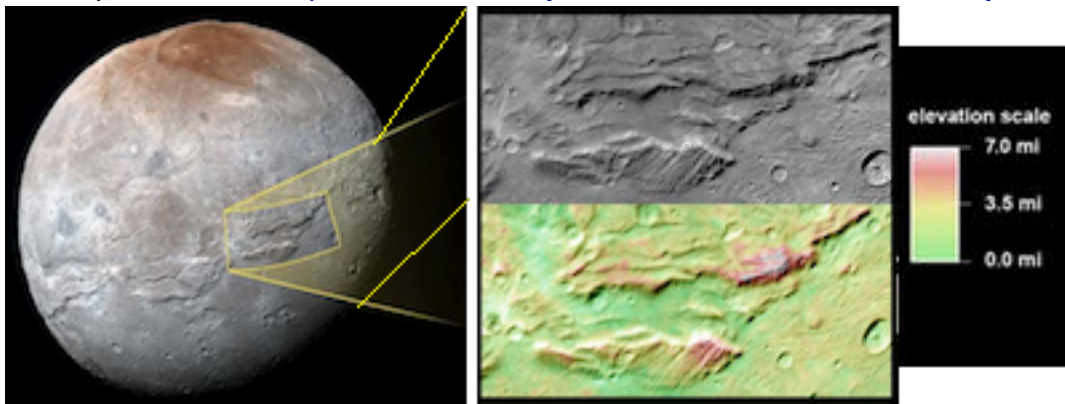
Pluto, known for more than eight decades as just a faint, fuzzy and faraway point of light, is shaping up to be one of the most complex and diverse worlds in the solar system. Pluto's frigid surface varies tremendously from place to place, featuring provinces dominated by different types of ices - methane in one place, nitrogen in another and water in yet another.



View of Pluto's atmosphere captured by NASA's New Horizons spacecraft during its July 2015 flyby of the dwarf planet ##

## Charon's Frozen Ocean May Have Been Liquid

22 February, 2016 – [www.space.com/32013-pluto-hulk-like-moon-charon-photo.html](http://www.space.com/32013-pluto-hulk-like-moon-charon-photo.html)



. The New Horizons probe took this image of Serenity Chasma, part of a vast belt of chasms along the equator of Pluto's largest moon, Charon. The shape of the features reveals that the moon's water-ice layer was once at least partially liquid before freezing solid. #

## Pluto's Recent Past: Liquid Lakes and Thick Atmosphere?

23 March, 2016 – [www.space.com/32346-pluto-nitrogen-lakes-new-horizons.html](http://www.space.com/32346-pluto-nitrogen-lakes-new-horizons.html)

As recently as 800,000 years ago, Pluto may have had an atmosphere thicker than that of Mars today, potentially allowing liquids to run across its surface.

Newly analyzed data collected by NASA's New Horizons which flew by of Pluto last July, suggest that the dramatically changing seasons of the dwarf planet could have resulted in an atmosphere that waxed and waned.

## BEYOND PLUTO-CHARON

## Planet X May Be Real – Evidence Mounting For 9th Planet | Video(s)

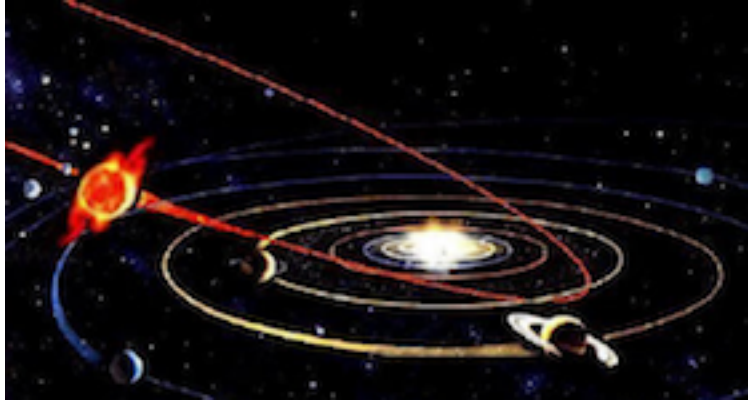
[www.space.com/31667-planet-x-may-be-real-evidence-mounting-for-9th-planet-video.html](http://www.space.com/31667-planet-x-may-be-real-evidence-mounting-for-9th-planet-video.html)  
[www.sciencemag.org/news/2016/01/feature-astronomers-say-neptune-sized-planet-lurks-unseen-solar-system](http://www.sciencemag.org/news/2016/01/feature-astronomers-say-neptune-sized-planet-lurks-unseen-solar-system)

20 January, 2016 – The solar system appears to have a new 9th planet (or 10<sup>th</sup> should Pluto-Charon be reaccepted.) Two scientists have announced evidence that a body nearly the mass of Neptune—but as yet unseen—orbital the Sun every 15,000 years (Neptune orbits every 164 years). During the solar system's infancy 4.5 billion years ago, this planet was knocked out of the planet-forming region near the Sun.

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)



Slowed down by gas, it settled into a distant elliptical orbit, where it still lurks today, moving only one degree (twice the angular diameter of the full moon) in 47 years!



Inferred its presence from the peculiar clustering of six previously known objects that orbit beyond Neptune. They say there's only a 0.007% chance, or about one in 15,000, that the clustering could be a coincidence. Instead, they say, a planet with the mass of 10 Earths has shepherded the six objects into their strange elliptical orbits, tilted out of the plane of the solar system.

The orbit of the inferred planet is similarly tilted, as well as stretched to distances that will explode previous conceptions of the solar system. Its closest approach to the Sun is seven times farther than Neptune, or 200 astronomical units (AUs). (An AU is the distance between Earth and the Sun, about 150 million kilometers.) And Planet X could roam as far as 600 to 1200 AU, well beyond the Kuiper belt, the region of small icy worlds that begins at Neptune's edge about 30 AU.

They hope to find visual proof in the near future with the help of the Subaru Telescope in Hawaii.

**Editor:** we prefer the monicker "Planet X" - (X is the Latin symbol for 10.)

**Note,** Pluto-Charon was "demoted" in part because most of its orbit lies in the realm of the Kuiper Belt. Consistency "Plante X" should not be given the name planer because it lies beyond the Kuiper Belt. Face it, Pluto's demotion was a stupid and unwarranted move. Time to admit it!

## Predicting Planets: The highs and lows

21 January, 2016 - [www.spacedaily.com/reports/Predicting\\_planets\\_The\\_highs\\_and\\_lows\\_999.html](http://www.spacedaily.com/reports/Predicting_planets_The_highs_and_lows_999.html)

In the mid-19th century, astronomers hypothesised an **extra planet in our solar system, orbiting between the Sun and Mercury**. Without ever seeing it, they calculated its orbit and named it **Vulcan** – the only explanation, they thought, for small deviations in Mercury's own orbit. But decades of searching yielded no proof, and finally in 1915, Albert Einstein's theory of relativity made sense of Mercury's strange behaviour in a way which obviated the need for Vulcan. The search was abandoned.

("Vulcan" was since resurrected, around another star, as the home planet of Spok, of Star Trek fame.)

But in one very well-known case, mathematical modelling turned out to be right. **The existence of Neptune** -- the eighth and furthest known planet from the Sun -- was deduced from a pull observed on the orbit of Uranus. Scientists launched a telescope search, and the planet was detected within days.

[ The article goes on to access the chances of finding the new "Planet X" as described in the article just above. ##

## Don't Blame 'Planet Nine' for Earth's Mass Extinctions

25 January, 2016 - [www.space.com/31725-planet-nine-earth-mass-extinctions.html](http://www.space.com/31725-planet-nine-earth-mass-extinctions.html)

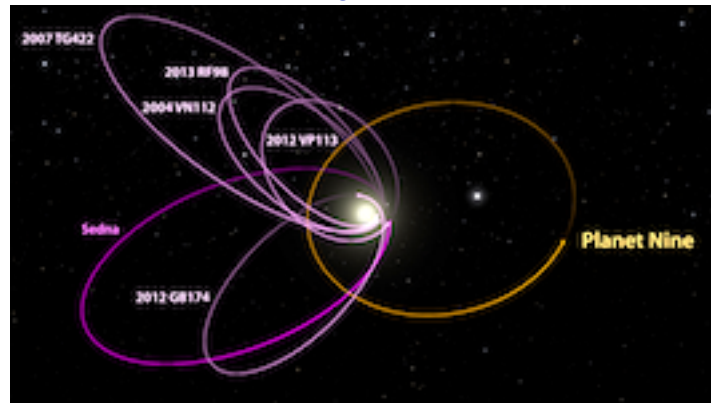
Planet Nine likely has an elliptical orbit, coming within 200 to 300 astronomical units (AU) of the Sun at its closest approach and getting as far away as 600 to 1,200 AU, Brown said. (One AU is the distance from Earth to the Sun — 150 million km (93 million mi), Neptune orbits about 30 AU from the Sun, and Pluto never gets farther than 49 AU from our star. So Planet Nine, if it exists, is very distant indeed — but not distant enough to stir up any of the trillions of comets in the Oort Cloud, which begins perhaps 5,000 AU from the Sun. ##

## 'Planet Nine' Is Still Just a Theory, NASA Cautions (Video)

27 January, 2016 – [www.space.com/31746-planet-nine-prediction-nasa-caution.html](http://www.space.com/31746-planet-nine-prediction-nasa-caution.html)

### Search narrows for Planet Nine

23 February, 2016 – <http://phys.org/news/2016-02-narrows-planet.html>



The 6 most distant known objects in the solar system with orbits (magenta) exclusively beyond Neptune and all mysteriously line up in a single direction. Also, when viewed in three dimensions, they all tilt nearly identically away from the plane of the solar system. A planet with 10 times the mass of the Earth in a distant eccentric orbit anti-aligned with the other six objects must maintain this configuration.##

### Finding Planet 9: NASA's Saturn Cassini Probe Helps with the Hunt

24 February, 2016 – [www.space.com/32037-saturn-probe-cassini-planet-nine-search.html](http://www.space.com/32037-saturn-probe-cassini-planet-nine-search.html)

The news that possible 9<sup>th</sup> major planet with a mass 10 times that of Earth could be orbiting in the dark region beyond Neptune lit up the public's imagination in January. The prediction is still just that — a hypothesis, based on modeling, not observation. Scientists behind the idea say telescope searches of the solar system could confirm (or deny) the prediction within five years.

Now, another group of scientists is showing how the existence of such a planet would affect the motions of the other eight planets. The work relies heavily on measurements taken by the Cassini probe, and aims to narrow down the hunting zone where scientists should point their telescopes as they search for this hidden monster. ##

## DEEP SPACE TECHNOLOGIES

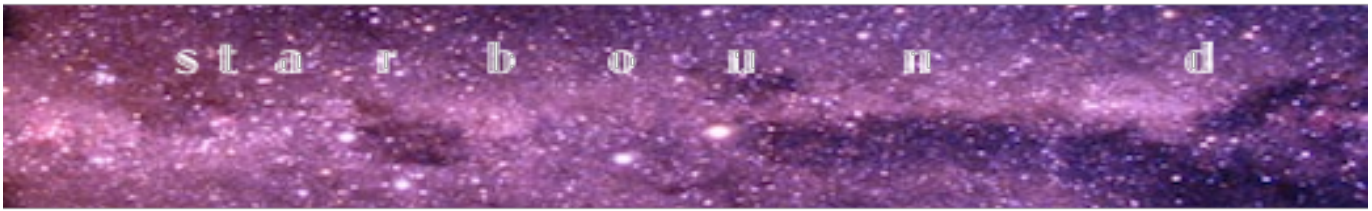
### NASA Selects Proposals for Better Solar Technologies for Deep Space Missions

[www.nasa.gov/press-release/nasa-selects-proposals-to-build-better-solar-technologies-for-deep-space-missions](http://www.nasa.gov/press-release/nasa-selects-proposals-to-build-better-solar-technologies-for-deep-space-missions)

14 March, 2016 – NASA's **Game Changing Development** (GCD) program has selected four proposals to develop solar array technologies that will aid spacecraft in exploring destinations well beyond low-Earth orbit, including Mars, **requiring solar arrays that can operate in high-radiation and low-temperature environments to improve mission performance, increase solar array life, and ultimately may allow solar-powered vehicles to explore deeper into space than ever before.**

- **Transformational Solar Array for Extreme Environments** -- Johns Hopkins University Applied Physics Laboratory of Laurel, Maryland
- **Micro-Concentrator Solar Array Technology for Extreme Environments** - The Boeing Company of Huntington Beach, California
- **Solar Array for Low-intensity Low Temperature and High-Radiation Environments**, NASA's Jet Propulsion Laboratory in Pasadena, California
- **Concentrator Solar Power Systems for Low-intensity Low Temperature and High Radiation Game Changing Technology Development** -- ATK Space Systems of Goleta, California ##

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**Because the Speed of Light is Finite, everything we see out there is in OUR past.  
We cannot see our contemporaries, much less converse with them. - Editor**

## EARTH-BOUND TELESCOPES

## SPACE TELESCOPES

### WFIRST – NASA’s Next Major Telescope Project To Begin in February

7 January, 2016 – [www.space.com/31533-nasa-wfirst-major-space-telescope-project.html](http://www.space.com/31533-nasa-wfirst-major-space-telescope-project.html)  
<http://wfirst.gsfc.nasa.gov> – [https://en.wikipedia.org/wiki/Wide\\_Field\\_Infrared\\_Survey\\_Telescope](https://en.wikipedia.org/wiki/Wide_Field_Infrared_Survey_Telescope)



artist rendering

The Wide Field Infrared Survey Telescope (WFIRST) will become a formal project in February thanks to increased funding. The fiscal year 2016 omnibus spending bill in December provided \$90 million for WFIRST, far above NASA's request of \$14 million. It is designed to perform wide-field imaging and surveys of the near infrared (NIR) sky.

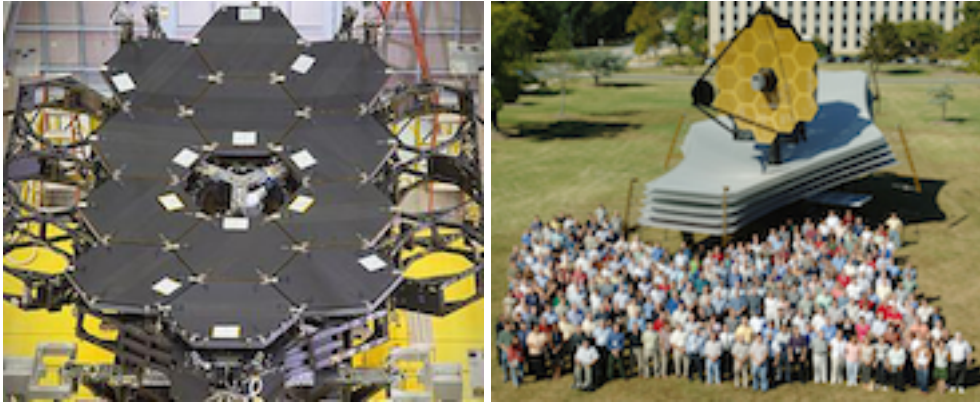
The science objectives of WFIRST overlap those of the EUCLID mission that ESA plans to launch in 2020, and include:

- Answer basic questions about dark energy: Is cosmic acceleration caused by a new energy component or by the breakdown of General Relativity on cosmological scales? If the cause is a new energy component, is its energy density constant in space and time, or has it evolved over the history of the universe? WFIRST will use three independent techniques to probe dark energy:
  - Baryon acoustic oscillations
  - Observing distant supernovae
  - Weak gravitational lensing
- Complete a census of exoplanets to help answer new questions about the potential for life in the universe: How common are solar systems like our own? What kinds of planets exist in the cold, outer regions of planetary systems? – What determines the habitability of Earth-like worlds? This census makes use of a technique that can find exoplanets down to a mass only a few times that of the Moon:
  - Gravitational microlensing
- Establish a guest investigator mode enabling survey investigations to answer diverse questions about our galaxy and the universe.
- Provide a coronagraph for exoplanet direct imaging that **will provide the first direct images and spectra of planets around our nearest neighbors similar to our own giant planets. ##**

## By the dozen: NASA's James Webb Space Telescope mirrors

[www.spacedaily.com/reports/By\\_the\\_dozen\\_NASAs\\_James\\_Webb\\_Space\\_Telescope\\_mirrors\\_999.html](http://www.spacedaily.com/reports/By_the_dozen_NASAs_James_Webb_Space_Telescope_mirrors_999.html)

8 January, 2016 – Since December 2015, scientists and engineers have been working tirelessly to install all the primary mirror segments onto the telescope structure in the large clean room at NASA's Goddard Space Flight Center in Greenbelt, Maryland. The 12th mirror was installed on January 2, 2016.



**Above right:** mockup of the JWST shows size in comparison to people working on it.

All of the hexagonal shaped mirrors on the fixed central section of the telescope structure are installed and only the 3 mirrors on each wing are left for installation. Each hexagonal-shaped segment measures just over 4.2 ft (1.3 m) across and weighs approximately 88 lbs (40 kg). After being pieced together, the 18 primary mirror segments will work together as one large 21.3-foot (6.5-meter) mirror.

The mirrors are made of ultra-lightweight beryllium and are placed on the telescope's backplane by a robotic arm, guided by engineers. The full installation is expected to be completed in a few months.

The primary mirror and the tennis-court-sized Sunshield are the largest and most visible components of the Webb telescope. However, there are four smaller components that are less visible, yet critical. **The Webb telescope is planned for launch in 2018. ##**

[www.nasa.gov/press-release/nasas-james-webb-space-telescope-primary-mirror-fully-assembled](http://www.nasa.gov/press-release/nasas-james-webb-space-telescope-primary-mirror-fully-assembled)

**Photo** [www.nasa.gov/sites/default/files/styles/full\\_width/public/thumbnails/image/16-013b.jpg](http://www.nasa.gov/sites/default/files/styles/full_width/public/thumbnails/image/16-013b.jpg)

5 February, 2016 – [www.space.com/31838-james-webb-space-telescope-mirror-assembled.html](http://www.space.com/31838-james-webb-space-telescope-mirror-assembled.html)

## Worldwide Telescope Network to take best-ever Images of Black Holes

8 January, 2016 – [www.space.com/31548-event-horizon-telescope-black-hole-photos.html](http://www.space.com/31548-event-horizon-telescope-black-hole-photos.html)

Black Hole Infographic: [www.space.com/19339-black-holes-facts-explained-infographic.html](http://www.space.com/19339-black-holes-facts-explained-infographic.html)



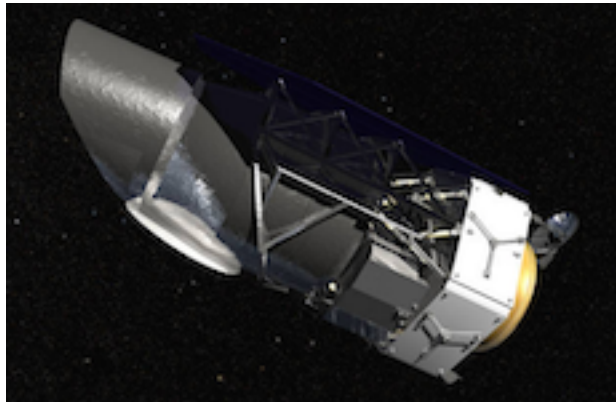
The **Event Horizon Telescope (EHT)** will take some of the best images of black holes ever captured, is ramping up its worldwide network of telescopes. Scientists hope to see the material moving around these dark monsters, as well as the shadows of the black holes themselves.

By 2018, the EHT will be an observatory that harnesses the power of **nine telescopes** around the world, including ones in **Chile, Arizona, Hawaii, Antarctica** and **Greenland**. These instruments will work together for higher-resolution images than any of these scopes can achieve alone. **Target black holes.**

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

## NASA Introduces New, Wider Set of Eyes on the Universe

[www.nasa.gov/press-release/nasa-introduces-new-wider-set-of-eyes-on-the-universe](http://www.nasa.gov/press-release/nasa-introduces-new-wider-set-of-eyes-on-the-universe)

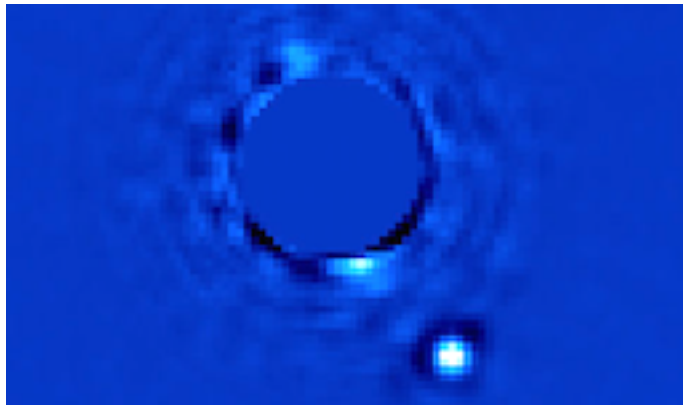


18 February, 2016 –

NASA's Wide Field Infrared Survey Telescope (WFIRST), illustrated here, will carry a Wide Field Instrument to capture Hubble-quality images covering large swaths of sky, enabling cosmic evolution studies. Its Coronagraph Instrument will directly image exoplanets and study their atmospheres. ##

## Palm-Size Satellites Could Hunt for New Alien Worlds

25 February, 2016 – [www.space.com/32038-cubesat-satellites-hunt-alien-worlds.html](http://www.space.com/32038-cubesat-satellites-hunt-alien-worlds.html)



When Gemini Planet Imager captured this picture of **Beta Pictoris b**, it blocked the starlight to keep it from interfering with light from the planet. A new project suggests using tiny satellites to hunt for other worlds closer to the star that can't be spotted with direct imaging. ##

## NASA Selects Instrument Team to Build Next-Gen Planet Hunter

[www.nasa.gov/press-release/nasa-selects-instrument-team-to-build-next-gen-planet-hunter](http://www.nasa.gov/press-release/nasa-selects-instrument-team-to-build-next-gen-planet-hunter)



The NEID instrument, will be installed on the 3.5-meter WIYN telescope at the Kitt Peak National Observatory in Arizona,

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

**25 March, 2016** – NASA has selected a team to build a new, cutting-edge instrument that will detect planets outside our solar system (exoplanets), by measuring the miniscule “wobbling” of stars.

The instrument will be the centerpiece the NASA-NSF Exoplanet Observational Research program, or NN-EXPLORE. NEID (pronounced “nee-id”), short for NN-EXPLORE Exoplanet Investigations with Doppler Spectroscopy, will measure the tiny back-and-forth wobble of a star caused by the gravitational tug of a planet in orbit around it. The wobble tells scientists there is a planet orbiting the star, and the size of the wobble indicates how massive the planet is.

The instrument will be built by a Pennsylvania State University research group and installed on the 3.5-meter WIYN telescope at the Kitt Peak National Observatory in Arizona.

## OUR CLOSEST STAR: THE SUN

### Black Holes May Have Set the Clock for Life on Earth

7 January, 2016 – [www.space.com/31546-black-holes-clock-life-earth.html](http://www.space.com/31546-black-holes-clock-life-earth.html)

There is a chance – just a chance – that if black holes rule the universe, they could have “switched on” habitable planets, such as Earth, allowing them to support complex life.

It's an unavoidable implication of the work of astrophysicist Paul Mason, who is examining the role of the super high-energy particles from black holes and exploding stars in the advent of habitable planets.

“It has taken the universe a while for the cosmic ray density and the frequency of bad events to decrease enough for life to handle it,”

“Compounding the early universe's problem with life is the fact that everything was much closer together. The small young universe was packed thick with sterilizing cosmic rays. It took billions of years for the expanding universe to pull things apart and help thin that deadly soup.”

