



To The
Stars



International
Quarterly #9

L: comet 67P/Churyumov-Gerasimenko R: India's Mangalayaan-1 Mars orbiter's 1st picture of Mars

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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 involve 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, Europa (Jupiter), Titan (Saturn), even the cloud tops of Venus, and interstellar destinations beyond.



NOTE TO READERS:

- Starting with this issue, most of the "editor's summaries" of news articles will be in the form of bullet points of the contents.

We welcome your comments - Peter Kokh, Editor, kokhmmm@aol.com



ANALOG FACILITY TRAINING

Preparing for Ventures in Space by Exercises in Caves

July 11, 2014 -

http://www.esa.int/Our_Activities/Human_Spaceflight/Caves/Dry_runs_preparing_for_underground_astronauts



Parallels: Clambering down to base camp hundreds of metres below the surface using safety tethers is similar to conducting a spacewalk. This year the procedures will include **astronaut terminology**.

- In space an object can quickly float away and be lost forever. In caving, dropped equipment can be lost forever in crevices or holes.
- In passing equipment, cavers and astronauts must make sure the recipient is grasping the item before the first person lets go: "**make before break**" in astronaut lingo.

"**Caves**" is an exploration mission, and this year will be more difficult as the astronauts venture further from base camp. These exercises takes place in a **cavern called Sa Grutta on the island of Sardinia**.

- For the first time the trainees will set up an outpost more than 5 km (3 mi) from base camp to spend the night, following directions and maps drawn by 'cavenauts' from previous years. As they distance themselves from base camp it will get more challenging.

MORE: Sept 10 - <http://www.space.com/27093-mock-space-mission-underground-caves.html>

- Six "astronauts" entered the cave for a six day mission.

Astronauts Simulate Deep-Space Mission in Underwater Lab

<http://www.space.com/26635-underwater-neemo-18-mission.html> = July 24, 2014



An unidentified crew member participates in a NASA Extreme Environment Mission Operations (NEEMO)

- A crew of 4 currently living in an underwater lab will create a 10-minute communications delay with Mission Control, simulating what speaking with people on Earth could be like on a mission to Mars or to a nearby asteroid.
- This will be in sharp contrast to the 3 second delay in communications between Earth and the nearby Moon. ##

TO THE EDGE OF SPACE

To The Edge of Space in a Balloon – 3 Videos

DATE

www.space.com/26527-edge-of-space-balloon-rides-test-delivers-amazing-views-video.html

<http://www.space.com/26531-world-view-balloon-test-flight-video.html>

<http://www.space.com/26338-edge-of-space-commercial-balloon-flights-closer-with-record-breaking-test-video.html>



SpaceX Soft Lands Falcon 9 Rocket First Stage

http://www.space-travel.com/reports/SpaceX_Soft_Lands_Falcon_9_Rocket_First_Stage_999.html

Videos: <https://www.youtube.com/watch?v=CQnR5fhCXkQ&feature=youtu.be>

<http://www.space.com/26856-spacex-reusable-rocket-airplane-video.html>

July 24, 2014 – After a successful launch of six ORBCOMM satellites, a Falcon 9 rocket's first stage soft landed in the Atlantic Ocean.

Experimental Space Plane Designs Wanted by US Military

July 15, 2014 - <http://www.space.com/26529-experimental-military-space-plane-designs.html>



Boeing

Version

The "Specs" Officials want the unmanned vehicle to launch 1,361–2,268 kg (3,000– 5,000-lb) payloads to orbit for less than \$5 million per flight, and able to blast off at least 10 times in a 10-day span.