“It implies that the **expansion of the universe is important for life.**”

**Comment:** Because the Speed of Light is Finite, everything we see out there is in OUR past.

**We cannot see our contemporaries, much less converse with them.** And the further away from Earth we look, the deeper into the past, making finding “inhabited worlds” less and less likely.

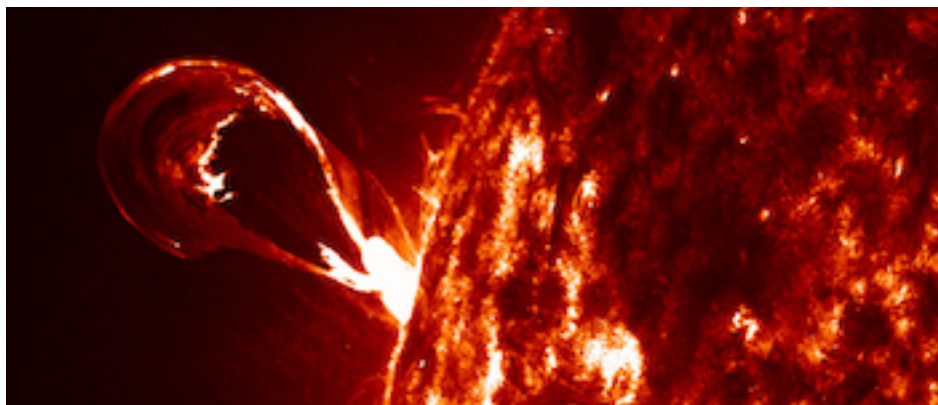
**On the other hand,** life began on Earth 3–4 **billion** years ago, so stars within 3–4 billion light years are just as likely to host life at some stage as Earth.

M31, the great Andromeda galaxy, “just” 2.5 **million** light years away (= 2.5 million years in our past) is in that sense our evolutionary contemporary. – Editor    β##

### Mysteriously Powerful Particles from Solar Explosions Unveiled

#### Matter Tears Through Sun's Atmosphere As Magnetic Filament Ruptures | Video

26 January, 2016 – [www.space.com/31344-mysteriously-powerful-particles-solar-explosions.html](http://www.space.com/31344-mysteriously-powerful-particles-solar-explosions.html)  
[www.space.com/31747-matter-tears-through-Sun-s-atmosphere-as-magnetic-filament-ruptures-video.html](http://www.space.com/31747-matter-tears-through-Sun-s-atmosphere-as-magnetic-filament-ruptures-video.html)



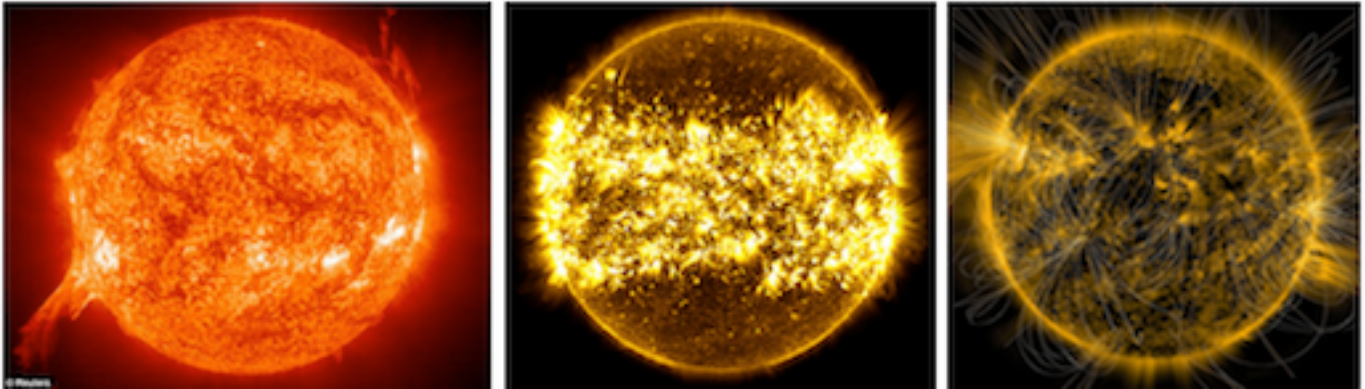
In a new study, researchers provide a first-of-its-kind look under the hood of these solar eruptions, taking specific aim at the physical process that accelerates the superfast particles.

A couple of times a month — sometimes more, sometimes less — an explosion goes off on the surface of the Sun, releasing energy that's equal to millions of hydrogen bombs. Mind boggling as that number is, this tremendous energy output cannot explain how material that is spit out by these explosions gets ramped up to nearly the speed of light.

## Our Sun is a Roiling Ball Of Magnetism, Computer Reveals | 2 Videos

[www.space.com/31832-our-Sun-is-a-roiling-ball-of-magnetism-computer-reveals-video.html](http://www.space.com/31832-our-Sun-is-a-roiling-ball-of-magnetism-computer-reveals-video.html)

Looping, swirling, whipping magnetic fields - not visible to the naked eye - power and direct titanic explosions off the Sun's surface. But scientists are not at all sure where the Sun's magnetism is created, amidst the complex dance of super-hot plasma driven by nuclear fusion at the star's center.



Right: <http://www.space.com/32278-sun-magnetic-field-sdo-image.html>

Middle: composite of 12 months of solar activity

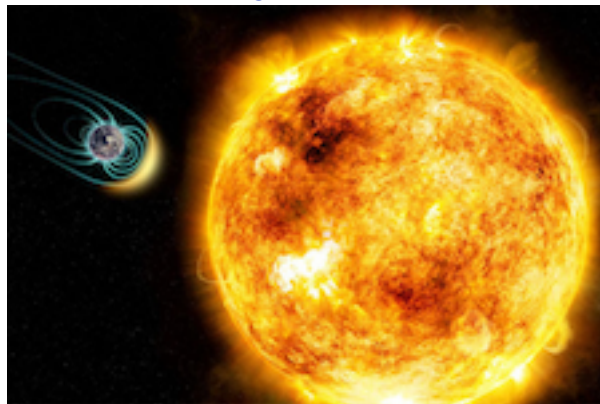
[www.space.com/images/i/000/053/333/original/sun-activity-sdo-portrait.jpg](http://www.space.com/images/i/000/053/333/original/sun-activity-sdo-portrait.jpg)

Left: [www.space.com/31942-suns-busy-buzzy-life-1-year-in-2-5-minutes-4k-video.html](http://www.space.com/31942-suns-busy-buzzy-life-1-year-in-2-5-minutes-4k-video.html)

NASA's Solar Dynamics Observatory has snapped **1 photo every 12 seconds at multiple wavelengths** since early 2010. Shown here, at 171 angstroms **the year of Jan. 1, 2015, to Jan. 28, 2016**. Then solar physicist Nicholeen Viall points out some mind-bending highlights

## Earth's Magnetism Saved It From Solar Sterilization

[www.space.com/32306-our-planets-magnetism-saved-it-from-solar-sterilization.html](http://www.space.com/32306-our-planets-magnetism-saved-it-from-solar-sterilization.html)



In this artist's illustration, the young Sun-like star Kappa Ceti is blotched with large starspots, a sign of its high level of magnetic activity.

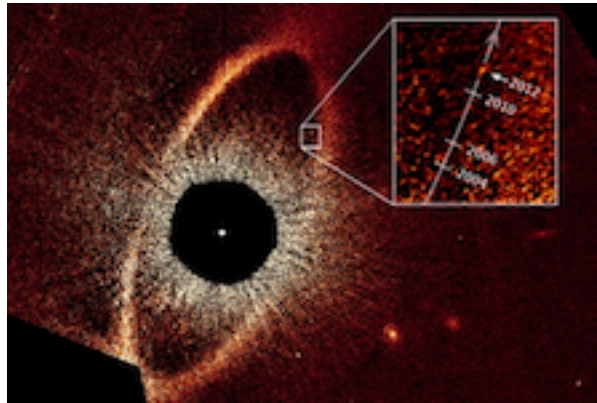
17 March, 2016 - When our sun was young, it was a very nasty star that erupted with "superflares" and blowtorched the inner solar system with powerful solar winds. Fortunately, the sun finally grew up and mellowed, reaching the calm(er) state it is now.

For early life on Earth, our planet's magnetosphere likely provided much-needed protection against the stellar onslaught, facilitating the evolution of our thriving biosphere.

Through the study of a nearby young sun-like star, Kappa Ceti, we now know how lucky we are to have such an effective global magnetic field. ##

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

## SEARCH FOR EXO-PLANETS &amp; LIFE

**Direct Imaging: The Next Big Step in the Hunt for Exoplanets**1 December, 2016 - [www.space.com/31497-exoplanets-direct-imaging-next-big-thing.html](http://www.space.com/31497-exoplanets-direct-imaging-next-big-thing.html)

False-color composite image traces the motion of the planet **Fomalhaut b**, captured by direct imaging. This method resembles photography, whether via visible or infrared light. But photographing a planet isn't easy, especially when it is literally outshone by its parent star. Scientists must use an instrument known as a coronagraph to block the light from the star (the planet's Sun) to reveal the dimmer light reflected by a planet in its shadow. ##

**Massive Planets May Punch Puzzling Holes in Planetary Nurseries**30 December, 2015 - [www.space.com/31494-huge-planets-punch-holes-planetary-nurseries.html](http://www.space.com/31494-huge-planets-punch-holes-planetary-nurseries.html)

A high-definition view of planetary nurseries around four young stars has revealed a new solution to a puzzling mystery: why a hole appears in the middle of some of those nurseries. (watch Video)

Young planets likely from large discs of gas and dust found around stars, sort of the way a rolling snowball can form an entire snowman from a flat field of snow.

But observations of some planet-forming discs show missing material close to the star: a gap in the dust, which looks like a hole in the middle of the disc. Jupiter-class planets around those stars are clearing out the debris near the star, effectively poking a hole in the middle of the disc. ##

**Kepler Space Telescope Roars Back with 100 New Exoplanet Finds**5 January, 2016 - [www.space.com/31528-100-alien-planets-discovery-nasa-kepler-spacecraft.html](http://www.space.com/31528-100-alien-planets-discovery-nasa-kepler-spacecraft.html)

Kepler has now discovered more than 100 confirmed alien planets in its 2nd-chance K2 mission.

The spacecraft finds planets by the "transit method," noting the tiny brightness dips caused when a planet crosses its host star's face from Kepler's perspective. This technique requires extremely precise pointing, an ability Kepler lost in May 2013 when the second of the observatory's four orientation-maintaining reaction wheels failed.22 mmm

But the Kepler team quickly figured out a way to keep the telescope stable, using solar radiation pressure as a sort of third wheel. That meant the spacecraft could eye different patches of the sky for around 80 days at a time to search for planets since May 2014. ##

**NASA's Next Great Space Telescope: The Quest Begins**1 February, 2016 - [www.space.com/31778-nasa-next-great-space-telescope.html](http://www.space.com/31778-nasa-next-great-space-telescope.html)

What kind of space telescope does NASA aim to build a few decades from now? The picture is getting a little clearer: Earlier this month, NASA announced that it is forming four working groups to investigate possible concepts for a large-scale space mission that would likely launch in the 2030s.

One of the four mission concepts is focused on direct imaging of the surfaces of exoplanets, to potentially search for signs of life.



The other three concepts are for space telescopes built to detect specific wavelengths of light: the ultraviolet/optical/near-infrared range, similar to what Hubble sees; X-ray light; and far-infrared light. The space agency is now accepting applications from scientists to join one of the four groups.

### The habitable exoplanet imager mission



This artist's illustration shows some of the planets identified in the Habitable Planets Catalog. A telescope designed to directly image the surface of exoplanets could potentially identify more signs of habitability, or even life, on other planets.

Scientists have indirectly identified about 2,000 planets outside Earth's solar system using the Kepler Space Telescope and other instruments. Now, scientists want a way to look directly at exoplanets that aren't too far from Earth. A direct-imaging planetary telescope could potentially reveal the atmospheres and surface conditions of alien worlds, and would search for signs of habitability or even bio-activity - ##

## How to Spy on Alpha Centauri & Other Binary Stars to Hunt Exoplanets

11 January, 2016 - [www.space.com/31565-hunting-exoplanets-alpha-centauri-binary-stars.html](http://www.space.com/31565-hunting-exoplanets-alpha-centauri-binary-stars.html)  
[www.space.com/18097-alpha-centauri-stars-planet-explained-infographic.html](http://www.space.com/18097-alpha-centauri-stars-planet-explained-infographic.html)

A new technique could allow scientists to photograph potentially life-supporting planets in nearby multistar systems. "Direct imaging" of exoplanets requires a way to blot out the overwhelming glare of a star. This task is especially challenging with multistar systems, such as the nearest stellar system to Earth, Alpha Centauri, which consists of two stars, Alpha Centauri A and B.

To directly image an exoplanet we must use special tools on or in front of a telescope to block out a star's light, and they can also use optical techniques through a telescope's mirrors or processing after the image is collected to cancel out extra noise and interference.



Astronomers at the European Southern Observatory announced in October 2012, the discovery of a planet similar in size to Earth, orbiting Alpha Centauri B. The planet, called Alpha Centauri Bb, (like our Venus) is too close to its star, Alpha Centauri B, to be habitable. But it is the closest alien world yet found.

We need to deform mirrors enough to blot out the disruptive effects of two stars at once, beyond the usual limit of how much interference a mirror can correct for..

The newly proposed set of techniques can be applied to telescopes without complex hardware modifications. Finding a way to look at multiple-star systems like Alpha Centauri using a similar process could lead to glimpses of interesting alien planets — in Alpha Centauri's case, with a much smaller telescope than previously thought possible. ##

## NOVA – Life on Earth got off to a rocky start

13 January, 2016 – [www.pbs.org/wgbh/nova/earth/life-rocky-start.html](http://www.pbs.org/wgbh/nova/earth/life-rocky-start.html)

Four and a half billion years ago, the young Earth was a hellish place—a seething chaos of meteorite impacts, volcanoes belching noxious gases, and lightning flashing through a thin, torrid atmosphere. Then, in a process that has puzzled scientists for decades, life emerged. But how? NOVA joins mineralogist Robert Hazen as he journeys around the globe.

NOVA joins mineralogist Robert Hazen as he journeys around the globe. From an ancient Moroccan market to the Australian Outback, he advances a **startling and counterintuitive idea—that the rocks beneath our feet were not only essential to jump-starting life, but that microbial life helped give birth to hundreds of minerals we know and depend on today.** It's a theory of the co-evolution of Earth and life that is reshaping the grand-narrative of our planet's story. ##

## On Alien Planets, Nitrogen May Be A Sign of Habitability

19 January, 2016 – [www.space.com/31621-nitrogen-may-signal-planet-habitability.html](http://www.space.com/31621-nitrogen-may-signal-planet-habitability.html)

We commonly think of Earth as having an oxygen-dominated atmosphere, but in reality the molecule makes up only a fifth of our air. Most of what surrounds us is nitrogen, at 78 %. Astrobiologists are beginning to see nitrogen — and not just oxygen — as a key indicator of a planet's habitability.

Nitrogen is essential for life on Earth and could signal an atmosphere thick enough to stabilize liquid water on a planet's surface, fundamental to creating habitable conditions. Nitrogen, in fact, was even more abundant in Earth's early atmosphere when volcanoes and other internal processes began replacing our planet's original envelope of hydrogen and helium.

But nitrogen is hard to see even with sophisticated telescopes. Its chemical signature isn't picked up well by a spectrograph because nitrogen does not interact strongly with most wavelengths of light. Given that Earth-like planets have thin, hard-to-see atmospheres to begin with, finding nitrogen on these planets will be difficult. ##

## When Will We Make Contact with Intelligent Aliens?

21 January, 2016 – [www.space.com/31662-alien-civilizations-when-make-contact.html](http://www.space.com/31662-alien-civilizations-when-make-contact.html)

"Are we alone?" is a pretty big question. But if the answer is "no," humanity may have to grapple with an even bigger issue — how to cope with crowds of extraterrestrial civilizations.

Over the last 20 years, astronomers have detected about 2,000 alien planets, and these discoveries suggest that potentially habitable worlds are common throughout our "Milky Way" galaxy (and likely throughout the universe as a whole).

There are thus many possible abodes for life throughout the cosmos and, given the age of the universe — about 13.8 billion years — there has been plenty of time for life forms to evolve complexity and intelligence

"Over the next decade, we should be able to search for radio signals from a million stars or more, a big enough number to make it reasonable to think that we'll find intelligent life ... if it's actually out there and trying to make contact." ##

**Editor:** As we have pointed out before, it is cheap and easy to listen (e.g. Arecibo Radio Telescope In Puerto Rico. But "astronomically expensive" to send for a long enough period and in all directions to increase the chances of being heard, and might only be undertaken by a messianic ("sicko") civilization. In our opinion, everybody is listening, no one is sending.

As for advanced civilizations which respect the right of young civilizations to mature on their own, something like Star Trek's "Prime Directive" - "do not make yourself known to young, adolescent civilizations" should be a common moral stance. – [https://en.wikipedia.org/wiki/Prime\\_Directive](https://en.wikipedia.org/wiki/Prime_Directive)

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## Sorry, E.T.: The Aliens May All Be Dead

22 January, 2016 – [www.space.com/31694-alien-life-extinct-fermi-paradox.html](http://www.space.com/31694-alien-life-extinct-fermi-paradox.html)

It might be relatively easy for life to evolve on hospitable planets throughout the universe, but very hard for it to get any kind of a foothold, a new study suggests. "The universe is probably filled with habitable planets, so many scientists think it should be teeming with aliens, Early life is fragile, so we believe it rarely evolves quickly enough to survive."

Young planets are unstable, and there is thus likely only a small window of time for life to get going, even on initially hospitable worlds.

In the first 500 million years or so of a wet, rocky planet's life, for example, it will be too hot and heavily bombarded to support life. Life could emerge over the next 500 million years, as the planet cools and the impact rates settle down a bit.

During that time, however, the planet will probably be losing its liquid water, perhaps as the result of a runaway greenhouse effect (e.g. Venus), or perhaps because it got too cold. There's a good chance that the planet will end up shifting from habitable to uninhabitable, by roughly 1 billion to 1.5 billion years after its formation — unless life gets going fast enough to stabilize things.

Between the early heat pulses, freezing, volatile content variation, and runaway positive feedbacks, maintaining life on an initially wet rocky planet in the habitable zone may be like trying to ride a wild bull. ##

## Advanced Civilizations Could Thrive in Chaotic Star Clusters

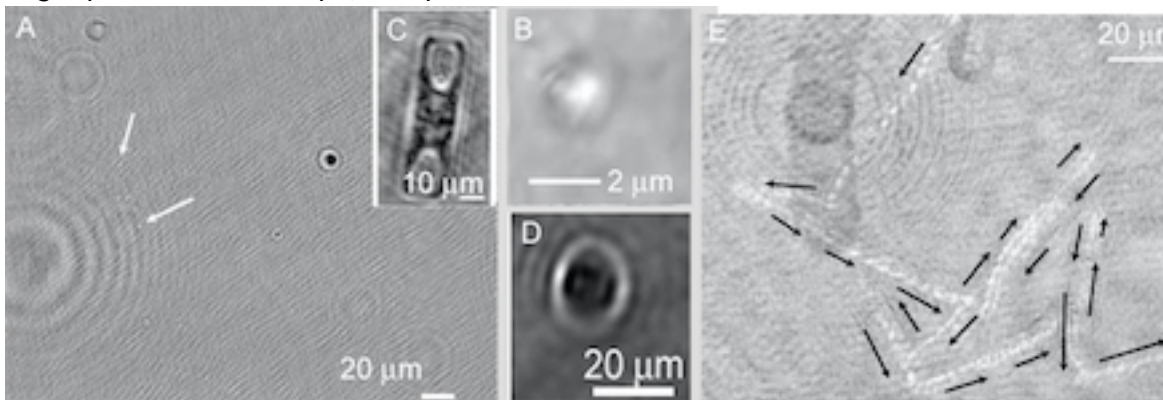
[www.spacedaily.com/reports/Advanced\\_Civilizations\\_Could\\_Thrive\\_in\\_Chaotic\\_Star\\_Clusters\\_999.html](http://www.spacedaily.com/reports/Advanced_Civilizations_Could_Thrive_in_Chaotic_Star_Clusters_999.html)

22 January, 2016 – In the search for alien civilizations, scientists have largely ruled out regions of space known as globular clusters, deemed too chaotic (and crowded) to sustain life. According to a new study, these may, in fact, be the best places to look. *(This article attempts to make the point that seeming disadvantages could be just the opposite - an intriguing idea)*

## How Holograms Could Aid Alien Life Hunt

23 January, 2016 – [www.space.com/31696-alien-life-hunt-holographic-microscope.html](http://www.space.com/31696-alien-life-hunt-holographic-microscope.html)

Scientists have detected microbes in Greenland sea ice using a specially built digital holographic microscope, suggesting that the instrument could have similar success on icy moons in the outer solar system, e.g. Jupiter's moon Europa, if any of them harbor life.



Examples of organisms and trajectories observed in sackhole brines of Malene Bay, **Greenland**, using digital holographic microscopy. (A) Appearance of a nearly full-screen image containing objects suggestive of bacteria (arrows). (B) Zoomed-in appearance of a single bacterial cell. (C) Amplitude image of non-motile diatom. Note the clear resolution of cell walls and nuclei. (D) More slowly swimming, typical photosynthetic algal cell. (E) Zig-zag motility of a bacterium, observed as a projection through 60 seconds of time. ##

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## Rogue Planet Finds Home in Biggest Solar System Ever Seen

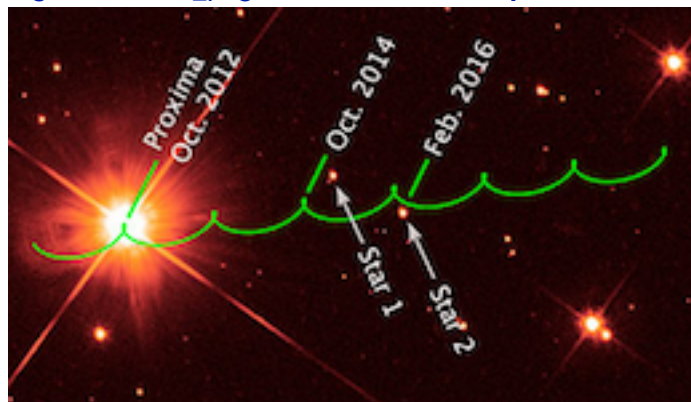
26 January, 2016 = [www.space.com/31731-rogue-planet-biggest-solar-system-discovery.htm](http://www.space.com/31731-rogue-planet-biggest-solar-system-discovery.htm)

A huge alien world orbits 1 trillion km (600 billion mi) from its host star, making its solar system the largest one known. Astronomers have found the parent star for a gas-giant exoplanet designated 2MASS J2126, previously thought to be a "rogue" world alone in space.

The planet and its star are separated by about 7,000 astronomical units (AU), meaning the alien world completes one orbit every 900,000 years or so. (One AU is the average distance from Earth to the Sun — about 93 million miles, or 150 million km). For comparison, Neptune lies about 30 AU from the Sun. Pluto averages about 40 AU from the Sun and the newly hypothesized "Planet X" never gets more than 600 to 1,200 AU away from the Sun. ##

## Rare Stellar Alignment Chance To Hunt For Proxima Centauri Planets

[www.nasa.gov/mission\\_pages/hubble/science/proxima-centauri.html](http://www.nasa.gov/mission_pages/hubble/science/proxima-centauri.html)

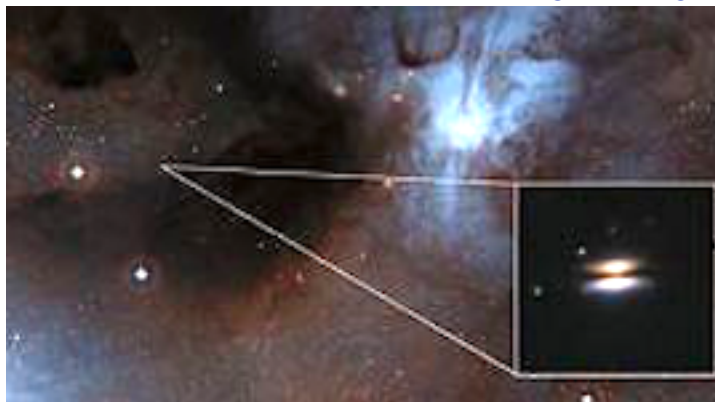


This plot shows the projected motion of the red dwarf star Proxima Centauri (green line) over the next decade, as plotted from Hubble Space Telescope observations. Because of parallax due to Earth's motion around the Sun, the path appears scalloped. Because **Proxima Centauri is the closest star to our Sun** (distance, 4.2 light-years), its angular motion across the sky is relatively fast compared to much more distant background stars. This means that in **February 2016** (as in 2014) Proxima Centauri will pass in front of two background stars that are along its path.

Red dwarfs are the most common class of stars in our Milky Way galaxy, and the longest lived (slowest burning). Any such star ever born is still shining today. Because lower-mass stars tend to have smaller planets, red dwarfs are ideal places to go hunting for Earth-sized planets. ##

## The frigid Flying Saucer (protoplanetary disk)

5 February, 2016 - [www.spacedaily.com/reports/The\\_frigid\\_Flying\\_Saucer\\_999.html](http://www.spacedaily.com/reports/The_frigid_Flying_Saucer_999.html)



The star at left (arrow) has a thin protoplanetary disk extending in both directions (R, L) that happens to cross in front of a nebula, which backlights it, our only evidence of its existence.

An international team in Bordeaux, France, measured the temperature of large dust grains around the young star 2MASS J16281370–2431391 in the spectacular Rho Ophiuchi star formation region, about 400 light-years from Earth. This star is surrounded by a disc of gas and dust – such discs are called protoplanetary discs as they are the early stages in the creation of planetary systems. This disc is seen nearly edge-on, and its appearance in visible light pictures led to the nickname “the Flying Saucer.” ##

## Eying Exomoons in the Search for E.T.

– 19 February, 2016 – [www.space.com/31982-eying-exomoons-in-the-search-for-e-t.html](http://www.space.com/31982-eying-exomoons-in-the-search-for-e-t.html)

The first definitive detection of an exoplanet was in 1991, identified by the tiny wobbles experienced by the parent star as its exoplanet swung around it. There are now around 1,600 confirmed exoplanets with almost 4,000 other known candidates.

There are exoplanets smaller than Mercury and others many times bigger than Jupiter. Their orbits around their parent stars range from a few hours to hundreds of years.

And the ones we know about are just a tiny fraction of the approximately 100 billion exoplanets we believe are spread throughout our Milky Way galaxy.

While the golden age of exoplanets has barely begun, a new and exciting chapter is taking shape: **the hunt for exomoons**. We haven't found a single one, not yet.

### The vital role the Moon has played in the emergence of life on Earth

The Earth's axis is tilted by 23.5 degrees relative to its motion around the sun. This tilt gives us seasons that are mild: most places never get impossibly hot or unbearably cold. One thing that has been crucial for life is that this tilt has stayed the same for very long periods: for millions of years, the angle of tilt has varied by only a couple of degrees, thanks to the gravity of our Moon.

**Editor:** Further, originally the Moon was much closer to Earth than it is now, raising huge tides in our oceans. This tidal interaction slowly pushed the Moon further out and more than doubled the original length of Earth's day. In short, without the Moon, Earth would never have become the haven for life that it now is.

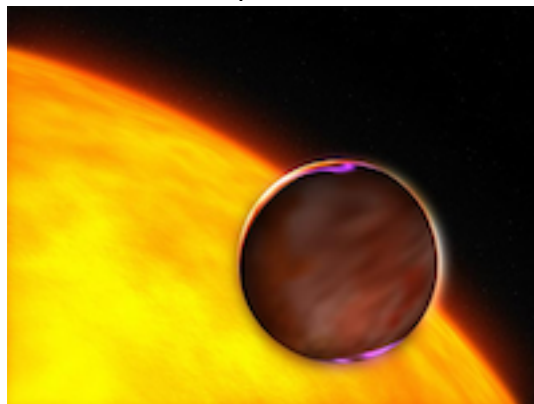
This suggests that worlds that are “Earth-like” in size and in relative distance from their sun, might not be truly “Earth-like” without a moon of size. **Hence the search for moons of size around planets in their sun's goldilocks zone, where oceans can exist.**

Finding exomoons is a key part of finding somewhere like here. ##

## Extremely Hot and Incredibly Close: How Hot Jupiters Defy Theory

[www.space.com/32011-extremely-hot-and-fast-planets-seem-to-defy-logic.html](http://www.space.com/32011-extremely-hot-and-fast-planets-seem-to-defy-logic.html)

22 February, 2016 – Planets move. And not just a little. They move a lot. All over the place. In fact, in the early days of a solar system's formation, planets are a little rambunctious: squirrely little toddlers jostling about underfoot. But it wasn't until we started observing planets in other solar systems (“extrasolar planets” or “exoplanets”) that we really noticed this fact.



Artist's impression showing a close-up of the extrasolar planet XO-1b passing in front of a Sun-like star 600 light years from Earth. The Jupiter-sized planet is in a tight four-day orbit around the star.

### Hot Jupiters whipping around

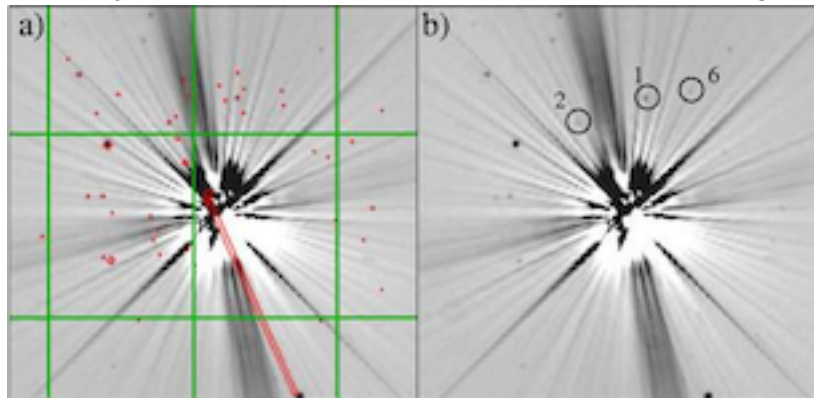
It wasn't just any type of exoplanet that kicked off this re-think; it was the hot Jupiters. Imagine: a planet more massive than the largest one in our solar system and 10 times warmer, a monstrous beast of hydrogen and other elements, complete with swirling bands of gas and a rich, dynamic atmosphere, orbiting closer its star than Mercury orbits the sun. In some solar systems, such a planet orbits so quickly that its year is shorter than the Earth's day. That means these worlds can whip around their parent stars in hours. The physics involved can reduce the most hardened scientist to tears.

Imagine: a planet more massive than the largest one in our solar system and 10 times warmer, a monstrous beast of hydrogen and other elements, complete with swirling bands of gas and a rich, dynamic atmosphere, orbiting closer its star than Mercury orbits the sun. In some solar systems, such a planet orbits so quickly that its year is shorter than the Earth's day. That means these worlds can whip around their parent stars in hours. Read on. ##

## Imaging technique may help discover Earth-like planets

23 February, 2016 - <http://phys.org/news/2016-02-imaging-technique-earth-like-planets.html>

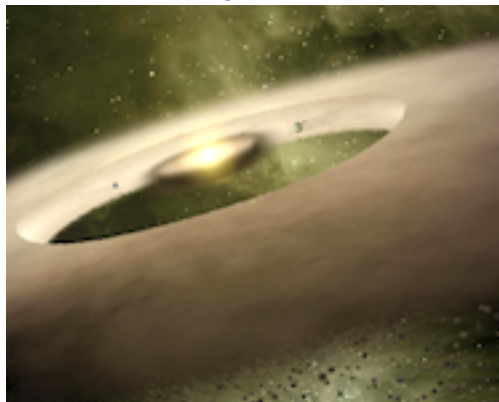
A charge injection device, or CID, has the ability to capture light from objects tens of millions of times fainter than another object in the same picture. An exoplanet next to bright star is an example.



A CID device can detect dim objects even behind Sirius, the brightest star in our galaxy. The "A" image shows the Sirius field and the sky coordinates in green. Red dots represent already cataloged objects. The red line is the motion of Sirius. The "B" image shows faint objects detected near Sirius. ##

## On the Origin of Worlds: Astrophysicists Zero in on How Planets Form

24 February, 2016 [www.space.com/32047-startling-observations-help-reveal-howplanets-form.html](http://www.space.com/32047-startling-observations-help-reveal-howplanets-form.html)



Artist's impression of a donut-shaped "transition disk" around a star, where still-developing planets have carved out a gap in a gassy, dusty, protoplanetary disk.

In November, using a new observing method, scientists snapped the very first pictures of an extrasolar planet still gathering up mass from its dusty, planetary nursery. Called LkCa 15 b, this immature gas giant has opened a window into the poorly understood process of how planets form. ##

## Universe contains fewer Earth-like planets than previously thought

24 February, 2016 – <http://phys.org/news/2016-02-earth-unique-thought.html>

A computer model of the known universe used to estimate the number of likely other exoplanets able to hold life, has found that there might be fewer Earth-like planets than has been thought.

## Newly discovered planet could shed light on planetary evolution

28 February, 2016 – <http://phys.org/news/2016-02-newly-planet-hyades-cluster-planetary.html>

University of Texas astronomers have discovered a planet in the nearby Hyades star cluster which could help astronomers better understand how planets form and evolve.

The planet “**K2-25b**” orbits a red dwarf star smaller and dimmer than the Sun. Red dwarfs are the most abundant stars. Its stars in the Hyades are young. Their planets must be young, too.

Open clusters are powerful tools as all the stars formed with the same age and composition. Once many planets are found orbiting young cluster stars, we can compare them to planets orbiting older stars elsewhere to see if they differ in some fundamental way—if they change with time. \$\$ For instance, he said, if planets orbiting young stars are farther from their host stars than their older counterparts, it suggests that planets migrate over their lifetimes. They may form farther out and migrate inward. Many exoplanetary systems have large planets orbiting close to their stars, unlike our own solar system. This kind of research could test the theory of planetary migration. ##

## Volcanoes Light Up Atmospheres of Small Exoplanets

29 February, 2016 – [www.space.com/32068-spot-alien-volcanoes-earth-sized-planet.html](http://www.space.com/32068-spot-alien-volcanoes-earth-sized-planet.html)

What if there was a large volcanic eruption on such an Earth-like planet — could we spot that? A group of graduate students at the University of Washington's astrobiology program considered this question after it arose during a class discussion about the search for life outside our solar system.

"All life needs energy. At first we thought about **plate tectonics**. It's not necessary for life\*, but it might be a good indicator of places that are habitable. But it's very hard to spot that, so we looked more closely at volcanism [the driver of plate tectonics. – Ed.]

The resulting article, "Transient Sulfate Aerosols as a Signature of Exoplanet Volcanism," was published in the journal *Astrobiology* in June.

**Editor's note:** See our definition of an "Earth-like planet"

[http://moonsociety.org/publications/m3glossary.html#hydro\\_tectonic](http://moonsociety.org/publications/m3glossary.html#hydro_tectonic)

In our opinion, those looking for "Earth-like" planets are using the term far too loosely. ##

## Hunt for Intelligent Aliens Should Focus on 'Transit Zone'

[www.space.com/32089-intelligent-alien-life-search-earth-transit-zone.html](http://www.space.com/32089-intelligent-alien-life-search-earth-transit-zone.html)

1 March, 2016 – If we can only find planets that transit in front of their suns, which means that the Sun and Earth line up with the “ecliptic” of such planets around their suns, then those systems are also in the ecliptic of our world around our Sun I,e, their system and our system

## Alien Planet May Have Kicked Its Neighbor Into the Sticks

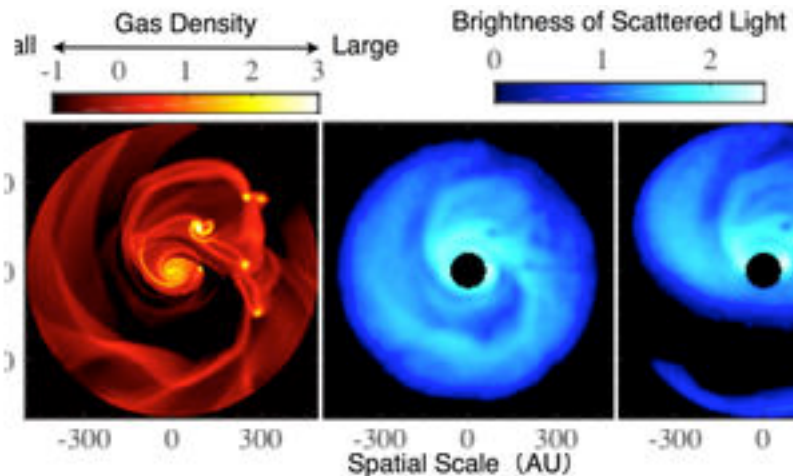
3 March, 2016 – [www.space.com/32085-alien-planet-kicked-out-by-neighbor.html](http://www.space.com/32085-alien-planet-kicked-out-by-neighbor.html)

A planet found at an extreme distance from its parent star may have been kicked out by a fellow planet. Planet HD 106906b orbits 16 times as far from its parent star as Pluto lies from the Sun.

A new study reveals what appears to be a lopsided comet belt surrounding its parent star — indicating a history of violence in the early era of this planetary system. "Since HD 106906b is very massive, the most likely culprit is another massive planet in the system that gravitationally jostled HD 106906b from its original orbit,"

## Young Stars May Feast Frantically, Grow Chaotically, New Study Shows

15 March, 2016 - [www.space.com/32266-young-stars-grow-chaotically-study-shows.html](http://www.space.com/32266-young-stars-grow-chaotically-study-shows.html)



Computer simulations show the possible motion of materials falling onto a baby star (left). The infalling matter could be producing bright bursts of light. The middle and right images show what the light patterns would look like, seen from two different angles. ##

## EXO-PLANET LIFE STAGES

### On Earth it took 3.7 billion years for Multi-Cellular Life to form

[www.nytimes.com/2016/01/12/science/genetic-flip-helped-organisms-go-from-one-cell-to-many.html](http://www.nytimes.com/2016/01/12/science/genetic-flip-helped-organisms-go-from-one-cell-to-many.html)

7 January, 2016 - The diversity of animal forms never ceases to amaze. At the root of this spectacular diversity is the fact that all animals are made up of many cells — in our case, about 37 trillion of them. As an animal develops from a fertilized egg, its cells may diversify into a seemingly limitless range of types and tissues, from tusks to feathers to brains.

**On Earth, the transition from our single-celled ancestors to the first multicellular animals occurred about 800 million years ago**, but scientists aren't sure how it happened. A team of researchers tackles this mystery in a new way. Earth was already 3.7 billion years old!

The authors of the new study focused on a **single molecule called GK-PID**, which animals depend on for growing different kinds of tissues. Without GK-PID, cells don't develop into coherent structures, instead growing into a disorganized mess and sometimes even turning cancerous. GK-PID's job, scientists have found, is to link proteins so that cells can divide properly.

**Editor: We do not know if the length of time it took Earth to develop multi-cellular life (all the life forms we can see around us) is typical.** The triggering event could happen sooner on some worlds, or not at all on others. **The point is that younger otherwise-Earthlike worlds are less likely to have reached our stage and to have joined "the metazoan club."**

The phrase "Earth-like" is being bandied about much too loosely by exo=planet hunters, and, **yes, this is meant to be taken in a derogatory way**. It is not in the public interest to bandy about the term "Earth-like" as simply a rocky planet in a certain size range.

"Our" Earth belongs to a select club. Not every rocky planet in its Sun's "goldilocks zone" (where water can remain liquid) necessarily hosts "life as we know it."

Now could such a "trigger molecule" drift through space and "inseminate" suitable worlds?



*We have but one instance from which to draw shaky conclusions. ##*

Nb. **Alpha Centauri A–B** is already about 6 billion years old. **Zeta Reticuli** only 1,8–2 billion years old, **Tau Ceti** 5.9 billion years old, As we have pointed out, Yellow=White stars (like **Procyon**) live less than 2 billion years so any otherwise “Earth-like” planets around such “Suns” could be “colonized” without risk of “interfering” with the chances of indigenous life forms to mature.

**Our definition of an “Earth-like planet” ?**

[www.moonsociety.org/publications/m3glossary.html#hydro\\_tectonic](http://www.moonsociety.org/publications/m3glossary.html#hydro_tectonic)

## Extraterrestrial Life Could Be Vulnerable to Greenhouse Effect

[www.space.com/31902-alien-life-vulnerable-to-greenhouse-effect.html](http://www.space.com/31902-alien-life-vulnerable-to-greenhouse-effect.html)

11 February, 2016 – Scientists assume water is necessary for life to arise on other planets. In the search for life outside our solar system, the focus is on a “habitable zone” around other stars. Inside such a zone, Earth-like planets are neither too hot nor too cold for liquid water to exist on the surface. A planet that orbits too close to its Sun may become parched because of the solar heat.

But now, scientists think an extreme greenhouse effect can also push a planet into dry conditions — similar to what happened on Venus. ##

## Real-Life 'Death Star' Continues to Destroy Alien Worlds

10 March, 2016 – [www.space.com/32216-death-star-destroy-alien-worlds.html](http://www.space.com/32216-death-star-destroy-alien-worlds.html)

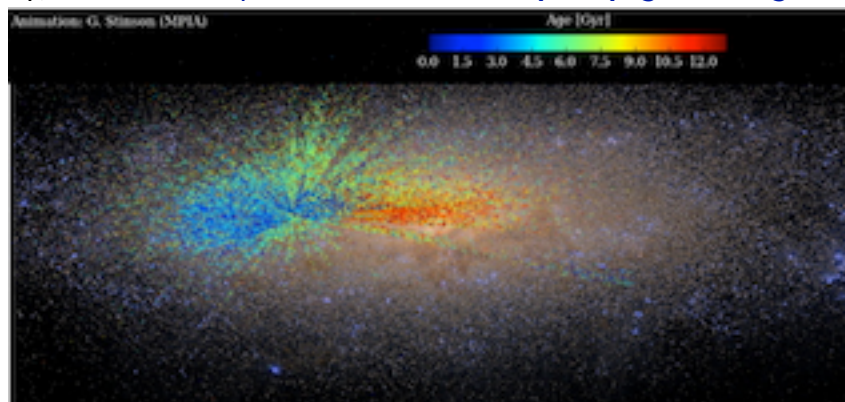
Recently, astronomers detected a dead star tearing apart a planetesimal — a small planetary body, such as a dwarf planet, large asteroid or moon. The dead star is a white dwarf known as WD 1145+017, which lies about 570 light-years from Earth in the constellation Virgo.

This finding could shed light on how dead stars rip apart their planetary systems — a phenomenon that could happen in our solar system billions of years from now. ##

## OUR MILKY WAY GALAXY

### Milky Way's Growth Rings Unveiled in 1st Age Map

8 January, 2016 – [www.space.com/31564-milky-way-growth-age-map.html](http://www.space.com/31564-milky-way-growth-age-map.html)



Colored dots over an artist's rendition of the Milky Way reveal the location and ages of stars in the galaxy. Red dots show the older stars, which formed early in the life of the galaxy, while blue dots show the younger generations that have formed since.

The first complete age map of the Milky Way shows that the galaxy grew from the inside out.

To construct the map, scientists measured the composition and masses of red giant stars to determine their ages. Using a revolutionary technique, the researchers found that older Milky Way stars tend to lie near the center of the spiral galaxy, whereas subsequent generations formed around the spreading edges of the disk. ##

## Milky Way's Second Most Massive Black Hole Found?

[www.space.com/31657-milky-way-second-most-massive-black-hole-found.html](http://www.space.com/31657-milky-way-second-most-massive-black-hole-found.html)

19 January, 2016 – Astronomers have detected what could be the second most massive black hole in our galaxy and it may be the missing piece of a cosmic puzzle. They spied the whirling gases caught in its powerful gravitational grasp, potentially establish a new method to track down elusive "intermediate-mass" black holes. The object is only 200 light-years from the Milky Way's supermassive black hole Sagittarius A\* (Sgr. A\*). By tracking the emissions from a swirling gas cloud called "CO-0.40-0.22," they found a "surprisingly wide velocity dispersion" — this cloud of gas is composed of material that is swirling at a wide range of speeds.

Using computer models, they were able to deduce that an extremely compact object — a black hole in the "eye" of this interstellar storm on the order of 100,000 solar masses-massive. If confirmed, this would make the invisible object at the core of CO-0.40-0.22 a so-called "intermediate-mass" black hole, second in mass only to mighty Sgr. A\* itself. ##

## Dying Star Betelgeuse Keeps Its Cool ... and Astronomers Are Puzzled

25 January, 2016 – [www.space.com/31693-dying-star-betelgeuse-puzzles-astronomers.html](http://www.space.com/31693-dying-star-betelgeuse-puzzles-astronomers.html)

<https://en.wikipedia.org/wiki/Betelgeuse>

"If Betelgeuse were at the center of the Solar System, its surface would extend past the asteroid belt, possibly to the orbit of Jupiter and beyond, wholly engulfing Mercury, Venus, Earth and Mars. Estimates of its mass are poorly constrained, but range from 5 to 30 times that of the Sun. Its distance from Earth was estimated in 2008 at 640 light years, yielding a mean absolute magnitude of about -6.02. Less than 10 million years old, Betelgeuse has evolved rapidly because of its high mass." – Wikipedia

Betelgeuse, in the constellation Orion, has entered the twilight of its life. Like many stars of a similar size that reach the end of the road, Betelgeuse is slowly shedding its mortal coil — by ejecting much of its mass out into space.

This phase of star death is extremely common in the universe — in about 5 billion years, when the Sun starts to die, it too will become a "red giant." It will shed much of its mass and swell to such an enormous size that it will engulf Mercury, Venus and Earth. But new observations of Betelgeuse show that scientists still can't explain what causes a red giant's massive expulsion of matter ##



Betelgeuse (Alpha Orionis) is the pink star to the upper right in the Constellation Orion

## Strange Superfast 'Cannonball' Star Likely Blasted from Supernova

25 January, 2016 – [www.space.com/31691-rare-cannonball-carbon-star-supernova.html](http://www.space.com/31691-rare-cannonball-carbon-star-supernova.html)

A star with an unusual history is racing through the galaxy at breakneck speed — most likely blasted away by a supernova and carrying traces of the exploded star. Rocketing along at more than 1.54 million km/hr (960,000 mi/hr) hour, is stained in carbon even though it's too immature to have created the stuff itself.