SpaceX Reusable Rocket Prototype Explodes Over Texas

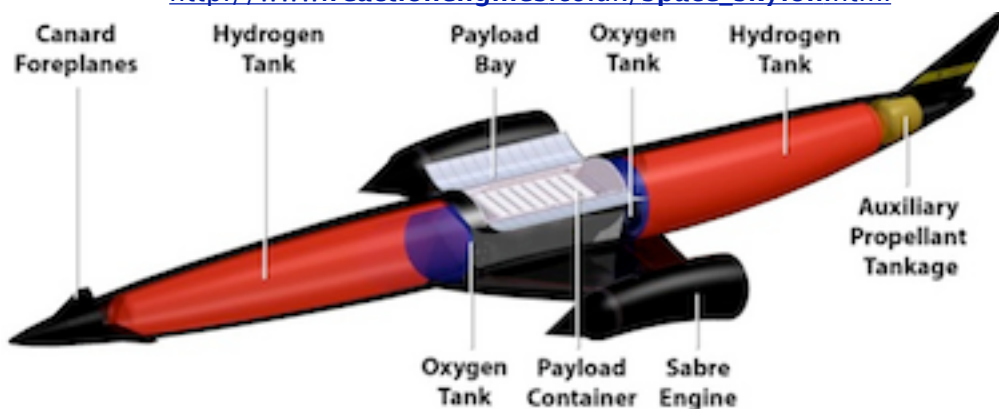
August 23, 2014 - www.space.com/26921-spacex-reusable-rocket-explodes-over-texas-video.html

- A reusable rocket prototype built by the private spaceflight company SpaceX exploded over the firm's McGregor, Texas proving grounds, Friday (Aug. 22) after an anomaly forced the destruction of the craft. SpaceX has been testing reusable rocket technology using its prototype Falcon 9 Reusable (or F9R) vehicle.
- During the flight, an anomaly was detected in the vehicle and the flight termination system automatically terminated the mission," SpaceX representatives said. "Throughout the test and subsequent flight termination, the vehicle remained in the designated flight area. There were no injuries or near injuries. An FAA representative was present at all times."

SKYLON Space-Plane Will Be Both Truck and Bus - Video

<http://www.space.com/26753-skylon-space-plane-will-be-both-truck-and-bus-video.html>

http://www.reactionengines.co.uk/space_skylon.html



For more on Skylon, see: http://www.reactionengines.co.uk/space_skylon.html and [http://en.wikipedia.org/wiki/Skylon_\(spacecraft\)](http://en.wikipedia.org/wiki/Skylon_(spacecraft))

NASA Picks 4 Companies to Test Innovative Tech Near Edge of Space

Sept. 10, 2014 - <http://www.space.com/27095-nasa-suborbital-space-tech-companies.html>

NASA has picked four private [companies](#) to fly experiments near the edge of space to test innovative new technologies as part of its suborbital flight services program.

- **Virgin Galactic** — which plans to fly tourists to space next year
- **Masten Space Systems**
- **Paragon Space Development Corp.**
- **Up Aerospace Inc.**

Each of the firms will receive at least \$100,000 to run flights for three years. The companies will perform flights "near the boundary of space" but still within Earth's atmosphere. The contracts could be extended for up to two years. The new awards build on previous contracts awarded in 2011.

These flight service providers will allow for payloads from NASA, industry, academia, and other government agencies to be tested on flights to the edge of space before being committed to demonstration in the harsh environment of space itself. The program allows researchers to test out their payloads in microgravity for three to four minutes, or in gravity loads that simulate what is found on the Moon or Mars. ##

Solar Power could be World's Main Energy Source by 2050

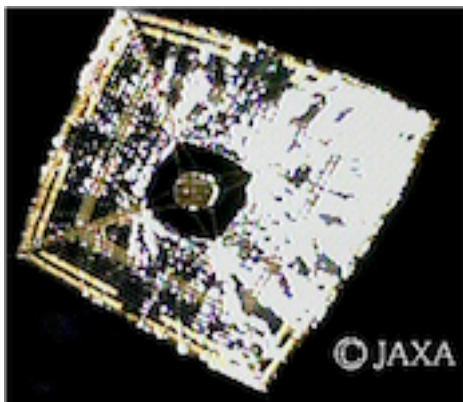
<http://www.iea.org/newsroomandevents/pressreleases/2014/september/how-solar-energy-could-be-the-largest-source-of-electricity-by-mid-century.html>

Sept 29, 2014 - According to a new report from the **International Energy Agency**, the sun could be the world's largest source of electricity by 2050, ahead of fossil fuels, wind, hydro and nuclear. The two IEA technology roadmaps show how **solar photovoltaic (PV) systems** could generate up to 16% of the world's electricity by 2050 while **solar thermal electricity (STE)** from concentrating solar power (CSP) plants could provide an additional 11%. Combined, these solar technologies could prevent the emission of more than 6 billion tonnes of carbon dioxide per year by 2050 - that is more than all current energy-related CO₂ emissions from the United States or almost all of the direct emissions from the transport sector worldwide today. ##