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

There may be something about it being a dwarf carbon star that has to do with it having this crazy-high speed. The top guess is that the speedy star was in a binary system with another star that imbued it with carbon before dying in a massive supernova explosion, shooting the first star out and away. The situation may be similar for several other "cannonball" candidates the researchers have identified. 33

## Why Is This Dwarf Galaxy So Clean Of Cosmic Soot? | Video

[www.space.com/31737-why-is-this-dwarf-galaxy-so-clean-of-cosmic-soot-video.html](http://www.space.com/31737-why-is-this-dwarf-galaxy-so-clean-of-cosmic-soot-video.html)

A tiny, tidy galactic neighbor of our Milky Way, named IC 1613, is surprisingly free of light obscuring dust, allowing astronomers to calibrate its distance very precisely at 2.3 million light years

## Hundreds Of Hidden Galaxies Behind Milky Way's Haze | Video

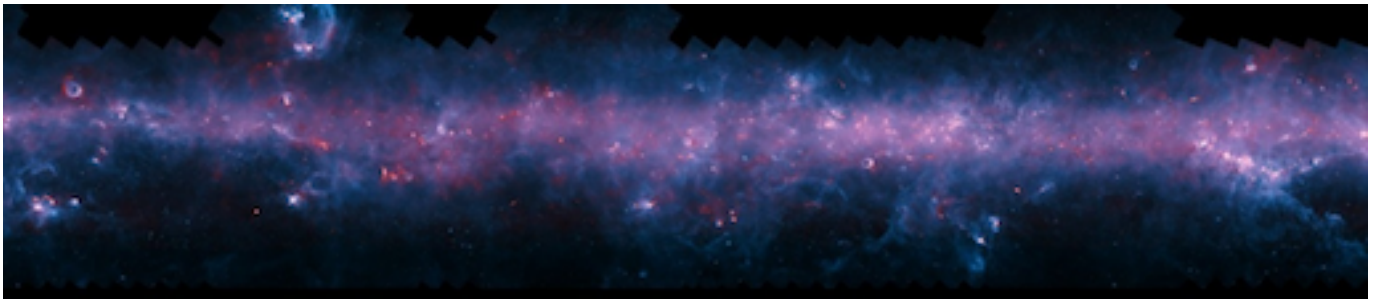
[www.space.com/31862-hidden-galaxies-behind-milky-way-haze-video.html](http://www.space.com/31862-hidden-galaxies-behind-milky-way-haze-video.html)

[www.space.com/31872-hidden-galaxies-behind-milky-way-revealed.html](http://www.space.com/31872-hidden-galaxies-behind-milky-way-revealed.html)

Australia's Parkes radio telescope looked through the dust and gas of our Milky Way galaxy to observe 883 galaxies, "a third of which had never been seen before." The combined mass of these previously unknown 'star cities' informs scientists' understanding of The Great Attractor gravity anomaly, which pulls our region of space towards it.

## Incredible New View of the Milky Way Revealed (Video)

25 February, 2016 – [www.space.com/32043-incredible-milky-way-telescope-view-video.html](http://www.space.com/32043-incredible-milky-way-telescope-view-video.html)



An incredible new picture of the Milky Way shows our home galaxy glowing eerily in wavelengths that are invisible to the human eye, revealing zones of hidden star.

## Mon-Stars! Cluster of Massive Suns Spotted by Hubble Telescope (Photo)

17 March, 2015 – [www.space.com/32305-monster-stars-hubble-space-telescope-photo.html](http://www.space.com/32305-monster-stars-hubble-space-telescope-photo.html)

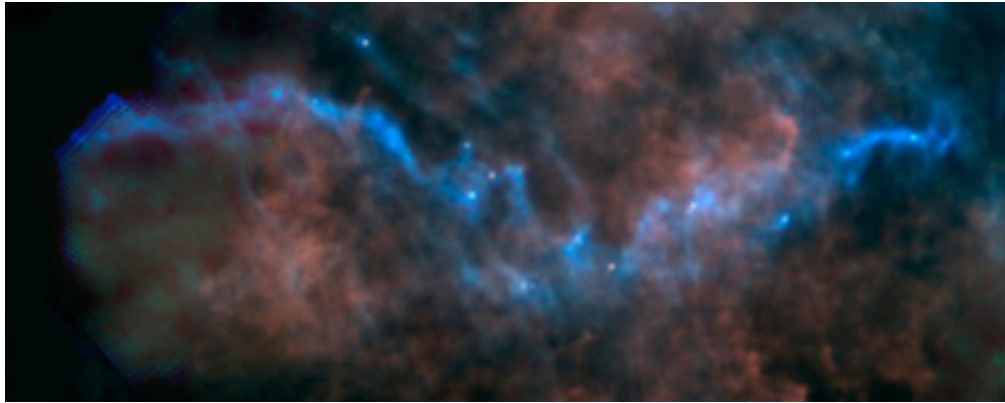


The central region of the Tarantula Nebula in the Large Magellanic Cloud (Satellite galaxy of the Milky Way) appears in this Hubble Space Telescope image

## Herschel Space Observatory Reveals a Ribbon of Future Stars

[www.esa.int/spaceinimages/Images/2016/03/Herschel\\_reveals\\_a\\_ribbon\\_of\\_future\\_stars](http://www.esa.int/spaceinimages/Images/2016/03/Herschel_reveals_a_ribbon_of_future_stars)

28 March, 3016



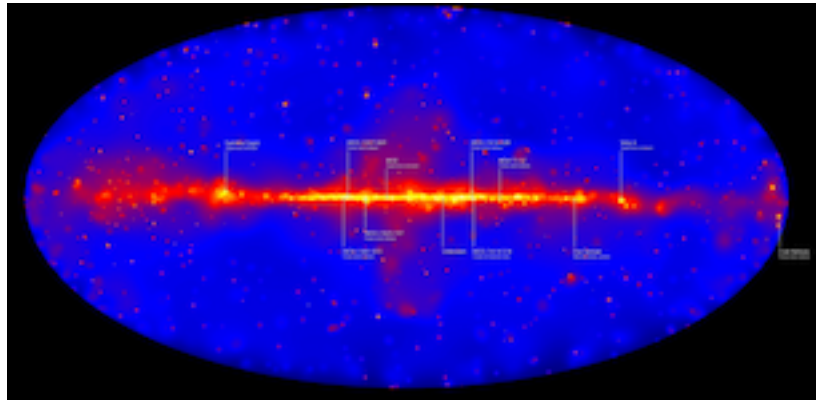
The Milky Way is laced with clouds of dust and gas that could become the nursery of the next generation of stars. Thanks to ESA's Herschel space observatory, we can now look inside these clouds and see what is truly going on. Astronomers look for the coldest spots in the Milky Way, because before the stars ignite the gas that will form their bulk, they must collapse together. To do that, the cloud has to be cold and sluggish, so that it cannot resist gravity. ##

## THE UNIVERSE AT LARGE

### Best Ever High-Energy Map of the Universe (must watch video)

12 January, 2016 - [www.space.com/31585-high-energy-sky-map-nasa-fermi.html](http://www.space.com/31585-high-energy-sky-map-nasa-fermi.html)

[www.space.com/22464-five-illuminating-years-from-the-fermi-gamma-ray-space-telescope-video.html](http://www.space.com/22464-five-illuminating-years-from-the-fermi-gamma-ray-space-telescope-video.html)

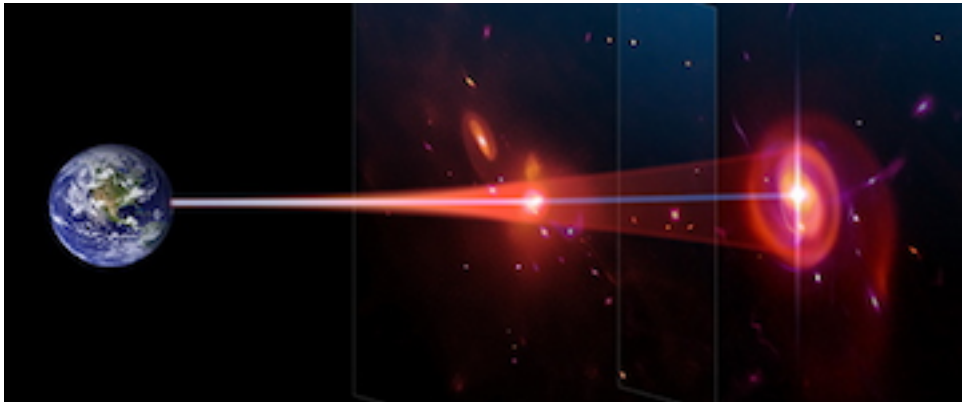


More than six years of observations by NASA's Fermi Gamma-ray Space Telescope show the entire sky at energies billions to trillions of times greater than visible light. This map reveals hundreds of sources of such light throughout the universe, from dead stars colliding within the Milky Way to distant galaxies that sport jets from supermassive black holes

Astronomers have performed the best-ever census of the high-energy sky. They used more than six years' worth of data collected by NASA's Fermi Gamma Ray Space Telescope to construct an incredibly detailed map of gamma-ray light, which can be more than a trillion times more energetic than visible light. The LAT has detected over 360 sources, which is an extremely large number of sources for this extreme energy range. ##

## Ancient Galaxies' light Illuminates 40-Year Mystery of Early Universe

19 January, 2016 - [www.space.com/31633-early-galaxies-40-year-mystery.html](http://www.space.com/31633-early-galaxies-40-year-mystery.html)



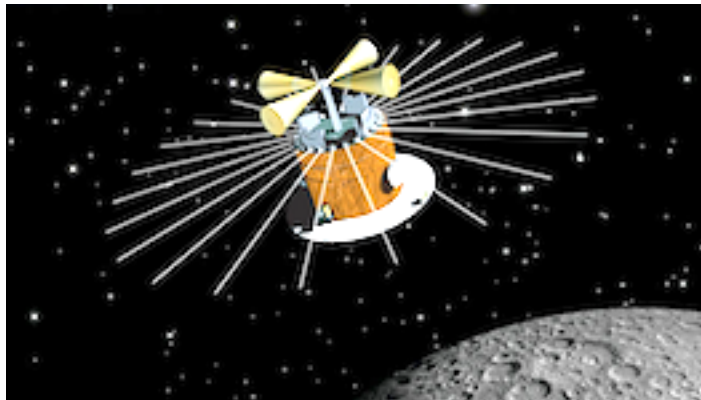
Artist's impression of using a background galaxy to measure the size and composition of the clouds of dust and gas that seed other galaxies

Early galaxies are shining light on a decades-old mystery, helping to determine the size and composition of the gas clouds responsible for forming their neighbors through a new technique to illuminate the clouds of gas that built galaxies like the Milky Way. ##

## Universe's 'Dark Ages' May Come to Light with Moon Orbiter

5 February, 2016 - [www.space.com/31811-universe-dark-ages-dare-moon-orbiter.html](http://www.space.com/31811-universe-dark-ages-dare-moon-orbiter.html)

Spacecraft would orbit the Moon, sheltered in its shadow to gaze into the early days of the universe.



The **Dark Ages Radio Explorer** would orbit the Moon, taking readings with a radio telescope **while it was shielded from Earth** in order to probe the universe's early "dark ages."

This is a unique way, and may turn out to be effectively the only way, of probing these first stars and galaxies that occurred in our universe — that led to galaxies like the Milky Way, stars like our Sun, several generations later. ##

## Gravitational Waves: A Black Hole Is Trying to Slap You - Can You Feel it?

10 February, 2016 - [www.space.com/31896-gravitational-waves-black-holes-sutter-op-ed.html](http://www.space.com/31896-gravitational-waves-black-holes-sutter-op-ed.html)

[www.space.com/31897-gravitational-waves-simply-explained-with-a-cube-and-marble-video.html](http://www.space.com/31897-gravitational-waves-simply-explained-with-a-cube-and-marble-video.html)

[www.space.com/31879-gravitational-waves-vs-gravity-waves.htm](http://www.space.com/31879-gravitational-waves-vs-gravity-waves.htm)

[www.space.com/31901-historic-gravitational-waves-discovery-explained-by-experts-video.html](http://www.space.com/31901-historic-gravitational-waves-discovery-explained-by-experts-video.html)

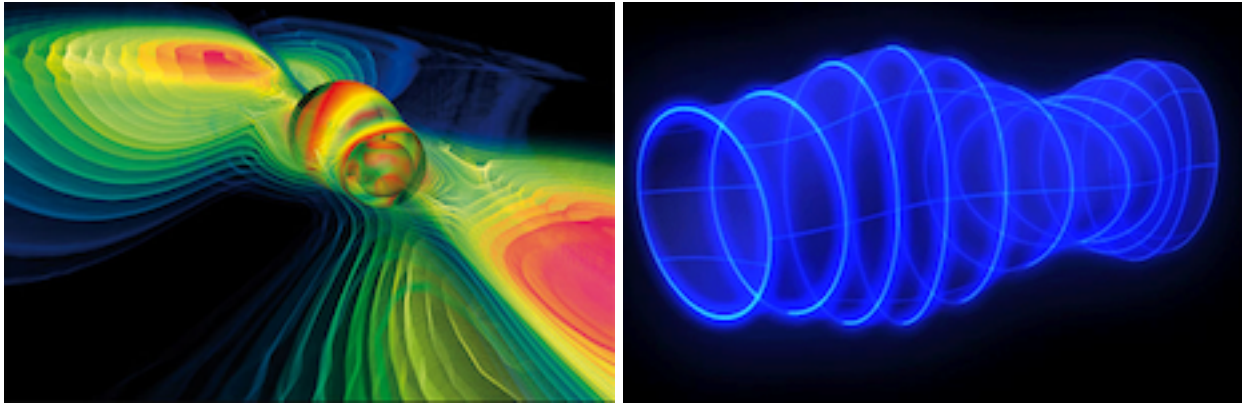
[www.space.com/31903-how-were-gravitational-waves-found-coming-movie-to-tell-all-exclusive-trailer.html](http://www.space.com/31903-how-were-gravitational-waves-found-coming-movie-to-tell-all-exclusive-trailer.html)

[www.esa.int/Our\\_Activities/Space\\_Science/ESA\\_congratulations\\_on\\_gravitational\\_wave\\_discovery](http://www.esa.int/Our_Activities/Space_Science/ESA_congratulations_on_gravitational_wave_discovery)

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[www.space.com/31916-what-gravitational-waves-sound-like-video.html](http://www.space.com/31916-what-gravitational-waves-sound-like-video.html)

[www.space.com/31913-how-scientists-detected-gravitational-waves-ligo.html](http://www.space.com/31913-how-scientists-detected-gravitational-waves-ligo.html)



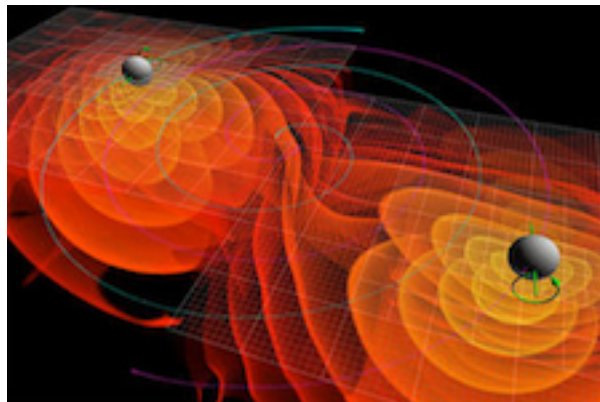
L: View from computer simulation shows production of gravitational waves during a black-hole collision  
R. Illustration of pulsing gravity wave.

In general relativity, space-time is dynamic. The stage is an actor, too! It can warp and twist, and bend and flex. It can wave. It responds to the presence of matter and energy and can influence the behavior of that same matter and energy, exactly as you can. Space-time is a thing.

Space-time isn't a wooden floor; it's a trampoline. ##

## Gravitational Waves: Spying the Universe's 'Dark Side'

[www.space.com/32090-gravitational-waves-spying-the-universes-dark-side.html](http://www.space.com/32090-gravitational-waves-spying-the-universes-dark-side.html)



This graphic shows the results from a numerical simulation of 2 spinning black holes orbiting one another, generating powerful gravitational waves — the phenomenon that was discovered by LIGO's super-sensitive detectors on Sept. 14, 2015.

29 February, 2016 – The Feb. 11 announcement that scientists finally had proof that space itself vibrates is expected to unleash a bevy of discoveries about things that go bump in the proverbial darkness.

The initial detection of so-called gravitational waves occurred in September when a pair of black holes, each about 30 times more massive than the sun, spiraled in toward each other and then merged into a new, larger black hole more than 1.3 billion light years away. ##

## India to Join Hunt for Gravitational Waves

2 March, 2016 – [www.space.com/32091-india-joins-ligo-gravitational-waves-hunt.html](http://www.space.com/32091-india-joins-ligo-gravitational-waves-hunt.html)

On Feb. 17, the Indian Cabinet, chaired by Prime Minister Shri Narendra Modi, granted "in-principle approval" for the country to start building a gravitational-wave detector that will work in concert with the two detectors currently operating in the United States and a third detector set to come online in Italy. It is feasible that the project could come online as soon as 2023. ##

## Gas Cloud Flung Out of Milky Way Is Coming Back for Revenge

[www.space.com/31873-gas-cloud-boomerangs-back-from-milky-way.html](http://www.space.com/31873-gas-cloud-boomerangs-back-from-milky-way.html)



This composite image shows what Smith's Cloud would look like in the night sky, if it were visible to human eyes. The cloud is on a course to collide with the Milky Way in about 30 million years. The cloud appears in false-color, radio wavelengths as observed by the Green Bank Telescope in West Virginia.

## Dark Matter Clue: Strange Radio Bursts Finally Reveal Host Galaxy

[www.space.com/32055-mystery-fast-radio-burst-space-explosions-location.html](http://www.space.com/32055-mystery-fast-radio-burst-space-explosions-location.html)

For the first time, scientists have determined the location and distance of a strange and powerful explosion known as a fast radio burst, a finding that allows them to refine models of dark matter.

The mysterious explosions light up the sky thousands of times a day, but what causes them and even where they come from has long remained a puzzle.

Thanks to a new observing program that allows for fast identification and follow-up of these blazes, scientists were able to identify the host galaxy for one of the fast radio bursts, known as FRBs, and use it to begin to unravel another puzzle as well — dark matter.##

## Farthest Galaxy Yet Smashes Cosmic Distance Record

3 March, 2016 – [www.space.com/32150-farthest-galaxy-smashes-cosmic-distance-record.html](http://www.space.com/32150-farthest-galaxy-smashes-cosmic-distance-record.html)  
[www.space.com/32148-hubble-takes-step-back-in-time-to-break-cosmic-distance-record-video.html](http://www.space.com/32148-hubble-takes-step-back-in-time-to-break-cosmic-distance-record-video.html)

The Hubble Space Telescope just calculated the distance to the most far-out galaxy ever measured, providing scientists with a look deep into the history of the universe. The far-away galaxy, named GN-z11, existed a mere 400 million years after the Big Bang, about 13.3 billion years ago. Because the light from such a distant galaxy must travel huge distances to reach Earth, ##



## To The Stars International Quarterly Editorial Team

TTSIQ is a project of the National Space Society's International Committee



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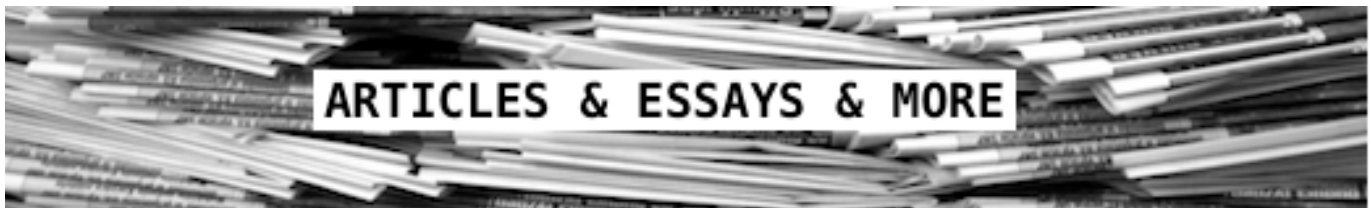
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**We welcome additional co-Editors and Contributors  
As well as Reporters from various nations and student groups**





## “Internationalization” and the Inevitable “Tragedy of the Commons”



By Peter Kokh

**Personal Comment:** I crossed the Atlantic from New York City to Southampton, England in late August 1961 aboard the steamship SS, United States.. The seas were calm, and the water clean. I returned 15 months later, Liverpool to St John’s New Brunswick aboard the Empress of Britain.. This time the waters were anything but calm, 20 m (60 ft) waves all the way, [I was one of 35 who did not get sea sick.] And the water was still clean. Today, 55 years later, it is full of trash as the photo above shows, because, beyond a certain limit, it “belongs to everyone.” “Everyone” has no way to exert responsibility and enforce antidumping laws. #

### **The Internationalization Trap and Space Debris**

We already see the same phenomenon in space: **Space Debris**. No country owns space and international organizations such as the United Nations and its derivatives, have no effective authority over anything. In the ocean, beyond 320 km/200 miles from continental shores, no nation can exert authority. The oceans belong to everyone (i.e, to no one.) Well intended regulations are totally toothless.

The same is true with space beyond Earth’s atmosphere. It is international territory, and that effectively means, that like the oceans, it is becoming a dumping ground for satellites and parts of satellites no longer operational. And as they crash into one another, Low Earth Orbit space is becoming a mine field. Another case where “International, er, to every country” means to no one.

What is happening to near Earth space – THE SPACE DEBRIS PROBLEM (capitalized to the last letter) threatens to reach a point where it could imprison us on Earth’s surface, ending the Space Age.

**Will not the same fate befall opening of the Moon and to Mars to human communities?**

**On worlds beyond Earth, there must be an effective regime of responsibility – self government responsible to settlers. Settlers must be able to assert sovereignty, and take responsibility for yet unsettled areas of these worlds. There must be no “International Turf.”**

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

We need autonomous Lunar and Martian governments, responsible to the settlers, not in some well intended but unpoliceable vague and toothless way “responsible” to Earth or “Humanity” at large.

We do not intend here to suggest how to rewrite “the Moon Treaty” – but only to point out that there is an urgent need to avoid this vacuum of responsibility for all of us who wish to see mankind spread throughout Earth’s consollar hinterspace in some responsible way.

We will not succeed in spreading mankind throughout the Solar System and its fringes, unless we all come to realize that **“International”, however well-meant, is a dirty word as presently meant.** ##

[[ If you haven’t yet, DO read Garret Hardin’s novel, **The Voyage of the Spaceship Beagle and the Tragedy of the Commons.** That it is now decades old, does not mean it has become irrelevant! ]]

Some of many books and articles about this monumental novel and its significance.

[http://www.garretthardinsociety.org/articles/art\\_tragedy\\_of\\_the\\_commons.html](http://www.garretthardinsociety.org/articles/art_tragedy_of_the_commons.html)

[https://en.wikipedia.org/wiki/Tragedy\\_of\\_the\\_commons](https://en.wikipedia.org/wiki/Tragedy_of_the_commons)

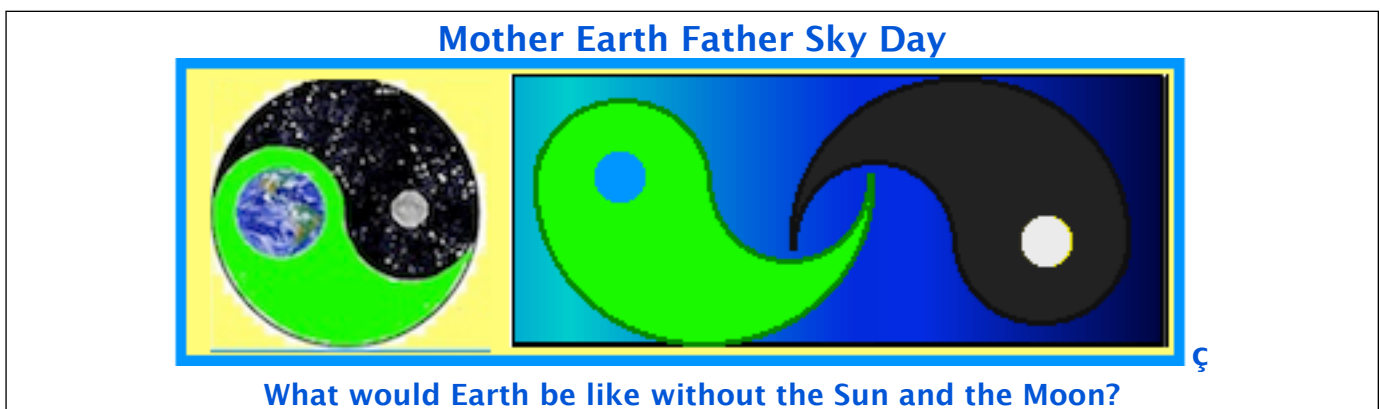
<http://web.mnstate.edu/gracyk/courses/phil%20115/Hardin-on-lifeboat.htm>

<http://www-personal.umich.edu/~rdeyoung/tragedy.html>

<https://www.youtube.com/watch?v=g8yOamWq3a0>

<http://www.eolss.net/sample-chapters/c13/e1-45-01-07.pdf>

Any and all discussion of Space Law without this vacuum in mind, is a dillusionary waste of time. PK



By Peter Kokh

When In December 1966, the **Apollo 8** astronauts circled the Moon and took photos of Earth – the whole planet, hanging there in the blackness of space – it made us all aware that despite our ethnic, political, linguistic, economic, and other differences, **we all share a special world, one that our new found powers to alter our environ- ment on purpose or through disregard, suddenly made us aware of our custodial burden – or is it a privilege – to hand over our priceless ecosphere to our children as we would want our elders to have done, if roles were reversed.**

Five years earlier, Yuri Gagarin’s daring journey as the first to orbit our planet, short as it was, made us aware of **how small our world is**, as did photos of Earth from far away.

### **Yin and Yang**

Nine years after Yuri’s trip, in April 1970, the world’s first Earthday was celebrated. Some of us are old enough to remember that. Those of us who realize how fragile our world is, and who care not just about the health of the economy we hand over to our children but as much about the environmental health of the biosphere we hand over to them, reflect on Earthday, about small victories, areas of deterioration, and more. If “conservatives” care only about the economy we hand over to the next generation and “environmentalists” only about the state of the environment we pass on, then both should hang their heads in shame. **Our children deserve not just a healthy economy, not just a healthy biosphere, but both.** To those who only look at one or the other, we say **“grow up!”**

### **What would Earth be like without the Sun and the Moon?**

In the composite logo above, I have tried to express in graphics a more holistic approach to Earthday. I have a book about mythologies that labels them as patriarchal or matriarchal. Hey, we need both! Yuri’s Night and the Apollo missions out to the Moon and back, made us aware that **our “local environment” includes the Moon**, and beyond that, the rest of the Solar System.

**Our Econsphere has already expanded out to Geosynchronous Orbit** (seven times as wide as Earth) where orbit-to-home TV and other kinds of satellite services have created an economic province of its own, with **over \$300 billion dollars of activity annually**, and that figure is rising.

Someday, resources and products from the Moon will be shipped down the gravity well to Geosynchronous orbit for a small fraction of the fuel cost of shipping them up the steep gravity well from Earth' surface. This will allow us to use materials from the Moon to construct power beaming relays and solar power satellites in GEO as well as huge platforms to collocate many satellites in each of the 180 available GEO slots, 2 degrees apart, providing power, robotic repair services and more.

Thus **Earth's Econsphere will expand beyond GEO to include the Moon**, and then asteroidal resources. Then **Space, what lies beyond our atmosphere, will become part of our "greater environment."** We might dub this marriage "**Mother Earth and Father Sky.**" Indeed, some of our pre-modern cultures and religions reflected this inseparable dynamic between maternal Earth goddesses and paternal Sky gods. Lets put these two remembrances together.

**It is not in the interest of Mother Earth that we overlook the services of Father Sky.**

We need to engage maternal environmentalists with those of us who are paternal environmentalists and show how together we can do much more to preserve our precious "**yinyang**" homeworld.

In MMM issues through the years, I have regularly pointed out that settlers on the Moon or beyond will live in small closed biospheres, **living "downwind and downstream" of themselves.** They cannot allow their tiny biospheres to become polluted less they have to abandon them. They will learn how to live right, and **those lessons can be put into effect "down here" to help stabilize and clean up our precious planet.**

Yes, in theory us Earthlubbers could learn all these tricks by ourselves. But in reality, we won't, because the dire consequences of not doing so will harm our descendants but not ourselves, so we will put it off, and off, and off.

**It does us, and our children and grandchildren no good to believe that if we hand over to them a "healthy economy" that will be enough.**

We need to hand over to them a "**healthy Earth**" and the best way to do this is to incorporate the potential gifts of "Father Sky" – the Moon first of all, and then beyond. PK

## Let's send a fleet of "Cube Probes" to Mars

By Peter Kokh

### Cubesat landers

- Weather stations: wind, air pressure, air dust, humidity, snow depths etc., CO2 snow physical characterization, WHERE: rims and bottoms of major volcanoes (Olympus, Pavonis, etc.; various locations in Valles Marineris, the Hellas Planitia basin, etc.
- In lavatube skylight pits
- Sand dunes
- Polar cap landers (on CO2 winter ice caps, on H2O summer ice caps) Close photo-mapping of each. Chemical tests, physical aspects of "ice" and "snow"
- Missions to Phobos, Deimos to characterize chemical nature of surface

### Cubesat drones

- Cubesat "Drones" into Hellas Planitia testing flight abilities seasonally at various altitudes
- We should be able to deliver a "bunch" of cubesat landers and drones piggybacking on larger landers and orbiters



PK

## Unfortunate Misstep in Forging the International Measurements System

By Peter Kokh

### Time and Distance: The Speed of Light binds them together

- **But** the current International Metric System failed to take this into account. (The French originated the **meter** in the 1790s as one/ten-millionth of the distance from the equator to the north pole along a meridian through Paris.) As a result, metric distance and area are measured on the basis of an arbitrary choice **based on the size of Earth which should have nothing to do with it**. Now our system of time is based on the fact that 365.25 days in a year is fairly close to 360 degrees in a circle. Thus it is based on the number of days it takes Earth to orbit the Sun, not on Earth's size or mass.
- The speed of light is expressed as 299792 "km/second" instead of simply in terms of "light seconds." This is a factitious standard, because >"kilometer" is a pure misstep choice  
So what should distance and length be measured by? Well, think about this.
- **One Light Nanosecond happens to be 11.999xx inches** – (1/5<sup>th</sup> of an inch shy of 1 foot), a more user friendly unit than a "meter" or "yard." **Long live the "foot!"**

**As a result of the misspick in distance, volume units are also misfigured as are weights.**

- If we were sincere about having a science-based measuring system, we would toss out the current metric system for a Speed of Light-based system.

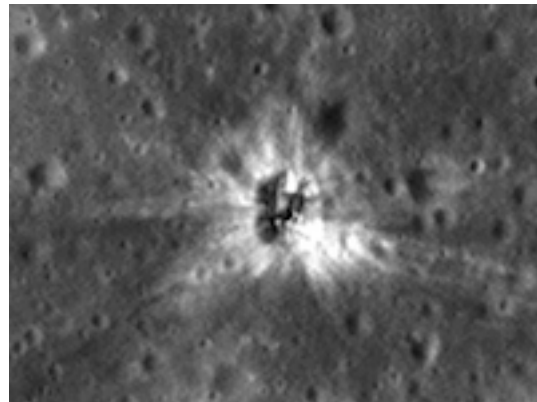
Nb, The gram is a the weight of a cubic centimeter of water – but if the nano-loght-second had been used for the basis of measuring length and distance, we might have chosen the weight of a cubic tenth of a nanolight second.

And, whie we are at it, let's adopt a **better dating system**. Jews, Christians, and Muslims each have their own dating system based on key religious events. We live together, and **the history of "civilization" which we all inherit is far older than key events in any of our religions. Why not add 10,))0)) years to the current system?** It would help everyone to see our histories in perspective and to accept that we are one people, not three or more. PK

## Apollo Booster Impact Craters as sites for Potential fresh Sub-Surface Sample Collection

By David Dunlop – January 08–2016

Another Lunar Reconnaissance Orbiter discovery is the impact site of the Saturn-IVB booster for the Apollo 16 Mission, The impact occurred on April 27, 1972 [Wikipedia: Apollo 16]



<http://www.space.com/31503-apollo-16-moon-rocket-crash-site-photo.html>

These booster have created shallow crater on the lunar surface. The January 04, 2016 space.com article indicated that the locations of these impact craters are now known for the Apollo 13, 14, 15, 16, 17. Nothing was mentioned in the article about boost impact craters having been identified for Apollo 8, 11, or 12 missions.

The article mentioned that the Apollo 16 crater was 40 meters (130 feet) wide but relatively shallow. These recent crater's present potential opportunities for sub-surface sample collection because they are specifically dated in time and may afford relatively easy access to the crater structure by robotic equipment.

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The LRO LOLA instrument may be able to provide measurements of the relative depth of these crater in relation to their surrounding terrain. and the LRO NAC camera may be able to provide meter scale resolution of crater features. Excavation of the lunar surface remains a challenge because of the mass constraints for landing drilling equipment. The drilling technology often discussed at NASA sponsored meeting has been provided by Honeybee Robotics and uses drills and sampling using forced gas flows to penetrate the densely packed lunar regolith. These system provide shallow access sample collection of perhaps a meter or two. The ejecta blankets from these crater excavations also provide easily accessible near subsurface materials.

The Apollo Saturn IVB impact sites might increase the depth of sampling if drilling rigs could simply roll into a shallow crater and sample the bottom. The excavation of materials from the crater itself might be sampled simply by traveling across the ejecta field without the risk of entering the crater itself as “a low hanging fruit” sampling effort.”

The success of the LCROSS mission splashing out and measuring out frozen volatiles might be repeated with subsequent lunar surface landing missions. At present there are a number of lunar surface missions in development. Getting ground truth is expensive and the use of the targeted boosters for additional assay work is another potential aspects of a coordinated international campaign.

The prediction of the trajectory of the crater impact ejecta splash out, the provision of a follow-on impactor that can measure the frozen volatiles content of the ejecta materials are of course significant complications to missions which have mass budget constraints for their soft landing primary mission. The remarkable achievement of LCROSS followed a series of unsuccessful attempts to learn from earlier lunar surface booster impacts. Should we continue to keep trying after that singular success?

**LCROSS REDUX?** [ <https://en.wikipedia.org/wiki/LCROSS> ]

**It is worth asking whether a coordinated international program might provide a polar orbital system with affordable cubesatellite-scale impactors and measurement platforms. If an orbiter could provide the sampling capability then the technical aspects of coordinating the scheduling of the measurement impactor with the booster impacts of new lunar landing missions might advance the range of “ground truth” we have from the most promising area identified from remote sensing data.**

The success of LCROSS suggests that what worked once can be accomplished again. The pursuit of ground truth data from the lunar surface remains a costly objective. It would take a significant level of international cooperation and money to take advantage of separate national and commercial lunar surface landing missions. Not to do so however could be seen as squandering the expense of such missions by “wasting such booster impacts” when such assay data are of immense value for future mission planning and the development of ISRU programs on the lunar surface by identifying operationally useful ice deposits. Increasing the number of ground truth samples is a high priority.

**Determining the Value of This limited potential set Random Fresh Crater Samples.**

**Another aspect of these site concerns their potential value in expanding the range of lunar surface samples. At the time of Apollo the consideration of the Saturn IVB impact crater sites for sampling by later mission was likely not considered, or considered to be so remote as to not be worth even speculative planning. Only those involved in planning those missions would know. So investigating these impact crater locations which are likely the random result of trajectory considerations for the manned Apollo missions is a rather late consideration. Each of these locations must be evaluated in terms of its geological context and of the potential contribution its surface and subsurface samples might provide.**

- 1 A shallow crater of this sort if positioned by luck might provide a look at crypto-mare areas and expose samples which expand the range of mare samples and the volcanic materials expelled from the lunar subsurface.
- 2 A shallow crater might in the higher latitudes where water ice concentrations are more prevalent might provide some measures. of the range of volatiles deposition in the soil column if a robotic rover could sample both the surface area surrounding the crater as well as access the interior.
- 3 Because these crater impacts are precisely known in time they provide a potential measure of the rate of deposition of surface produced hydroxyls on these freshly excavated surfaces over a period of roughly 4 decades. The shock and heating effects of the impact may presumably drive off pre-existing volatiles leaving presumably more “pristine fresh surfaces.”

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- 4 Models of these hydroxyl molecules hopping across the lunar surface have been proposed but the measurement of fresh craters would provide a real world real time test of such theories especially if these measurements could be contrasted with surrounding surface measurements distant enough from the impact site to be considered “undisturbed.”
- 5 The measurement of the amount of sunlight exposure on these fresh impacts, the level of temperature range from Diviner instruments could also inform the models of lunar surface volatiles production and capture in relation to the sample collected.

Such questions might not justify a mission to these craters in and of themselves but at least provide another set of potential targets for surface exploration in surface exploration campaigns by robotic rovers or as targets for sortie missions.

#### **Other booster impact sites**

We have mentioned only Apollo impact booster but similar value might be determined from all booster impact sites that exist on the lunar surface as a limited class of “time stamped” human produced research opportunities. ##

## UN COPUOS Presentation on The Proposed International Lunar Decade

By David Dunlop

(Targeted as a Technical Presentation with a 15 minute limit) Introduction

### Slide #1 25 Sec

Thank you Ladies and Gentlemen and members of the COPUOS Subcommittee on Science and Technology. I am David Dunlop Chair of the International Committee of the National Space Society in the United States which is also an organization with Observer Status in the Economic and Social Council. I am also a member of the International Lunar Decade – Working Group of organizations promoting that idea and here at the generous invitation of COPUOS Chair David Kendall.

### Slide #2 picture of JFK at Berkeley in 1962 12 sec

In a 1962 speech at the University of California, John F Kennedy turning away from a doctrine of Mutual Assured Destruction proposed going to the Moon with the Soviet Union.

### Slide #3 pictures of Apollo 11 and Lunakhod 14 sec

Kennedy’s lunar campaign with the Soviet Union never materialized, but repeated peaceful and successful competitive missions to go to the Moon did occur followed by the Apollo–Soyuz test mission, which signaled a detente in 1975. (2)

### Slide #4 Apollo 11 Plaque We Came in Peace For All Mankind 10 sec

Apollo 11’s proud announcement that “We come in peace for all mankind” was an exercise in a peaceful avoidance of war and a signature legacy of that American President.

### Slide #5 “We return to the Moon With All Mankind” ILD Logos ok 54 sec

Today, at COPUOS we propose “We return to the Moon in Peace With All Mankind” as the motto for an International Lunar Decade Campaign. We face in our time another shared threat of Mutual Assured Destruction closely entwined with our economic system: the relentless destruction of the Earth’s environment. This must be rightly addressed in COPUOS, because the transformative path forward to a genuinely sustainable global economy lies in the use of space resources, including those which we know are present on our Moon. (3)

In pursuit of the goals of economic and social development and “progress”, we are outstripping the limited carrying capacity of Earth’s environment, but abundant resources can be obtained on our Moon and in cislunar space. This challenge facing COPUOS members is one that cannot be avoided, and one that must be embraced.

### Slide #6 Picture of Flags in front of UN 12 sec photo credit Reuters

The International Lunar Decade Campaign is a peaceful course of actions to begin together, a new sustainable economic path that will access the resources in cislunar space and on our closest neighbor, the Moon. (5) (6)

### Slide #7 Picture of Deep Space Habitation Facility” 8 sec

We must begin to use space based clean energy, material resources (including engineering metals and silicon to capture solar energy),

**Slide #8 Orion Arriving at Deep Space Habitat 9 sec**

We can use abundant oxygen, and frozen volatiles (including water ice) found on the Moon and accessible asteroids, to add to those we are also developing on Earth.

**Slide #9 A Bigelow Deep Space Habitat 8 sec**

For the first time in our history we can obtain resources from the lifeless Moon and asteroids, not from additional injury to our finite living Planet Earth.

**Slide #10 A UN Logo 23 sec**

Together we can begin this campaign to expand the econosphere of the Earth and to live and work in cislunar space and on the surface of the Moon as an open and shared Global Frontier. The minority of UN countries that constitute the 83 COPUOS members, do possess the economic and technical resources to begin this campaign, and all should be welcomed to participate. (6) ok

**Slide #11 Space Solar Power Satellite System Alpha on Right) 30 sec**

Since the 1960s, the world has grown a commercial space economy now amounting annually to \$250B. In a similar period of time, we believe the space based economy can develop into a multi-trillion dollar economy that will begin to satisfy the world's endless thirst: for clean energy, for clean water from the oceans, and for personal education, health services, and communications by expanding these services to the 3 billion people who now barely participate in the global economy. (7)

**Slide # 12 Picture of Pollution in Beijing, Dehli, Mexico City 26 sec**

While some may skeptically dismiss this proposal as an appeal for untested schemes of geo-engineering, I would argue that we are already suffering the consequences of unintended economic geo-engineering with our predominantly fossil fueled economic system.(8) That evidence is documented by the Inter-governmental Panel on Climate Change. We can no longer plead ignorance or ignore these processes changing our climate system. (9) (10)

**Slide #13 Pictures of Polar Bears 11 sec**

Our human activities have been and are destroying the habitat of the other creatures with which we share our planet. We are witnessing a 6th mass extinction of the Earth's species. (11)

**Slide # 14 Pictures of Lunar Ice Cube 15 sec**

In Paris we have just agreed to take a few halting steps to control and reduce those effects. An ILD Campaign presents additional options and actions which can build a sustainable global economy with a sustainable and restored environment on Earth.

**Slide #15 Young Engineers Showing CubeSats Are Mainstream 9 sec**

Such achievements will take time, but we must not delay engaging our educational and scientific institutions and the energies of young people.

**Slide #16 Picture of International Space Exploration Coordination Group Logo 19 sec**

The ILD-proposal embraces existing planning as well as the science and technology roadmaps of the major space faring nations, but also encourages much expanded international participation and voluntary commercial engagement. (12) (13) (14)

**Let me highlight a few examples of what we believe can be accomplished through the ILD campaign:****Slide # 17 Communications Satellite 15 sec**

1. This can start with cislunar "utilities" involving communications, navigation and positioning, and even early solar generated power beaming to exploration rovers and robotic miners supporting precursor missions for a human return. (15) (16)

**Slide #18 Picture of Space Debris 8 sec**

2. We must also clean up space debris and preserve space access as well as existing satellite infrastructures and services.

**Slide #19 Earth-Moon Extended Duration "Gateway" Station 18 sec**

3. We can build an Earth-Moon Lagrange Gateway and research station in the proving ground of cislunar space. NASA's Administrator has stated that NASA is supportive of this objective, which will also enable its international and commercial partners to pursue their goals to return to the lunar surface. (17)

**Slide #20 Moon Village 5 sec**

4. Next we can establish a permanent human presence on the lunar surface!

**Slide # 21 Golden Spike Proposed Lunar Facility 7 sec**

The Director General of the European Space Agency has proposed an internationally supported Moon Village. (18)

**Slide # 22 Radio Astronomy facility being deployed 21 sec**

On the lunar far-side, radio astronomy facilities protected from Earth's radio interference could peer farther into the universe. (19) Recent studies have shown how an initial facility could be established for a tenth of the cost of the ISS. (20) (21) An International Lunar Research Park can expand where researchers from every country may develop new technologies.

**Slide #23 Picture of CubeSatellite "LunarH-Map 14 sec**

5 Affordable tools such as Cube-satellite scale spacecraft and instrumentation will permit countries with fewer resources to work with wealthier nations and new commercial providers to increase opportunities for participation. (22)

**Slide #24 Picture of 3D Printing Machine on ISS Made in Space 13 sec**

6 New exploration and manufacturing technologies could provide markets in every country with vital supplies of clean energy and other products and services needed by a peaceful and sustainable global civilization. (23) (24)

**Slide #25 Investigating the origin and location of the Moon's Water 10 sec**

7 Fuels produced on the lunar surface could reduce the cost of space operations on the lunar surface, at the Gateway Proving Ground Station, and even expeditions to Mars. (21)

8 An ILD Campaign is needed for us to learn to live and work beyond the Earth and extend the range of terrestrial life. Lessons learned from living in the extreme environments of space can also promote sustainable living within the boundaries of the Earth's ecosphere, in balance with the requirement of the species with which we are co-dependent, and to preserve the rich biological heritage of terrestrial evolution.

**Slide # 26 Picture of Resources Prospector 13 sec**

9 An International Lunar Survey Working Group could share the work of exploration planning, setting geodetic standards for mapping and shared data, and identifying lunar resources and their economic use. (25)

**Slide # 27 Picture of Antarctic Bases 14 sec US at South Pole: French-Italian Indian base**

At the height of the cold war, the International Geophysical Year demonstrated that some 60 countries could contribute projects to study the Earth as a whole, led to a Treaty to Preserve Antarctica and to the Outer Space Treaty. (26)

**Slide 28 ILD Areas for Collaborative Policy Development 26 sec**

We can do no less today. That success of Antarctica can be repeated in a new collaborative campaign to further explore, understand, and develop the potential of the Earth's nearest neighbor which we all share in the night sky. We can encourage international confidence and investments with transparency and confidence building measures crafted to the unique circumstances and resources in cislunar space and on the Moon in the following areas:

**Slide 29 (New NASA Earthrise image 32 sec**

- 1 We can share and greatly reduce development costs through Public Private Partnerships. as demonstrated by IntelSat and the NASA Commercial Cargo and Crew programs.
- 2 We must collaborate in the challenges to characterize and develop operationally useful frozen volatiles on the lunar surface which can advance access to deep space by lowering costs.
- 3 We must provide collaborative mechanisms sharing investment opportunities and costs and equitable access and pricing in the development of resources in a common cislunar market.

**Slide 30 LRO · Artist's visualization of the LRO spacecraft passing over areas of extended illumination at the poles 29 sec**

- 4 We must collaborate in the development of areas of extended illumination where there are opportunities for investment in solar power production which can supply a common market on the lunar surface.
- 5 We must collaborate in the use, and protection of the Lunar Farside quiet zone for radio astronomy using the mechanism of the International Telecommunications Union.



6 We must share development of cryogenic permanently shadowed locations in the lunar polar regions where there are opportunities for Infrared astronomy.

**Slide 31 Lava Pits 41 sec**

7 Subsurface lava tube locations offering protection from the radiation hazards and temperature extremes of the lunar surface offer additional opportunities for shared development and use.

8 Shared cryogenic environments where fuel processing and storage are economically enabled are another resource.

9 Cislunar orbits presents opportunities for shared use in applications for communications, navigation and positioning, and power beaming requirements in cislunar space and the lunar surface.

10 The ITU regulated system of GEO orbital assignments may need to be similarly extended to the orbital environment of the Moon.

**Slide 32 NASA Moon lander image 72 sec**

11 Planetary Protection Observatories in cislunar space might enable us to identify objects which threaten terrestrial life, and avoid a fate similar to the dinosaurs.

12 Shared use of landing zones and associated infrastructure on the lunar surface can meet treaty obligations for astronaut rescue and support human life and operations.

13 Shared investment and use of habitation and laboratory facilities could enable a common market on the lunar surface.

14, Investments in utility infrastructures for electrical power, communications, fuel production, and life support services could provide access to all nations and enable a common market on the lunar surface. The proposed I L D Campaign is an important start in replacing a global economy which is not sustainable with one that is. Our economy can and must grow beyond the constraints of the Earth with natural resources in space, and also preserve life on Earth. In doing so, we can realize the unfolding potential of our species and extend our survival as the intelligence test of evolution.

**Slide # 33 Picture of Refugee Camps in Jordan, Kenya, Peshawar, Pakistan 14 sec**

Today millions of refugees flee and have lost all hope of peaceful lives in their home countries where environmental destruction, food insecurity, and competition for limited resources are often root causes for internal conflict.