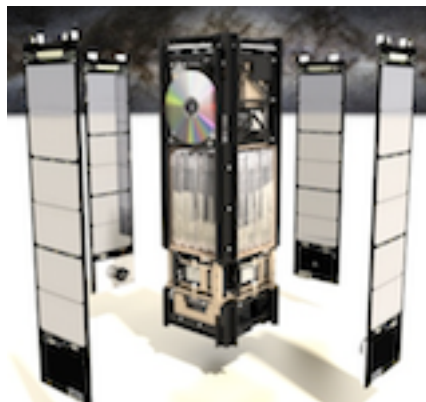
Solar Sails Could Beat the 'Rocket Equation' | Animation Surfin' on Sunlight! Privately Funded Solar Sail to Launch by 2016

July 11, 2014 - <http://www.space.com/26493-lightsail-solar-sail-launch-2016.html>

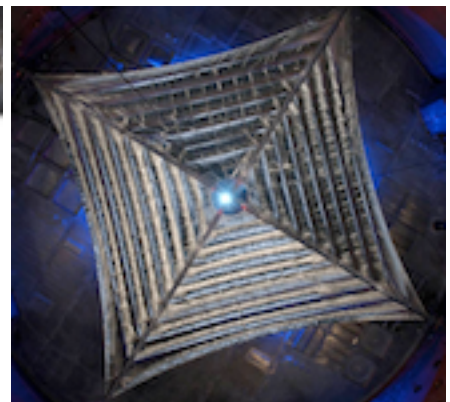
<http://www.space.com/26488-solar-sails-could-beat-the-rocket-equation-animation.html>



Japan's Ikaros



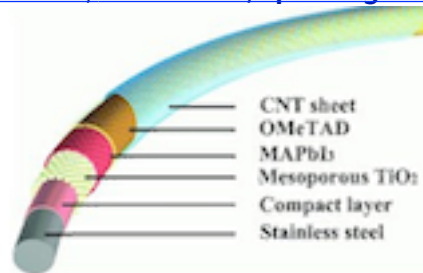
Lightsail-A before deployment



Sunjammer

Spinning Solar Cells Into Textiles – Power for future Spacesuits?

<http://www.asianscientist.com/in-the-lab/spinning-solar-cells-textiles-2014/>



Aug. 7, 2014) – Scientists have developed solar cells in the form of fibers that can be woven into textiles, paving the way for powering small electronic devices incorporated into clothing. This research has been published in the journal *Angewandte Chemie*.

Although promising as a source of renewable energy, **solar cells** face a trade-off between cost and efficiency: **either inexpensive and inefficient, or reasonably efficiency but very expensive.**

- One solution may come from solar cells made of perovskite materials, which are less expensive than silicon and do not require any expensive additives. Perovskites are materials with a special crystal structure like that of perovskite, a calcium titanate. These structures are often semiconductors and absorb light relatively efficiently. Most importantly, they can move electrons excited by light for long distances within the crystal lattice before they return to their energetic ground state and take up a solid position, a property that is very important in solar cells.
- A team at Fudan University in Shanghai has now developed perovskite solar cells in the form of flexible fibers that can be woven into electronic textiles. Their production process is relatively simple and inexpensive because it uses a solution-based process to build up the layers.
- The anode is a fine stainless steel wire coated with a compact n-semiconducting titanium dioxide layer. A layer of porous nanocrystalline titanium dioxide is deposited on top of this.
- This provides a large surface area for the subsequent deposition of the perovskite material $\text{CH}_3\text{NH}_3\text{PbI}_3$. This is followed by a layer made of a special organic material.
- Finally a transparent layer of aligned carbon nanotubes is continuously wound over the whole thing to act as the cathode. The resulting fiber is so fine and flexible that it can be woven into textiles.
- The perovskite layer absorbs light, exciting electrons and setting them free, causing a charge separation between the electrons and the formally positively charged “holes.” The electrons enter the conducting band of the compact titanium dioxide layer and move to the anode. The “holes” are then captured by the organic layer.
- The large surface area and high electrical conductivity of the carbon nanotube cathode aid in the rapid conduction of the charges with high photoelectric currents. Fiber solar cells can have an energy conversion efficiency of 3.3 %, more than all previous dye or polymer coaxial fiber solar cells.