**Slide # 34 UN Platform for Space-based Information for Disaster Management and Emergency Response (SPIDER) 14 sec**

The ILD can replace the narratives of hopelessness that stem from a lack of understanding of options with one of hope. The UN Space-based Information for Disaster and Emergency Response (UN SPIDER) Program is a tangible example.

**Slide #35 of NASA Power Beaming Satellite James Shier 18 sec**

What if we could beam power to areas destroyed by natural disasters and save both lives and properties?

What could be developed to meet power requirements on the Moon could also enhance our responses for disaster relief and support of refugees on Earth. If we can provide a pathway of hope for the global future why wouldn't we?

**Slide # 38 Logos of International organizations 31 sec**

Indeed we must by working with other national and international organizations whose role in the exploration of space is strategic including:

1 COSPAR,

2 ILEWG

3 The International Science Council

4 The International Space Exploration Coordination Group

5 Members of the G-20 group, as well as the G-77 and beyond. (6)

An ILD Declaration and Expanded Engagement

11 This summer at the COSPAR meeting in Istanbul we hope the International Lunar Exploration Working Group can move this agenda forward through a declaration launching an International Lunar Decade Campaign open to all nations.

**Slide # 39 Apollo 8 Earth rise over the Moon with ILD-WG Logo 28 sec**

I thank David Kendall COPUOS Chair and the committee members for providing me with this opportunity to present this proposal for an inclusive International Lunar Decade Campaign to further explore and use the resources in cislunar space and on our Moon for a sustainable Earth. I have provided copies of my remarks and supplemental sources of information about the ILD. I am happy also to take questions at present or subsequently offline. ###

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410 N Ashland, Green Bay, Wisconsin 54303

**Additional International Lunar Decade Campaign Resources can be found at:**

- 1 <https://ildwg.wordpress.com>
- 2 <https://ildsg.wordpress.com/the-international-lunar-decade-declaration/>
- 3 [www.nss.org/news/LunarDeclaration.pdf](http://www.nss.org/news/LunarDeclaration.pdf)
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- 5 <http://aerospace.hawaii.gov/2014giantleap/>
- 6 <http://www.space.com/29285-moon-base-european-spaceagency.html>

**\*Note additional members of the International Lunar Decade WorkingGroup:**

Gary Barnhard XISP Inc., Space Development Foundation  
Vid Beldavs, Photonika Institute, University of Latvia  
Dr. Pamela Clark, Jet Propulsion Lab & Catholic University  
Russell Cox, The Lunar Initiatives and Flexure Engineering  
Jim Crisafulli, Hawaii Aerospace Office, Hawaii Dept of Economic Development & Transportation  
Dave Dunlop, National Space Society & Space Development Foundation  
Dr. Bernard Foing European Space Agency  
Bruce Pittman, Space Portal at NASA AMES and NSS  
Chip Proser, Celestial Mechanics  
Dan Rasky Space Portal at NASA AMES  
Mark Nall, NASA Marshal Space Flight Center

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  - (4) ILD Declaration at Next Giant Leap Conference November, 2014, Hawaii.
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  - (6) [https://en.wikipedia.org/wiki/G-20\\_major\\_economies](https://en.wikipedia.org/wiki/G-20_major_economies)
- Note G-20 Group countries account for 85% of Gross World product, 80% of world trade, and 66% global population. The G-77 include an additional 134 countries
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Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

A Review and Critique of the Article  
**Planetary Societies: The Humans Orbiting Mars Plan for a Sustainable,  
 Executable and Affordable Mars Exploration Campaign**  
 by John Logsdon and Casey Dreier

By David Dunlop

Review by David Dunlop, National Space Society

March 10, 2016

In the Spring Issue of **Ad Astra** [the quarterly magazine of the National Space Society] John Logsdon and Casey Dreier provide a list of eight claims in support of their program model of The Humans Orbiting Mars Plan for a Sustainable, Executable, and Affordable Mars Exploration Campaign. I find most of these claims questionable and far from convincing.

**CLAIM # 1 A “Kennedy moment” will not come again.**

A Ignores that a Reagan Bush commitment to a Space Shuttle program occurred and endured for thirty years and 135 flights until 2011.

B Ignores that an ISS Treaty was forged and signed with the Canadians, Europeans, Japanese, and the Russians and that has produced and sustained the greatest heretofore satellite which is both a habitable space structure and working lab .

This is a false justification for a US centric (as opposed to international development program) that would slow progress for the next thirty years.

**CLAIM # 2 Claims to provide a step by step strategy to get to Mars that is based on a “realistic” budget** (that is a conservative projection of NASA’s purchasing power through to 2045) This is a thirty year prophecy of political support. What have they been smoking?

Instead of being based on an internationally comprehensive view of national and private commercial capital investment resources and an operational model of shared budgets this looks very myopically at NASA expenditures. The potentially much more favorable strategic options and outcomes of an expanded economic base are not even considered. This is an example of thinking small.

**CLAIM # 3 Their model uses developing SLS–Orion Launch system over the next 30 years.**

This program defends the current NASA status quo job program at all costs. This is a whitewash of criticism of the economic feasibility of the status quo.

Sustaining of a low flight rate of aging technology over thirty years could repeat the cost escalation and accident pattern of the low flight rate shuttle program. ( No fiscal or operational management lessons have been learned here except that this program does not even pretend to have reusable components) Recent warnings of the safety risks of a low flight rate SLS–Orion system by NRC are blithely ignored.

**CLAIM # 4 A. Claims “we” cannot afford to hit the reset again as justification of a status quo program.** Rather than seek more favorable outcomes or benefit from technological investments in reusable and much more cost-effective evolution, this locks us into what will rapidly become yesterday’s technologies. This is just another defense against new technologies and the protectionism of the status quo.

Like it nor not the “reset button” has already been pushed by Elon Musk and Jeff Bezos with the reusable Falcon 9 R and New Shephard vehicles to be followed by ULA Vulcan and the Ariane 6 reusable vehicles. Maybe they missed this news.

B. The probability is that even by contemporary standards this will be a financial trainwreck for both NASA and the US. The SLS–Orion expendable mega rocket is the functional equivalent of the old Constellation program with much the same approach that was found to be financially unsustainable by the last Augustine Commission at \$2B per launch.

**CLAIM # 5 Dismissed past Mars program estimates as no longer relevant.**

So much new technology and new architectures are being developed that we agree with this statement. Ongoing independent cost estimates are required in order to establish credibility and realistic budgeting.

We agree that ongoing independent cost estimates are required. The estimates provided ignored a more comprehensive view of budget options involving both international and commercial partnerships,

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the potential for Public Private Partnership mechanisms to both reduce cost and accelerate program objectives, and new technology developments.

**CLAIM # 6 A strategy and baseline architecture (beyond the next five years) is needed to engage the stakeholders.**

Those with a sustaining interest in their jobs and contracts are easily engaged. The “interest horizons” of the “stakeholder” changes with every presidential administration and Congress. A flexible path strategy as recommended by the last Augustine commission and pursued by the Obama administration has offered a political and budgetary strategy that evolves with the changing political and economic environment and that is more likely to survive unpredictable political changes than the highly questionable assumption of thirty years of stability in approaches from Congress and changing Administrations.

**CLAIM 7. Establishing a U.S. –led humans –to– Mars architecture will allow international and commercial partners to identify clear areas for contribution.**

To the contrary the flip-flop from the lunar program to a stand along Mars priority has made the US change from being perceived as a reliable to an unreliable partner. Notice how our international partners have not lined up behind this US outlier objective but instead clustered together in support of the Moon priority. If they stick together and demonstrate that an effective partnership can be created and sustained without the US, our position and standing as the standard setter and leading international competitor will have been greatly weakened by this intransigent Mars only priority.

**CLAIM 8. In order to fund an executable human exploration program, NASA must end its large financial commitment to operating the International Space Station.**

The termination and sacrifice of the ISS LEO facilities, capabilities, and program resources (without a major public debate and much independent transparent study) for Mars only Exploration priority is an absurd and inadequate proposal. One step forward and two steps back. Creating a space station gap, at the precise time the Chinese are introducing their new space station is simply shooting ourselves in the foot.

The shining international success of this largest in-space project in history must continue with an evolved commercialized international space station. It would be foolish to toss away the network of successful relationships involved with the ISS without a clear programmatic continuity that ensures both international and commercial partners a progressive commitment to LEO capabilities by the US.

This is especially true in the face of potential Russian competition and Chinese competition. A “Can’t Do” strategic Thinking will insure “Won’t Do” performance.

- A. A Bigelow transition in habitation facilities is technically feasible with the installations of BA 330 modules that would more than double the ISS pressurized volume when the Russian segments are separated.
- B US boost capabilities can be installed based on existing hardware before the Russians leave with their booster system.
- C European and Japanese investments in the Columbus and Kibo research laboratories should maintain and extend their operational life where cost feasible.
- D The Truss structures, power arrays, and mobile support systems, boost capabilities, and multiple docking capabilities should be sustained.
- E An evolved commercial ISS facility that is also internationally open to all national users including new customers from Ukraine, China, India, the missing economies of G-20 group countries in the ISECG should be courted in a more commercialized and customer focused financial model that also assures US continuity in LEO.
- F US capacity for additional growth from new segments and new commercial space stations should be in place before the original ISS elements are retired.
- G Aspects of the ISS that might sensibly add to an Earth Moon Lagrange Gateway station should be studied as an ISS end of life alternative including use of materials as feedstocks for in-space manufacturing of new facilities.

The objective of a permanent presence on Mars should reflect a global programmatic commitment that is more specifically detailed in the ISECG GER process and that is based on an even broader international consensus than the prior ISS Treaty program commitment.

What has been proposed is more like the Dieppe raid of WWII than the preparations needed for the Normandy invasion which required tremendous depth of logistics planning and redundancy in supplies and reserves. Those are the lessons learned from the ISS as well. It is more important to prepare to live and work in the Mars system in a sustained build-up with many partners.

The program priorities of the Earth's requirements for clean space based energy supplies and the mitigation of climate change through alternative space based energy transitions and the economic growth associated with the rapid growth of the cislunar economy must be openly debated as competitors for investment and operations resources to the Mars First Exploration Strategy. We propose an International Lunar Decade Campaign that will lay the foundations for geometric growth of the space economy.

No substantial and credible model of economic return on investment has been made for the Mars Exploration Program, especially in comparison with a multiple range of benefits that have been envisioned for an expanded Cislunar Ecosphere of the Earth in the next 30 years.

Elon Musk has proposed sending 10,000 individuals to colonized Mars as the announced goal of his forming the Space-X company. Perhaps he has invented or discovered such a model but not yet shared it with the global community. It is quite possible that there are many economic and program synergies that a Moon to Mars program can create that may get to Mars firstest with the mostest.

The protection of the Earth's environment and the requirements for a sustainable global economic system that can be provided by expanding the space economy are much more important claims on limited space development investment resources than Mars exploration. The requirements of a much expanded in-space economic system will also move up the Mars-on ramp so that both objectives are advanced. The Earth's interests however should not be sacrificed by those enthusiasts for the narrow interests of Mars exploration. The Moon versus Mars choice is a long held and divisive. The alternate economic model is that of conceiving of a progressive and expansive economic model of the development of the space economy over the next 30 years. An Integrated international and commercial economic and program model that introduces new industries, and provides new capabilities for clean energy, communications, positioning, in-space manufacturing, and tourism, and higher employment associated with these new activities is needed. This will more credibly expand permanent human presence on the Moon and out to Mars and beyond. A program and economic model that produces geometric growth and development outcomes is what is needed but very much lacking in this proposal.

### **Lets dispute the Orbiting Mars proposal with some alternatives**

**(W)** Other architectural options currently in development were ignored.

**Option A** Use of an architecture of existing Falcon 9 class launches with a very high flight rate. Promises an order of magnitude reduction in launch costs with Falcon 9 Reusables.

- 1 Most likely use of the Falcon 9 which has been successfully recovered (at least once.) would provide a potential of a high volume supply chain to LEO.
- 2 A fuel depot system in LEO could boost large payload components to an E-M Lagrange Gateway (Mission Assembly gateway with a much lower risk of long duration damage from the space debris clouds now in LEO.) from the high volume delivery system.

**Option B** The E-M Gateway system would provide a programmatic trifecta:

- 1 NASA's current Mars Mission priority
- 2 Lunar exploration and
- 3 Lunar economic development.

**A** The E-M Gateway would support dual use and an integrated and parallel and accelerated set of program priorities: Going to the Moon for the environmental economic and benefits to Earth and continuing with a forward leaning exploration and permanent human presence on and in the Mars system is the sensible Next Big Thing to expand on the success of the ISS coalition

**B** Even in thinking in of a US only program architecture redundancy could still be envisioned with a mutiplicity of options and resources

- 1 Falcon 9 R Cargo & Crew
- 2 Vulcan reusable first stage with Cargo
- 3 Vulcan reusable with CST-100 Crew
- 4 Boeing extended duration life support

- 5 SLS–Orion Crew
- 6 ESA–extended duration life support for Orion
- 7 SLS–Cargo
- 8 Falcon Heavy (for an order of magnitude less than SLS–Orion Block A)
- 9 Falcon Heavy Reusable (for an order of magnitude reduction in heavy lift launch)
- 10 Bigelow BA330 Extended duration Facility International resources and options could further reinforce the Moon on the way to Mars program architecture.

**C** An Integrated International and Commercial Mars Strategy should leverage investments based on the lessons learned in the last forty years:

a Treaty Commitments for the ISS have been honored by ISS International Partners for this long duration project.

b This has been an important symbol of international solidarity and cooperation in spite of other political and economic differences.

**D** This has focused complimentary development as well as redundant development providing a resilient supply program in the face of major accidents and set-backs

✓ Challenger (STS) loss and flight gap

✓ Cygnus–Taurus 2014 loss and flight gap

✓ Falcon 9 2014 loss and flight gaps

✓ Soyuz 2014 loss and flight gas Redundant ATV and H–II B deliveries and supply stocks for continuity of crew occupancy and ISS boost requirement were maintained.

Abandoning this redundancy for an SLS–Orion only architecture is folly. It is important to share both the risks and the costs together. The bonds forged with shared sacrifice hold the project together in the face of both political, technical, and financial adversity.

The partnership strategy in the international realm is better aligned with a shared international interest in stability, predictability, and reliability of maintaining performance and meeting objectives and in doing so with international transparency.

Public Private Partnerships can and have produce dramatic increases in both cost reductions and program performance in contrast to government only management in a politically turbulent and unpredictable environment. (ComSat, IntelSat, and Commercial Cargo are examples.)

**E** This Comprehensive Strategy Model is much better aligned with the program investment and development priorities of the other major international space faring powers (many of which have been ISS Treaty partners\* (Canada).

**Program Investment Categories:**

I Human Lunar Surface

II Robotic Lunar Orbit & Surface

III Human Mars

IV Robotic Mars Orbit & Surface

V Big Booster Development

China,	2013	Long March 3
	2016	Long March 5
	(2029)	Long March SH
ESA,*	2010	Ariane 5
	(2024)	Ariane 6
India	2009	PSLV Mark III
Japan*	2018	H–II B
Korea,		
NASA*	2018	Test SLS–Orion
	2021	Human orbit earliest
	2023	Human orbit slip date (2032–39)
Russia*.	2016	Progress
	2025	Angara H

**Commercial companies**

Space-X	2012	Falcon 9
	2016	Demo Falcon 9R
	2016 ?	Falcon H
ULA	2020	Vulcan, Taurus II
Astrobotic	2017	
Bigelow	B330	
Golden Spike		
Moon-X	2017	Rocket Lab
ULA	X	
Team Space IL	2017	Falcon 9

**Looking at the next thirty years of development only in terms of technologies** available or that are about to be available in the near term, can miss game changing developments. We can see things on NASA's technology development roadmap that can further improve our progress:

**Future Tech Investment**

- Ion Drive Propulsion Vasimir system (Reduced transit time to Mars)
- Small in-space Fission Reactor development for power and Propulsion (Less dependence of solar technology)
- Commercial in-space Fusion Reactor for power and Propulsion
- Miniaturized atomic clocks and expanded cislunar positioning and navigation
- Pulsar navigation system (Improved deep space navigation)
- Dust Roaster Element Separator for O<sub>2</sub>, silicon, and engineering metals production from regolith feedstocks

The high unit cost of the SLS-Orion system is in part a result of a low production and flight rate. A higher production and flight rate might conversely result in a more competitive comparative cost structure.

A broader set of programmatic demands for this system including significant mass deliveries for solar power satellite Earth sourced component might dramatically improve the unit cost structure and sustainability of this launch system compared to the brutal comparison with reusable competitors.

- 1 ESA is currently proposing an internationally supported Moon Village. (A Public Private Investment model might accelerate initiative for
  - a An Earth Moon Gateway station
  - b An Low cost lunar base \$10B in 5 to 7 years)
  - c An International Lunar Research Park as a Phased Development
  - d Lunar polar mining and fuel production may prove to be more cost efficient than Earth sourced fuel for a Mars program lasting decades.
- 2 A fuel depot at the Gateway would be a market for cislunar sourced propellants from the lunar surface (or Near Earth Asteroids)
  - A An economic case for lunar sourced propellant in support of Mars Missions has been initially shown to have advantages over Earth sourced propellant at an E-M Lagrange location.
  - B The E-M Lagrange economic advantage could be extended to lunar surface sorties and lunar ferry operations to and from the Gateway station.
  - C Other Frontier Class deep space missions could also benefit from lunar sourced propellant.
  - D Lunar surface propellant production would be likely to be the most cost effective for lunar surface transportation and life support requirements.
- 3 The Moon has a surface area equal to that of Africa and Australia will most logically require a network of surface nodes combined into an integrated market organized economic system for multiple international customers including national space agencies, PPP, non-governmental scientific and Commercial organizations. Redundancy and reliability are essential requirements for sustainable human economic activities and international and commercial partnerships can meet these essential requirements of permanent human presence. It seems likely that several human outposts would be

established in N Polar regions S Polar Regions, on the lunar farside, on the lunar Nearside These locations would meet both scientific and commercial objectives and the supply logistics system for all these options requires both an internationally and economically integrated approach.

4 The resilience and redundancy of the projected launchers being developed could provide a much accelerated and parallel Moon to Mars exploration and commercial development program:

1 Optimizing both public and private resources where redundant Public Private Partnerships can be developed for internationally agreed “core” program objectives.

A Early Commitment to an Internationally Public Private Partnership managed Earth–Moon Gateway Station.

1 Shared major international investment elements within a PPP structure

2 National Space Agency utilization contracts (Occupancy commitments with associated utilization costs over fixed time periods)

3 Fixed price supply contracts (with an integrated cost averaged cost structure based on redundant supply lines and schedule interruption. Risk mitigation with insurance mechanisms and a “floating and growing risk management pool due to premium retention within self–insurance pool or core partners for subsequent risk reduction and reinvestment)

4 Commercially purchased (bidded facilities development with qualified contractor pool arrangements.

5 Cislunar Infrastructure would also support the Trifecta Program Priorities of:

A. Mars Robotic Exploration and Permanent Human Settlement and

B. Moon Exploration and permanent Settlement and

C. Cislunar and Lunar Economic Development of an Expanded Earth–Moon Ecosphere

a Space Situational Awareness Development for Space Security And Planetary Protection

b.Space Debris Mitigation and Remediation Development

c.Space Manufacturing from space based feedstocks

d.Space Communications Infrastructure

e. Space Positioning and Navigation Infrastructure

f. Space Power Utility Infrastructures

g. Space Tourism

h. Space Astronomy: Radio Lunar Farside

Infrared Permanently shadowed observation sites in lunar polar cryogenic terrains.

Helio–physics Observations from lunar surface

Cislunar Interferometry

Reusable and serviceable Observatories

Development at Sun–Earth Lagrange locations

New Observatories for Planetary Protection from both ecliptic and out of ecliptic threats

I. International Science Council

Lunar InterDisciplinary Program

International Lunar Survey Working Group

(Similar in program Structure to Antarctic program

Committee on Space Research (COSPAR) organizing Committee

International Telecommunications Union (ITU) early member

International Union of Geodesy and Geophysics IUGG early member

International Committee Global Navigational Satellite System: early member

International Space Exploration Coordination Group ISECG early member

J. Qualified Cislunar Vendor Council (from ISECG member countries)

K. LEO Facilities Council

ISS and ISS Evolved Commercialized Station (post 2028)

Russian ISS Evolved–Space Station

Chinese ISS Space Station

Bigelow Commercial Space Station

Space debris mitigation feedstocks for space manufacturing



- L GEO Facilities Council: ITU Regulated Orbital slots
  - Communications
  - Beamed Power
  - Positioning and Navigation
  - In-Space Economic Investments and Industries
  - GEO Space Communications Platforms
  - GEO Space Solar Power Platforms
  - Space debris mitigation feedstock for space manufacturing
- M. Cislunar Facilities Council (ITU Regulated) Orbital slots
  - Earth Moon Lagrange locations and orbits
  - Low lunar orbits
  - Highly Elliptical lunar orbits
  - Lunar Polar Orbits
  - Lunar retrograde orbits

This multiplicity of locations, projects and investments may produce a “multi-win” of shared risk, investment, operations, and benefits and an integrated and coordinated schedule that operates in promoting geometric economic and programmatic results. This is in contrast to the Planetary Societies sand charts of projected expenditures through 2045. An International Lunar Decade Campaign looks at a much broader landscape of potential partnership and initiatives and also the potential for geometric as opposed to both conservative assumptions about linear economic expenditures and conservative results.

Accelerated Program Schedule with Much Greater Redundancy in Supply chain organizations  
The Program implementation schedule might be greatly accelerated with a much higher flight rate and volume of landed mass in both lunar surface, Lunar Gateway, Mars Gateway and Mars Surface locations.

Eight G-20 Group nations have not had their national space agencies join the ISECG.

Some 8 Trillion dollars of Global GDP would be added to the economic based sustaining this much expanded and integrated parallel Moon to Mars program.

Other economically advanced small nations might also have their national space agencies join the ISECG adding to the space economy economic base.

The “bin thinking” of looking at only NASA’s constrained purchasing power leads to the narrowed and flawed “either or choices” that are presented in the Humans Orbiting Mars program.

An anemic Mars Program that may arrive by 2039 but hardly thrive by 2045.

No ISS continuity

No Moon Program or cislunar economy with an ROI.

No initiatives for Space solar power for essential clean energy.

Lets choose an International Lunar Decade Campaign much expanding international and commercial partnerships while providing continuity with a commercialized ISS and more than likely increased capacities from another Chinese and Russian Station. Rather than worry about over capacity in LEO lets plan to harness a much larger economic base in pursuing a new space economy.

Lets choose a permanent return to the lunar surface to learn to live and work in that environment. The Moon’s surface is equivalent to having an eighth continent the size of Africa and ninth continent the size of Australia.

Lets build a vibrant and rapidly growing cislunar economy.

Lets service the unserved 3 billion outside of the economic mainstream and build their potential for economic participation.

Lets clean-up space debris and protect space access assets and space security.

Lets develop space solar power for clean energy and clean water requirement on Earth.

Lets provide for a sustainable environment of Earth’s systems with space resources supplanting what the Earth can provide in sustaining a viable standard of living for anticipated 10 billion to 11 billion.

Lets provide a sustainable and hopeful civilization both on our home planet, expanding a sustainable Earth-Moon econo-sphere and rapidly providing a sustainable human presence and terrestrial biosphere on Mars and beyond.

An expanded international and commercial model capable of geometric growth adding value in multi-economic dimensions is a more useful tool for projecting the pathways moving human civilization outward in cislunar space, to the surface of the Moon and moving in parallel out to the Mars system and Mars surface.

**Other architectural options currently in development were ignored.**

**Option A** Use of an architecture of existing Falcon 9 class launches with a very high flight rate. Promises an order of magnitude reduction in launch costs with Falcon 9 Reusables.

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4. Redundant ATV and H-II B deliveries and supply stocks for continuity of crew occupancy and ISS boost requirement were maintained. Abandoning this redundancy for an SLS-Orion only architecture is folly. It is important to share both the risks and the costs together. The bonds forged with shared sacrifice hold the project together in the face of both political, technical, and financial adversity. The partnership strategy in the international realm is better aligned with a shared international interest in stability, predictability, and reliability of maintaining performance and meeting objectives and in doing so with international transparency. Public Private Partnerships can and have produce dramatic increases in both cost reductions and program performance in contrast to government only management in a politically turbulent and unpredictable environment. (ComSat, IntelSat, Commercial Cargo, and Commercial Cargo are examples.)

D. This Comprehensive Strategy Model is much better aligned with the program investment and development priorities of the other major international space faring powers (many of which have been ISS Treaty partners\*).

**Program Investment Categories:**

	I	II	III	IV	V
	Human	Robotic	Human	Robotic	Big Booster
	Lunar	Lunar	Mars	Mars	Development
	Surface	Orbit &	Orbit &	Surface	Surface
Canada*					
China,	2013	Long March 3			
	2016	Long March 5			
	(2029)	Long March SH			
ESA,*	2010			Ariane 5	
	(2024)			Ariane 6	
India	2009			PSLV Mark III	
				2017	
Japan*	2018			H-II B	
Korea,					
NASA*	2018 Test			SLS-Orion	
	2021 Human orbit earliest				
	2023 Human orbit slip date			2032-39	
Russia*.	(2016			Progress	
	2025			Angara H	

**United States Commercial**

Space-X			2012		Falcon 9
			2016 Demo ?		Falcon 9R
			2016 ?		Falcon H
ULA			2020		Vulcan
			Taurus II		
Astrobotic			2017		Falcon 9
Bigelow	X				
Golden Spike					
Moon-X			2017		Rocket Lab
ULA	X				
Team Space IL			2017		Falcon 9

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available or that are about to be available in the near term can miss game changing developments.

We can see things on NASA's technology development roadmap that can further improve our progress:

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- Small in-space Fission Reactor development for power and Propulsion (Less dependence of solar technology)
- Commercial in-space Fusion Reactor for power and Propulsion
- Miniaturized atomic clocks and expanded cislunar positioning and navigation
- Pulsar navigation system (Improved deep space navigation)
- Dust Roaster Element Separator for O<sub>2</sub>, silicon, and engineering metals production from regolith feedstocks

**The high unit cost of the SLS-Orion system** is in part due to a low production and flight rate. A higher production and flight rate might conversely result in a more competitive comparative cost structure.

A broader set of programmatic demands for this system including significant mass deliveries for solar power satellite Earth sourced component might dramatically improve the unit cost structure and sustainability of this launch system compared to the brutal comparison with reusable competitors.

ESA is currently proposing an internationally supported Moon Village.

(A Public Private Investment model might accelerate initiative for

- 1 An Earth Moon Gateway station
- 2 An Low cost lunar base \$10B in 5 to 7 years)
- 3 An International Lunar Research Park as a Phased Development

4 Lunar polar mining and fuel production may prove to be more cost efficient than Earth sourced fuel for a Mars program lasting decades. A fuel depot at the Gateway would be a market for cislunar sourced propellants from the lunar surface (or Near Earth Asteroids)

- 1 An economic case for lunar sourced propellant in support of Mars Missions has been initially shown to have advantages over Earth sourced propellant at an E–M Lagrange location.
- 2 The E–M Lagrange economic advantage could be extended to lunar surface sorties and lunar ferry operations to and from the Gateway station.
- 3 Other Frontier Class deep space missions could also benefit from lunar sourced propellant.
- 4 Lunar surface propellant production would be likely to be the most cost effective for lunar surface transportation and life support requirements.
- 5 The Moon as a surface area equal to that of Africa and Australia will most logically require a network of surface nodes combined into an integrated market organized economic system for multiple international customers including national space agencies, PPP, non–governmental scientific and Commercial organizations. Redundancy and reliability are essential requirements for sustainable human economic activities and international and commercial partnerships can meet these essential requirements of permanent human presence. It seems likely that several human outposts would be established in N Polar regions, S Polar Regions. on the lunar farside, on the lunar Nearside

These locations would meet both scientific and commercial objectives and the supply logistics system for all these options requires both an internationally and economically integrated approach.

The resilience and redundancy of the projected launchers being developed could provide a much accelerated and parallel Moon to Mars exploration and commercial development program: Optimizing both public and private resources where redundant Public Private Partnerships can be developed for internationally agreed “core” program objectives.

A Early Commitment to an Internationally Public Private Partnership managed Earth–Moon Gateway Station.

- 1 Shared major international investment elements within a PPP structure
- 2 National Space Agency utilization contracts (Occupancy commitments with associated utilization costs over fixed time periods)
- 3 Fixed price supply contracts (with an integrated cost averaged cost structure based on redundant supply lines and schedule interruption. Risk mitigation with insurance mechanisms and a “floating and growing risk management pool due to premium retention within self–insurance pool or core partners for subsequent risk reduction and reinvestment)
- 4 Commercially purchased (bidded facilities development with qualified contractor pool arrangements.

5 Cislunar Infrastructure would also support the Trifecta Program Priorities of:

- 1 Mars Robotic Exploration and Permanent Human Settlement and
- 2 Moon Exploration and permanent Settlement and
- 3 Cislunar and Lunar Economic Development of an expanded Earth–Moon Ecosphere

A Space Situational Awareness Development for Space Security And Planetary Protection

B Space Debris Mitigation and Remediation Development

C Space Manufacturing from space based feedstocks

D Space Communications Infrastructure

E Space Positioning and Navigation Infrastructure

F Space Power Utility Infrastructures

G Space Tourism

H Space Astronomy:

- ✓ Radio Lunar Farside
- ✓ Infra–red Permanently shadowed observation sites in lunar polar cryogenic terrains.
- ✓ Helio–physics Observations from lunar surface
- ✓ Cislunar Interferometry
- ✓ Reusable and serviceable Observatories
- ✓ Development at Sun–Earth Lagrange locations
- ✓ New Observatories for Planetary Protection from both ecliptic and out of ecliptic threats

- I International Science Council
  - Lunar InterDisciplinary Program
  - International Lunar Survey Working Group
    - (Similar in program Structure to Antarctic program)
  - Committee on Space Research (COSPAR) organizing Committee
  - International Telecommunications Union (ITU) early member
  - International Union of Geodesy and Geophysics IUGG early member
  - International Committee Global Navigational Satellite System early member
  - International Space Exploration Coordination Group ISECG early member
- J Qualified Cislunar Vendor Council ( from ISECG member countries)
- K LEO Facilities Council
  - ISS and ISS Evolved Commercialized Station (post 2028)
  - Russian ISS Evolved-Space Station
  - Chinese ISS Space Station
  - Bigelow Commercial Space Station
  - Space debris mitigation feedstocks for space manufacturing
- L GEO Facilities Council
  - ITU Regulated Orbital slots
  - Communications
  - Beamed Power
  - Positioning and Navigation
  - In-Space Economic Investments and Industries
  - GEO Space Communications Platforms
  - GEO Space Solar Power Platforms
  - Space debris mitigation feedstock for space manufacturing
- M Cislunar Facilities Council
  - (ITU Regulated) Orbital slots
  - Earth Moon Lagrange locations and orbits
  - Low lunar orbits
  - Highly Elliptical lunar orbits
  - Lunar Polar Orbits
  - Lunar retrograde orbits

This multiplicity of locations, projects and investments may produce a “multi-win” of shared risk, investment, operations, and benefits and an integrated and coordinated schedule that operates in promoting geometric economic and programmatic results. This is in contrast to the Planetary Societies sand charts of projected expenditures through 2045.

An International Lunar Decade Campaign looks at a much broader landscape of potential partnership and initiatives and also the potential for geometric as opposed to both conservative assumptions about linear economic expenditures and conservative results.

### **Accelerated Program Schedule with Much Greater Redundancy in Supply chain organizations**

The Program implementation schedule might be greatly accelerated with a much higher flight rate and volume of landed mass in both lunar surface, Lunar Gateway, Mars Gateway and Mars Surface locations.

Eight G-20 Group nations have not had their national space agencies join the ISECG. Some 8 Trillion dollars of Global GDP would be added to the economic based sustaining this much expanded and integrated parallel Moon to Mars program, Other economically advanced small nations might also have their national space agencies join the ISECG adding to the space economy economic base.

The “bin thinking” of looking at only NASA’s constrained purchasing power leads to the narrowed and flawed “either or choices” that are presented in the Humans Orbiting Mars program.

A anemic Mars Program that may arrive by 2039 but hardly thrive by 45.

- No ISS continuity
- No Moon Program or cislunar economy with an ROI.
- No initiatives for Space solar power for essential clean energy.

**Lets** choose an International Lunar Decade Campaign much expanding international and commercial partnerships while providing continuity with a commercialized ISS and more than likely increased capacities from another Chinese and Russian Station. Rather than worry about over capacity in LEO lets plan to harness a much larger economic base in pursuing a new space economy.

**Lets** choose a permanent return to the lunar surface to learn to live and work in that environment. The Moon's surface is equivalent to having an eighth continent the size of Africa and ninth continent the size of Australia.

**Lets** build a vibrant and rapidly growing cislunar economy.

**Lets** service the unserved 3 billion outside of the economic mainstream and build their potential for economic participation.

**Lets** clean-up space debris and protect space access assets and space security.

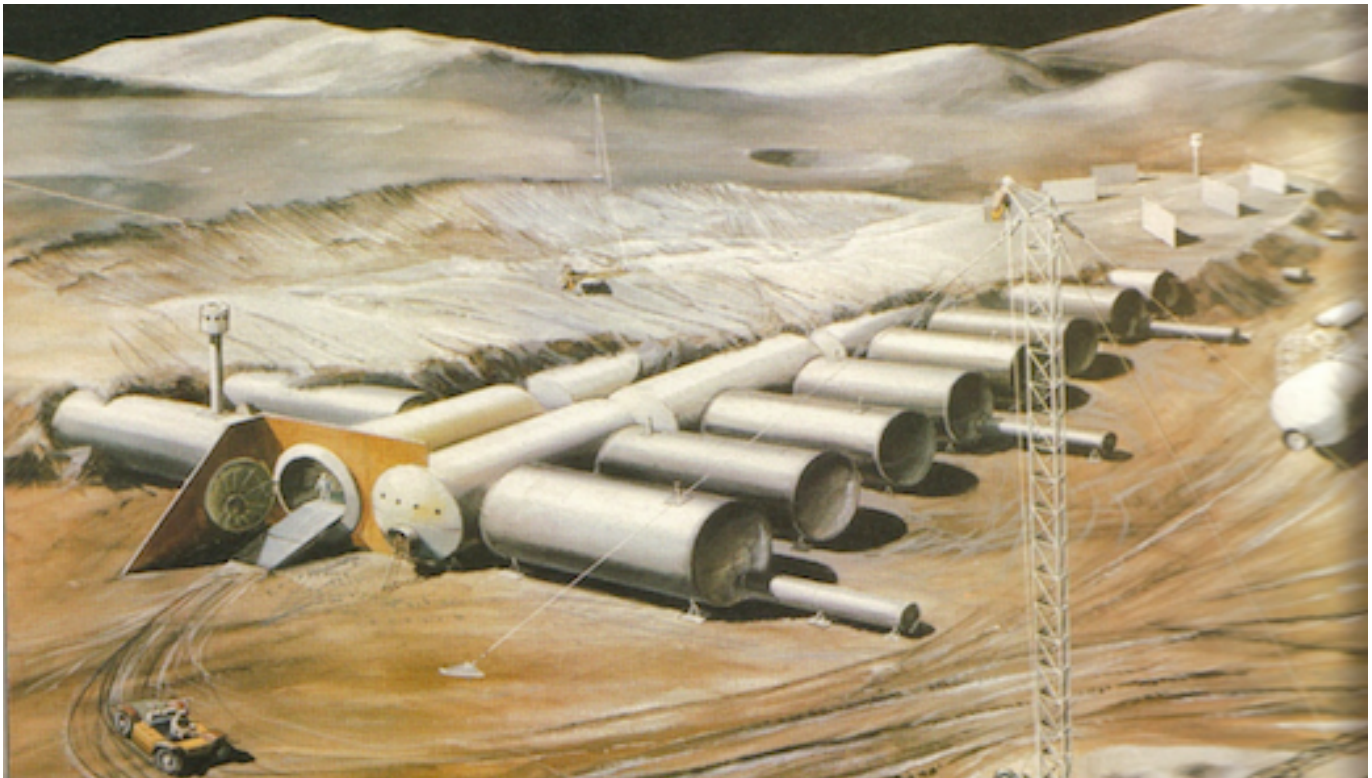
**Lets** develop space solar power for clean energy and clean water requirement on Earth.

**Lets** provide for a sustainable environment of Earth's systems with space resources supplanting what the Earth can provide in sustaining a viable standard of living for anticipated 10 billion to 11 billion.

**Lets** provide a sustainable and hopeful civilization both on our home planet, expanding a sustainable Earth-Moon econo-sphere and rapidly providing a sustainable human presence and terrestrial biosphere on Mars and beyond.

An expanded international and commercial model capable of geometric growth adding value in multi-economic dimensions is a more useful tool for projecting the pathways moving human civilization outward in cislunar space, to the surface of the Moon and moving in parallel out to the Mars system and Mars surface. **DD**

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**We can do it!, if we want to bad enough!**  
 The less government involvement  
 driven by irrelevant political considerations,  
**the better and faster**

**ONLINE OP-ED ARTICLES FROM OTHER WRITERS WORTH READING****NASA's Journey to Mars and ESA's Moon Village enable each other**

18 January, 2016 – [www.thespacereview.com/article/2904/1](http://www.thespacereview.com/article/2904/1)

by Vid Beldavs, Bernard Foing, David Dunlop, and Jim Crisafulli

**The unfortunate provincialism of the space resources act**

25 January, 2016 – <http://www.thespacereview.com/article/2910/1>

By Thomas E. Simmons

**Aldrin recounts successes and challenges of historic space journey**

[www.space-travel.com/reports/Aldrin\\_recounts\\_successes\\_and\\_challenges\\_of\\_historic\\_space\\_journey\\_999.html](http://www.space-travel.com/reports/Aldrin_recounts_successes_and_challenges_of_historic_space_journey_999.html)

**Why a Mars landing could be terrific for science**

[www.thespacereview.com/article/2922/1](http://www.thespacereview.com/article/2922/1)

by Chris Carberry and Rick Zucker

**In space no one can hear you dream**

<http://www.thespacereview.com/article/2925/1>

By Dwayne Day

**Space Launch Lite: The SWALA Concept**

<http://www.thespacereview.com/article/2933/1>

By John Holloway

**The Paris climate agreement and space solar power**

[www.thespacereview.com/article/2934/1](http://www.thespacereview.com/article/2934/1)

By Mike Snead

**'Breaking the Chains of Gravity' Reveals Pre-NASA Era**

[www.space.com/32190-breaking-chains-of-gravity-spaceflight-before-nasa.html](http://www.space.com/32190-breaking-chains-of-gravity-spaceflight-before-nasa.html)

[www.space.com/32192-breaking-chains-of-gravity-book-excerpt.html](http://www.space.com/32192-breaking-chains-of-gravity-book-excerpt.html)

By Amy Shira Teitel

**A proposal for cooperation on the ISS and the Chinese Space Station**

[www.thespacereview.com/article/2944/1](http://www.thespacereview.com/article/2944/1)

By Chen Lan

**US terrestrial non-fossil fuel energy vs. space solar power**

[www.thespacereview.com/article/2941/1](http://www.thespacereview.com/article/2941/1)

By Mike Snead

**Review: Mars One: Humanity's Next Great Adventure**

[www.thespacereview.com/article/2940/1](http://www.thespacereview.com/article/2940/1)

By Jeff Foust

## List of Recent Feature Articles and Essays in Our Sister Publications



**Ad Astra** [Latin (ancient Roman): "To The Stars"]

**Sent to all National Space Society Members as a primary membership benefit**  
(with choice of print hardcopy or downloadable pdf file)

### SPRING 2016

- 16 Welcome to NSS' International Space Development Conference In San Juan, Puerto Rico
- 18 **Humans Orbiting Mars:** A Critical step in a sustainable executable and affordable Mars Exploration campaign – John Logsdon and Casey Breier
- 24 How to think about going to Mars – Dale. L. Skran
- 30 The International Space Station Testbed for Deep Space Missions – Clifford R. McMurray
- 34 Is China's Space Station the new "ISS"? – Mark Williamson
- 38 Space is Closer than you Think: What happens in the atmosphere as you ascend to the stars –  
– Paul Contursi
- 42 The Art of Living and Working in Space Settlements: Winners of the Space Settlement Student Art contest – Lynne Zielinski
- 44 Touching Students Lives: Space Settlement Teachers achieve NSS Excellence Awards



[www.MMM-MoonMinersManifesto.com](http://www.MMM-MoonMinersManifesto.com)

### FEBRUARY 2016 – MMM #282

- 2. In Focus: Monasteries in Space far from the world's distractions & problems – Peter Kokh
- 3. **Space Monastery Economics on the Moon's Farside** – Peter Kokh
- 4. Off the beaten track, yet special potential monastery sites on Mars – Peter Kokh
- 5. Lunar Homes of Extruded Basalt – Dave Dietzler
- 7. Products we can make on the Moon from Glass and **Basalt** [ basalt images below ] – Dave Dietzler

### MARCH 2016 – MMM #283

- 2. In Focus: Why not send commercial probes to Mars?
- 3.-Where I would choose to live on Mars, if offered the chance – Peter Kokh
- 4. Martian and Lunar frontiers will have much in common – Peter Kokh
- 5. Mars' Assets and what we can do with them – patiently – Peter Kokh
- 6. Let's send a fleet of "CubeProbes" to Mars; Moon and Mars Science Missions that will help both – P; Kokh
- 7. Mass Production, Reusability and Scavenging for CATS – Dave Dietzler –

### APRIL 2016 – MMM #284

- 2. In Focus: The steady watering down of the Mother Earth Mission – Peter Kokh
- 3. Using the Challenges of Living in Space to Rescue Mother Earth – Peter Kokh
- 6. "Internationalization" and the Inevitable "Tragedy of the Commons"
- 7. Metal Massive, Unitary, Simple Things – Dave Dietzler  
Brakes, Batteries, and Other Automotive Needs on the Moon – Dave Dietzler  
Space Manufacturing: Old Meets New – Dave Dietzler
- 8. Making musical instruments on the Moon – Peter Kokh





## International Space Advocacy Organizations Encouraging Student Participation

**National Space Society (US)** – <http://www.nss.org> – NSS

NSS currently has chapters in Australia, Canada, Germany, France, Netherlands, Brazil, and India  
<http://www.nss.org> – <http://chapters.nss.org/a/lists/>

**NSS' International Space Development Conference – ISDC** – <http://isdc.nss.org>

The “ISDC” is usually held the weekend of the last Monday in May (Memorial Day weekend) in various locations, hosts students from around the world, many of them presenting their entries to NASA’s annual Space Settlement Design Contest. Usually, The Moon Society and SEDS participate in this conference.

**ISDC 2016 San Juan, Perto Rico** – <http://isdc.nss.org/2016/#/> “Space Beyond Borders”

**ISDC 2017 St. Louis, Missouri** –

**The Moon Society** – <http://www.moonsociety.org> – TMS

The Moon Society has informal relationships with the Calgary Space Workers, Calgary, Alberta, Canada and with the Sociedad Espacial Mexicano, Mexico, with individual members in many countries.

The Moon Society’s **Moon Miners’ Manifesto India Quarterly** – the “older sister” to To The Stars International Quarterly, had been going to students and others in India and Elsewhere since August 2008. Older issues are available as free pdf downloads at: [www.moonsociety.org/india/mmm-india/](http://www.moonsociety.org/india/mmm-india/)

**Students for the Exploration and Development of Space – SEDS** – <http://www.seds.org>

SEDS has had more success in setting up chapters around the World than any other Space organization.

Chapters of SEDS are found in: USA, India, Nigeria, United Kingdom, Philippines, and more;

How to Stars a SEDS Chapter – [http://wiki.seds.org/index.php?title=Start\\_a\\_SEDS\\_Chapter](http://wiki.seds.org/index.php?title=Start_a_SEDS_Chapter)

<http://seds.org/chair/ChapterExpansionKit30.pdf>

**SEDS–Earth** – <http://earth.seds.org/index.php> – This is the international chapter.

SEDS–Earth is a central node for communication between these worldwide chapters.

**YURI’S NIGHT** – <https://yurisnight.net> – [http://en.wikipedia.org/wiki/Yuri's\\_Night](http://en.wikipedia.org/wiki/Yuri's_Night)

An Annual Celebration around the world, on April 12<sup>th</sup>, celebrating the first manned flight in space by Yuri Gagarin, of the Soviet Union, who piloted the first manned space capsule, **Vostok 1**, and made a complete orbit and landed safely in 1961.

**STEM [ Science, Technology, Engineering, Math]– STEM Academy** – [www.stem101.org/about.asp](http://www.stem101.org/about.asp)

The STEM Academy, Inc. is a national non–profit status organization dedicated to advancing economic development by improving STEM literacy for all students. State and national standards based K–16 STEM curriculum to create student pathways for industry and post–secondary advancement.

### Available Space Topic STEM Videos

- <http://www.nasa.gov/audience/foreducators/expeditions/stem/>
- <http://www.nasa.gov/audience/foreducators/expeditions/stem/stem-science-index.html>
- <http://www.nasa.gov/audience/foreducators/expeditions/stem/stem-tech-index.html>
- <http://www.nasa.gov/audience/foreducators/expeditions/stem/stem-eng-index.html>
- <http://www.nasa.gov/audience/foreducators/expeditions/stem/stem-math-index.html>

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

## The Moon, Planets & Pluto to be on New US Postage Stamps in 2016

[www.space.com/31496-postage-stamps-feature-moon-planets-pluto.html](http://www.space.com/31496-postage-stamps-feature-moon-planets-pluto.html)

<http://www.collectspace.com/index.html>



## Student Experiments Vital for Space Research

31 December, 2015 - [www.space.com/30936-student-experiments-space-research-pat-hynes.html](http://www.space.com/30936-student-experiments-space-research-pat-hynes.html)

The International Symposium on Private and Commercial Spaceflight is an annual meeting for the industry's top leaders and innovators, its central purpose is to **get student projects off the ground.** ##

## Don't Miss These 9 Must-See Skywatching Events the rest of 2016

[www.space.com/31550-12-best-skywatching-events-of-2016.html](http://www.space.com/31550-12-best-skywatching-events-of-2016.html)

(The first three events on the list will have occurred before publication of this issue of TTSIQ)

**May 21: A "blue moon" with Mars.** Many people know about the so-called "blue moon rule," which states that, if two full moons occur in a single calendar month, the second one is called a "blue moon." However, this is actually a misinterpretation of the original rule, which involves four full moons during a specific calendar season (instead of the usual three); the third full moon of the four was called a blue moon. This latter case applies on May 21. In addition, Mars, which is very close to its opposition, will appear to blaze almost directly below the Moon on that date.

**Late spring: A very favorable apparition of Mars.** In 2016, Mars will appear brightest **from May 18 to June 3.** Mars arrives at opposition to the Sun on May 22. Opposition is the moment when Earth, the Sun and another planet (Mars, in this case) are all aligned, with Earth in the middle. On May 22, the Red Planet will rise at Sunset, peak high in the south at midnight and set at Sunup the next day. Mars will

then be shining at its brightest for 2016, at magnitude minus 2.1 — nearly twice as bright as Sirius, the brightest star in the sky.