ORBITAL REFUELING & REPAIR SERVICES

NASA Eyes Robotic Space Gas Stations for Satellites

July 29, 2014 – <http://www.space.com/26675-nasa-robot-satellite-gas-station.html>

<http://www.space.com/24949-robotic-satellite-refueling-tech-works-nasa-proves-video.html>



- **Trade money for time – Test flight in 2015 possible**

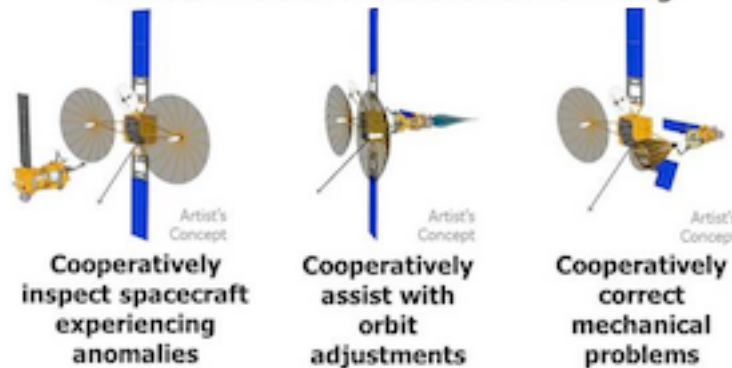
The **Remote Robotic Oxidizer Transfer Test (RROxiTT)** robot demonstrated a way for future servicing satellites to transfer oxidizer to a satellite in need of re-fueling, at the Kennedy Space Center's Payload Hazardous Servicing Facility.

DARPA Wants to Test Satellite Repair Droids in Orbit

Sept. 12, 2014 – <http://www.space.com/27128-darpa-robotic-satellite-repair-droids.html>
<http://www.space.com/25624-on-orbit-satellite-builds-darpa-phoenix-project-animation.html>
<http://www.space.com/16329-darpa-to-salvage-satellites-for-scrap.html>

- DARPA the United States military's high-technology branch, DARPA (**D**efense **A**dvanced **R**esearch **P**rojects **A**gency), is hoping to test out on-orbit satellite servicing in orbit in the next five years.
- Satellites that sit in geostationary orbit, about 36,000 km (about 22,000 m) above Earth's surface, are traditionally used for communications and surveillance because they orbit in the same length of time as Earth's surface below rotates, with the same area of Earth's surface in view around the clock.
- This location is too far away for conventional satellite servicing mission concepts, and at the end of a satellite's lifespan it needs to be moved away from that orbital slot to make way for new missions.

DARPA Goals for GEO Robotics Servicing



- The partnership would save money for both commercial and military owners with satellites in "GEO" since new satellites wouldn't need to be launched as often, lowering satellite construction and deployment costs and improving satellite lifespan, resilience and reliability,
- DARPA has put out a request for information looking for "technical, security and business insights" to make this service possible, seeking technical information on a possible "robotic servicer" that would make use of previously developed DARPA space robotics.
- Ideally, the robot would be able to fix mechanical problems like antenna issues, or inspect spacecraft that had operational problems, providing more information to controllers on Earth.
- The servicer might even be able to move satellites into other orbits. ##

CREW CAPSULES

The First Orion Crew Capsule is Complete & Ready for Deep Space Test

Sept.6,2014 – <http://spaceref.com/orion-1/the-first-orion-crew-module-is-complete.html>



NASA's first completed Orion crew module sits atop its service module at the Neil Armstrong Operations and Checkout Facility at Kennedy Space Center in Florida.

Larger image: <http://www.nasa.gov/content/orion-s-first-crew-module-complete/>

- The module was transferred to another facility for fueling, before moving again for the installation of the launch abort system. At that point, the spacecraft will be complete and ready to stack on top of the Delta IV Heavy rocket that will carry it into space on its first flight in December.
- For that flight, Exploration Flight Test-1, Orion will travel 3,600 miles above the Earth – farther than any spacecraft built to carry people has traveled in more than 40 years – and return home at speeds of 20,000 miles per hour, while enduring temperatures near 4,000 degrees Fahrenheit.

SPACEPORTS

China completes construction of Hainan Island space launch facility

www.spacedaily.com/reports/China_completes_construction_of_advanced_space_launch_facility_999.html

August 12, 2014 – China has finished building of its fourth and most advanced space launch center.