On **May 30**, Mars will make its closest approach to Earth for the year at 5:35 p.m. EDT (2135 GMT), at a distance of 46.8 million miles (75.3 million kilometers). Because Mars can come as close as 34.6 million miles (55.7 million km) to Earth (as was the case in 2003), this year's approach can be considered a fairly close encounter. In the weeks and months following opposition, from the end of May on through the balance of the year, Mars will become a fixture in the evening sky, but it will also be receding from the Earth and consequently will get progressively fainter.

**July 29: Another occultation of Aldebaran.** This one occurs in the dawn twilight and involves a waning gibbous moon. The occultation will be visible over western Canada and the United States, low in the east-northeast sky before Sunrise.

**Aug. 11–12: The Perseid meteor shower.** The Perseids are considered among the best of the annual meteor showers, thanks to their reliability and high rates of up to 90 "shooting stars" per hour. This year's peak will occur well after the moon — which will be just past first quarter — sets around midnight. There is also a possibility of a meteor outburst, which might produce an enhanced display this year. ]

**Aug. 28: A brilliant double planet.** Shortly after Sunset, in the west-southwest sky, the two brightest planets, **Venus** and **Jupiter**, will be strikingly close together. As seen from the Atlantic Seaboard, for example, only 5 arc minutes (or one-sixth the apparent width of the moon in our sky) will separate the two, making for a very eye-catching sight!

**Oct. 19: Aldebaran occulted again.** A waning gibbous Moon will again pass in front of Aldebaran, the angry eye of Taurus the Bull. This occultation will be visible over eastern Canada and most of the United States, except parts of the Northern Plains and the Pacific Northwest.

**Nov. 14. The "supermoon."** The full Moon that occurs on this day will also very nearly coincide with perigee, the object's closest approach to Earth for the year, in an event popularly known as a supermoon. The Moon will turn full at 8:52 a.m. EST (1352 GMT), just 2.4 hours after it comes within just 221,541 miles (356,536 km) of the planet. (The Moon's average distance from Earth in its elliptical orbit is 238,900 miles, or 384,470 km.) The last time the Moon came this close was on Jan. 26, 1948. Expect a large range in ocean tides (exceptionally low to exceptionally high) for the next few days.

**Dec. 13–14: The Geminid meteor shower and yet another occultation of Aldebaran.** If there is one meteor display guaranteed to put on a very entertaining show, it's the Geminids. Most meteor experts put the Geminid shower at the top of the list, surpassing the August Perseids in brilliance and reliability. In many cases, this would be your chance to see an average of as many as two meteors every minute — 120 per hour! But sadly, the Moon will be full this night, likely making it hard to see all but the brightest of the Geminid meteors. However, there is a consolation prize: For the fourth time this year, the Moon will occult Aldebaran for much of North America. ##

## NASA Astronaut to Highlight Space Station History from Orbit

[www.space.com/31561-astronaut-will-mark-space-station-history.html](http://www.space.com/31561-astronaut-will-mark-space-station-history.html)

NASA's next astronaut to launch to the International Space Station will use his unique position — in both time and space — to share the history of the orbiting outpost.

In March, Jeff Williams will have become the first American to spend three long-duration expeditions aboard the space station and will set a new U.S. record for cumulative time off the Earth. The astronaut will dedicate part of his upcoming six-month expedition to highlighting how the orbital complex came to be what it is today.

He had the unique opportunity to have gone in the early days before Expedition 1, to the station for the first time and then to be there again, halfway through assembly with a crew of two, and then back with a crew of three, and then later with a crew of six. His career covers the history of the station."

Williams, whose first trip to the outpost was aboard space shuttle Atlantis in May 2000, six months before the space station's first expedition crew arrived, is now set to join the Expedition 47/48 some 15 years later, launching with cosmonauts Alexey Ovchinin and Oleg Skripochka of Roscosmos on Russia's Soyuz TMA-20M spacecraft from the Baikonur Cosmodrome in Kazakhstan on March 18.

Williams intends to devote some of his time and outreach activities to taking a look back at what the station has accomplished and where that might lead as missions move out into the solar system. ##

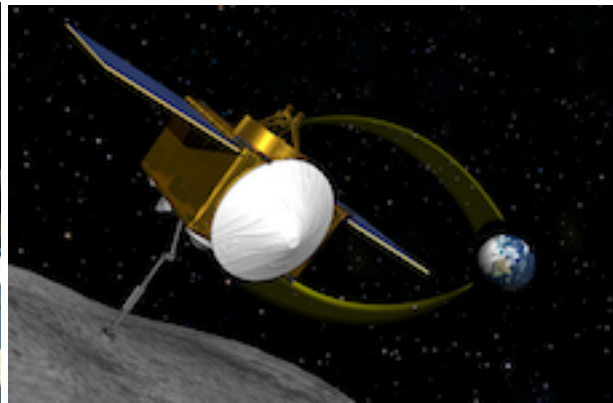
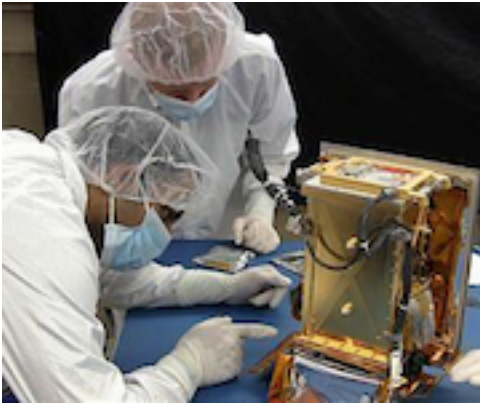
## Student-Built Experiment Integrated into NASA's OSIRIS-REX Mission

[www.spacedaily.com/reports/prnewswire-space-news.html?rkey=20160107DC93791&filter=1639](http://www.spacedaily.com/reports/prnewswire-space-news.html?rkey=20160107DC93791&filter=1639)

<http://astrobob.areavoices.com/2013/08/20/why-you-should-care-about-asteroid-101955-bennu/>  
[https://en.wikipedia.org/wiki/101955\\_Bennu](https://en.wikipedia.org/wiki/101955_Bennu)

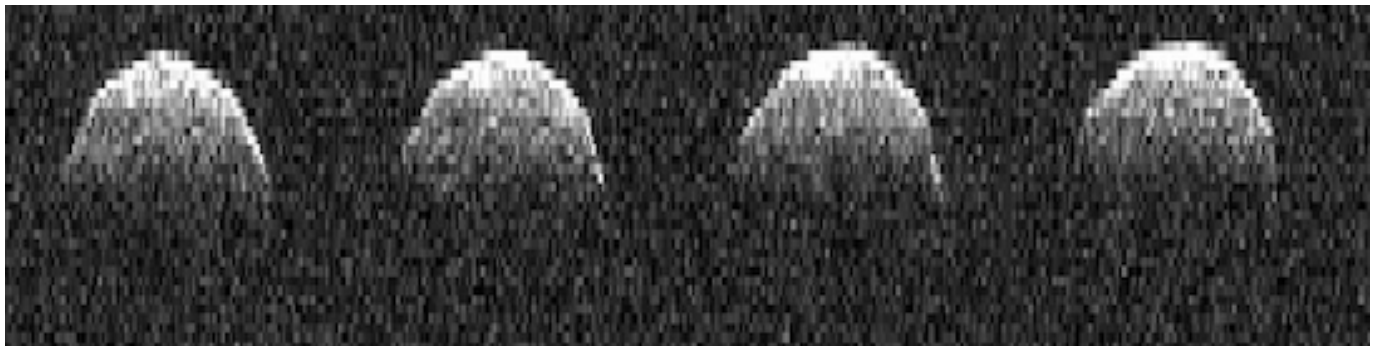
7 January, 2016 – A student-built experiment aboard NASA's Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REX) mission has been integrated onto the spacecraft.

The **Regolith X-ray Imaging Spectrometer** (REXIS) will determine elemental abundances on the surface of asteroid Bennu, complementing the mineral and chemical mapping capabilities provided by two other instruments on the spacecraft.



**Above Right:** studentbuilt experiment contribution

**Above Right:** probe taking a sample from asteroid Bennu



Asteroid Bennu has a diameter of c. 500 meters and orbits the Sun in 437 days (between Earth and Mars)

**REXIS will observe the solar X-rays and their interaction with the asteroid's surface material, or regolith.** The surface responds to this incoming energy by glowing faintly, or fluorescing, by emitting X-rays. These X-rays have an energy that is uniquely characteristic of the elements.

REXIS is a telescope that images this X-ray fluorescence, allowing the production of maps of the different elements present on Bennu's surface.

REXIS brings together students and faculty from Massachusetts Institute of Technology (MIT) and Harvard University, both in Cambridge. After a competitive process REXIS was selected as a student collaboration experiment as part of OSIRIS-REX.

The instrument will involve more than 100 students throughout the mission. Students at Harvard and MIT will perform data analysis as part of their coursework.

**OSIRIS-REx will be the first U.S. mission to sample an asteroid. After launch in September 2016,** the OSIRIS-REx spacecraft will travel to the near-Earth asteroid Bennu and retrieve at least 60 grams (2.1 ounces) of surface material and return it to Earth for study.

Scientists expect that Bennu may hold clues to the origin of the solar system and the source of the water and organic molecules that may have made their way to Earth. OSIRIS-REx's investigation will also inform future efforts to develop a mission to mitigate an asteroid impact on Earth, should one be required. ##

## International Space University Wants an American Campus

<http://acuriousguy.blogspot.ca/2016/02/isu-wants-american-campus.html>

[https://en.wikipedia.org/wiki/International\\_Space\\_University](https://en.wikipedia.org/wiki/International_Space_University)

The Strasbourg, France based **International Space University** (ISU), founded in 1987 by X-Prize founder and chairman Peter Diamanis, human space exploration advocate Todd Hawley and serial space entrepreneur Robert D> Richards, is seeking bids from American educational institutions to establish a permanent US based campus. The Strasburg, France location was opened in 1994.

The new campus location, will be called **the Robert A. Heinlein Institute for Space Entrepreneurship & Space Innovation**.

The Chancellor of the International Space University is Apollo astronaut **Buzz Aldrin**.

As of January 2014, there were over 3700 ISU alumni from more than 100 countries.##

## Train Like a Martian Challenge Inspires Kids to Get Active

[www.space.com/32087-train-like-a-martian-kids-challenge.html](http://www.space.com/32087-train-like-a-martian-kids-challenge.html)



The **Train Like a Martian** program challenges kids to participate in daily physical activities, just like a NASA astronaut would

The nonprofit group The Mars Generation (TMG) is inviting children (and adults, too) to "Train like a Martian" between April 18 and April 24. The initiative is inspired by NASA's "Train Like an Astronaut" program, which encourages physical activity among children by comparing it with astronaut training. (TMG has no affiliation with NASA.) ##

## Crowdsourcing the Universe: How Citizen Scientists are Driving Discovery (Kavli Roundtable)

[www.space.com/31626-crowdsourced-astronomy-finding-faint-galaxies-in-deep-space.html](http://www.space.com/31626-crowdsourced-astronomy-finding-faint-galaxies-in-deep-space.html)

14 January, 2016 – Astronomers are increasingly enlisting volunteer "citizen scientists" to help them examine a seemingly endless stream of images and measurements of the universe, and their combined efforts are having a powerful impact on the study of the cosmos.

Last November, a citizen science project called **Space Warps** announced the discovery of 29 new gravitational lenses, regions in the universe where massive objects bend the paths of photons (from galaxies and other light sources) as they travel toward Earth.

As cosmic phenomena go, the lenses are highly prized by scientists because they offer tantalizing glimpses of objects too distant, and dim, to be seen through existing telescopes, and information on the objects that are acting as lenses.

Impressive because of how it was obtained. During an 8-month period, about 37,000 volunteers icombed 430,000 plus digital images in a huge, online photo library of deep space.

Automated computer programs have identified most of the 500 gravitational lenses on astronomer's books. However, **computers failed to flag the 29 lenses the Space Warps volunteers spotted, speaking to unique skills we humans possess.** ##

## The Stars Within Us: Why Everything in You is Stellar

[www.space.com/31764-why-every-element-in-your-body-is-stellar.html](http://www.space.com/31764-why-every-element-in-your-body-is-stellar.html)

Take a deep breath.

That air filling up your lungs, that oxygen pulled into your bloodstream, stoking your metabolic fire, making you possible, is old. Older than you, older than the Earth itself. That oxygen once lived in the heart of a star that is now long dead. That calcium in your bones? That iron in your blood? The same.

Billions of years ago, there was no Earth, no Sun, nor even a solar system. There was just a relatively featureless cloud of gas and dust, hundreds of light-years across. Pretty much in stable equilibrium, that cloud could persist for hundreds of thousands, or even millions of years. But given just a little nudge — perhaps by a nearby supernova going off, sending its blast wave echoing through the nascent cloud — it quickly fragmented, folding in on itself in a complicated tangle of knots and streams.

**This is just the beginning. Read on!**

## Join the Starfleet Academy for a Day – Exhibit goes on tour

[www.space.com/31780-star-trek-exhibit-at-intrepid-museum.html](http://www.space.com/31780-star-trek-exhibit-at-intrepid-museum.html)

This summer, the Intrepid Sea, Air & Space Museum in New York City will host a new exhibit entitled "**Star Trek: The Starfleet Academy Experience.**"

The exhibit, which will fill a 10,000-square-foot (930 square meters) space in the museum, celebrates the 50<sup>th</sup> anniversary of the famed space franchise and will include props, costumes and technology (such as a medical tricorder table or planet projection mapping). Exact dates for the New York City appearance of Starfleet Academy have not been released. ##

## Unboxing The Best Inexpensive Telescope: AWB OneSky 130 | Video

[www.space.com/31791-unboxing-the-best-inexpensive-telescope-awb-onesky-130-video.html](http://www.space.com/31791-unboxing-the-best-inexpensive-telescope-awb-onesky-130-video.html)

[www.space.com/31231-best-inexpensive-telescopes.html](http://www.space.com/31231-best-inexpensive-telescopes.html)

SPACE.com's Dave Brody sets-up this amazing tabletop Dobsonian. Nearly half your purchase price (\$200) goes to support science education around the world through the non-profit Astronomers Without Borders organization. Read Dave's full review: [One People – One Sky!](#)



## How to Use Mobile Apps to Spot the Space Station and Iridium Flares

[www.space.com/32387-satellite-space-station-skywatching-mobile-apps.html](http://www.space.com/32387-satellite-space-station-skywatching-mobile-apps.html)

## Loaded with Celestial Snapshots, 'Armchair Astronomer' Tours Cosmic Nebula

[www.space.com/32264-armchair-astronomer-book-tours-nebula.html](http://www.space.com/32264-armchair-astronomer-book-tours-nebula.html)

A new **e-book** that introduces readers to cosmic nebula — massive clouds of gas and dust that often harbor newborn stars — is easy to read and loaded with inspiring imagery. ##

Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

## Best Space Books and Sci-Fi: A Space.com Reading List

[www.space.com/28973-best-space-books.html](http://www.space.com/28973-best-space-books.html)



Space.com's editors present a reading list for space and sci-fi lovers, as well as children who are interested in astronomy and spaceflight.

### Five Categories:

- Astronomy and Astrophysics
- Spaceflight and Space History
- Children's Astronomy and Spaceflight
- Science Fiction
- Space Photography

Thirty books are reviewed ##

## Introducing Space.com's New Satellite Tracker from N2YO

[www.space.com/32072-introducing-space-satellite-tracker.html](http://www.space.com/32072-introducing-space-satellite-tracker.html)

[www.space.com/32054-satellite-tracker.html](http://www.space.com/32054-satellite-tracker.html)

Space.com's new satellite tracker will report the locations and speeds of 12 satellites that orbit Earth and forecast when they'll be overhead.

- International Space Station
- Hubble Space Telescope
- Terra (Earth observing)
- KMS-4 (Earth observing)
- Tiangong-1 (China space station)
- NOAA-15 weather satellite
- Aqua (Ocean observing)
- X-37B Air Force space plane
- NOAA-18
- ALOS Japan land observing
- Landsat 8
- NOAA 18 polar Earth observing

## Star Chart Virtual Reality App Puts Planetarium on Your Smartphone

[www.space.com/32200-star-chart-virtual-reality-solar-system-app.html](http://www.space.com/32200-star-chart-virtual-reality-solar-system-app.html)

A new virtual reality app lets users explore the solar system up close, from scorching-hot Mercury to faraway Pluto and beyond. The app, called **Star Chart for VR**, is billed as the first virtual reality planetarium. Used with the Google Cardboard viewer, it lets viewers experience virtual reality via their **smartphones** or other mobile devices.

Star Chart for VR currently includes a **3D Solar System** (with sun, planets and major moons), **88 night-sky constellations** and a **real-time view of the planets and stars visible from Earth** ##

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## S

[www.space.com/31921-mobile-stargazing-apps-smartphone-astronomy.html](http://www.space.com/31921-mobile-stargazing-apps-smartphone-astronomy.html)



In the past you would point at an object in the sky and ask "What star is that?"  
Today you can pull your phone from your pocket and find out.



Being out under the stars on a clear night can be "food for the soul," and it's been known to trigger a lifelong passion for astronomy in more than one impressionable youngster. But it can also leave you wondering what you're looking at.

**Is that** bright object a star, or a planet, or even a satellite? **Where does** one constellation end, and the next one begin? And **where can I** find that comet that everyone's been talking about? **Is it even visible from where I live?**

Nearly everyone has a mobile device these days, and there are plenty of apps available for sky watchers of all ages and knowledge levels. In this series of columns, we'll explore astronomy the 21st century way – with astronomy and space-related apps and gadgets.

An astronomy app can tell you where the four Galilean moons of Jupiter are, and whether they are eclipsing one another, or casting their little round black shadows on the big planet's face. Jupiter rotates once every 10 hrs or so, so your app is a great aid to determine when to look for the Great Red Spot. ##

This article was provided by Simulation Curriculum, the leader in space science curriculum solutions and the makers of the SkySafari app for Android and iOS. Follow SkySafari on Twitter @SkySafariAstro. Follow us @Spacedotcom, Facebook and Google+ .##

## 'Moon Shot': Web Series About Private Moon Race Coming Soon

[www.space.com/32135-moon-shot-google-lunar-xprize-documentary-video.html](http://www.space.com/32135-moon-shot-google-lunar-xprize-documentary-video.html)

"Moon Shot" is a new nine-part documentary web series about the Google Lunar X Prize (GLXP). The \$30 million private race to the Moon is about to hit computer and smartphone screens world-wide.



## NASA Top Chef: High-School Teams Compete to Cook Astronaut Food

2 March, 2016 – [www.space.com/32119-nasa-astronaut-food-cooking-competition.html](http://www.space.com/32119-nasa-astronaut-food-cooking-competition.html)



Students plate their quinoa curry during the HUNCH Culinary Challenge pre-competition tasting at NASA's Langley Research Center on Feb. 16, 2016 ##

## Celestial Buddies' Pluto & Charon May Be the Cutest Space Toys Ever

[www.space.com/31938-pluto-charon-plush-celestial-buddies.html](http://www.space.com/31938-pluto-charon-plush-celestial-buddies.html)



Past TTSIQ issues are online at: [www.moonsociety.org/international/ttsiq/](http://www.moonsociety.org/international/ttsiq/) and at: [www.nss.org/tothestars/](http://www.nss.org/tothestars/)

## Moon Miners' Manifesto Resources

<http://www.moonsociety.org/chapters/milwaukee/mmm/>

MMM is published 10 times a year (exc. Jan July). The December 2014 issue begins year # 28.

Most issues deal with the **opening of the Lunar frontier**, suggesting how pioneers can make best use of **local resources** and learn to **make themselves at home**, through psychological, social, and physiological adjustment.

Some of the points made will relate specifically to **pioneer life** in the lunar environment. Much of what will hold for the Moon, will also hold true for **Mars and for space in general**. There is one Mars theme issue each year. **Other space destinations** are discussed: the asteroids, moons of Jupiter and Saturn), even the cloud tops of Venus.

Issues #145 (May 2001) forward through current are as pdf file downloads with a Moon Society username and password. Moon Society International memberships are \$35 US; \$20 students, seniors – join online at:

<http://www.moonsociety.org/register/>

**MMM Classics:** All the “non-time-sensitive editorials and articles from past issues of MMM have been re-edited and republished in pdf files, one per publication year. A 3-year plus lag is kept between the MMM Classic volumes and the current issue. **As of December 2011, the first twenty-two years of MMM, 200 issues, will be preserved in this directory**, These issues are freely accessible to all, no username or password needed, at:

[www.moonsociety.org/publications/mmm\\_classics/](http://www.moonsociety.org/publications/mmm_classics/)

**MMM Classic Theme Issues:** introduced a new series to collect the same material as in the Classics, but this time organized by theme. The first MMM Classic Theme issue gathers all the **Mars** theme articles from years 1–10 in one pdf file. A second pdf file collects all the Mars Theme issues from year 11–20. The 2<sup>nd</sup> Classic Theme is “**Eden on Luna**,” addressing environmental issues underlying lunar settlement. **Asteroids, Tourism, Research, Select Editorials, and Analog Programs** have been added. New Theme Issues will be coming: Lunar Building Materials, The Lunar Economy, The Lunar Homestead, Modular Architecture, Modular Biospherics, Frontier Arts & Crafts, Frontier Sports, Other Solar System Destinations, and so on.

[www.moonsociety.org/publications/mmm\\_themes/](http://www.moonsociety.org/publications/mmm_themes/)

**MMM Glossary:** The publishers of MMM, the Lunar Reclamation Society, has published a new Glossary of “MMM-Speak: new words and old words with new meaning” as used in Moon Miners' Manifesto.

[www.moonsociety.org/publications/m3glossary.html](http://www.moonsociety.org/publications/m3glossary.html)

The initial addition includes over 300 entries, many with illustrations. Additional entries are under construction. It is hoped that new members will consider this to be a “Read Me First” guide, not just to Moon Miners' Manifesto, but to our vision and goals.

**All of these resources are available online or as free access downloads to readers.  
But TTSIQ does need your help!**

### To The Stars International Quarterly Advisors, Liaisons, Contributors, Reporters, Illustrators

If this publication is to help spread the word about Space worldwide, among the public at large, especially among the students and younger people, it must become a truly International publication. We need people from many fields and many nations to join our team.

If you can add to the usefulness and vitality of this publication, in any of the ways listed above, or in fields we had not thought of, write us at: [ttsiq@moonsociety.org](mailto:ttsiq@moonsociety.org) [This email address goes to the whole editorial team]

Tell us about yourself; your interest in space, and how you think you can make this publication of real service in the education of the public worldwide, and in the education of young people on whom our future rests.

**Guidelines for Submissions:** TTSIQ is intended for wide public distribution to encourage support for space research and exploration and development. TTSIQ is not a scholarly review or a technical journal for professional distribution. Submissions should be short, no more than a few thousand words. Longer pieces may be serialized editorials and commentary, reports on actual developments and proposals, glimpses of life on the future space frontier, etc. Articles about launch vehicles, launch facilities, space destinations such as Earth Orbit, The Moon, Mars, the asteroids, and beyond, challenges such as moon dust, radiation, reduced gravity, and more.

### Help Circulate To The Stars International Quarterly

If you know someone who might enjoy reading this publication, send us their email address(es) so that they receive notice when a new issue is published. Readers are encouraged to share and to distribute these issues widely, either as email attachments, or via the direct download address (for all issues):

<http://www.nss.org/tothestars/> and <http://www.moonsociety.org/international/ttsiq/>

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