- Infrastructure construction on the Wenchang Satellite Launch Center in the southern island province of Hainan has been completed and that the station will soon become operational.
- China has three operational space launch centers in Sichuan and Shanxi provinces and the Inner Mongolia autonomous region.
- More than 6,000 people would be relocated to make way for the Wenchang center.
- Construction of the center had been approved in 2007, and work began in 2009.
- The biggest advantage of the Wenchang center is its low latitude – 19 degrees north of the equator – which will enable rockets to save a lot of fuel compared with launches from other centers in China.
- A satellite launched from Wenchang is expected to have a longer service life as a result of the fuel saved by the shorter trip from transit orbit to geosynchronous orbit.
- The favorable location also allows a substantial increase in payload on the rockets to allow them to carry heavier spacecraft.
- The new center would be suitable for the launch of the Long March-5 because the large rocket can be transported to the center by sea.
- Other launch centers in China are in inland regions and have to transport their rockets by rail.
- Launching from the Wenchang facility also means rocket wreckage will fall into the sea rather than onto inhabited areas ##

Construction of Space-X' new Spaceport in Brownsville, Texas to begin in 2015

<http://spaceflightnow.com/news/n1409/28brownsville/#.VCqLRIZzMs>

<http://www.space.com/27234-spacex-texas-spaceport-groundbreaking.html>

http://en.wikipedia.org/wiki/SpaceX_private_launch_site

Sept 22, 2014 – BROWNSVILLE, Texas -- SpaceX broke ground on a new commercial spaceport Sept. 22 on the shores of South Texas, committing to the construction of **the world's first privately-owned satellite launch pad** scheduled to be **operational as soon as late 2016**.

**Location:** Boca Chica Beach

- a remote stretch of shoreline about three miles north of the U.S.–Mexico border at the mouth of the Rio Grande River.
- where a little-traveled road dead-ends at the Gulf of Mexico about 32 km (20 mi) east of Brownsville
- This site beat out proposed locations in Florida, Hawaii and elsewhere
- This location is 2 degrees further south than Cape Canaveral in Florida, giving it a slight advantage

Site usage:

- SpaceX plans up to a 12 launches of its Falcon 9 and Falcon Heavy rockets from the site, for starters

SPACE STATIONS

NASA Urged to Accelerate 3D Printing on Space Station

July 30, 2014 – <http://www.space.com/26676-3d-printing-international-space-station.html>

The International Space Station likely has just six to 10 years of operational life left so NASA must move quickly to demonstrate the advantages of 3D printing on board. A 3D printer is scheduled to arrive at ISS this month (August)

- At 3D printing's current state of development, it makes sense to have humans supervising the process to make sure it is meeting standards
- The station provides a good opportunity to learn more about how 3D printing works in microgravity.
- And if the process were performed outside of the station, it would teach researchers how thermal stresses — quick changes from hot to cold, for example — could affect the materials.

Not a panacea

- A lot of hype surrounds 3D printers, with many news reports saying the machines can produce parts that are lighter, stronger and more advanced than those made using traditional manufacturing techniques. For example, that it's possible for a single component to have different properties along its length, or to put together parts that don't have traditional connectors.
- The use of 3D printing in space requires a strong understanding of materials science to make it work
- 3D printing is still in its infancy in manufacturing "thinking" materials like semiconductors.
- Printing today is more focused on prefabricated components and "primitive" items like conductors.
- You can build a part, but it isn't altogether clear that a 3D-manufactured part is going to be necessarily as good [as a part] that was built some other way.
- There are things we talk about that we haven't even begun to understand, like certification."

From ISS to the Moon and Mars

- The European Space Agency has spoken about 3D printing of lunar base components and habitats.
- NASA is also funding a company called Tethers Unlimited, which hopes to launch very small materials (such as thread spools) that would transform into kilometer-long antennas or solar arrays in space.
- The US Air Force plans to use 3D printing on the ground to manufacture lighter parts for rockets and satellites, to reduce the amount of fuel needed to lift things into space.

- Most of the Air Force's experience so far is focusing on aerospace and not space parts. The report urges the Air Force and NASA to talk more closely and share expertise.

Producing a comprehensive report on 3D printing

- Committee members spent more than a year examining the state of the industry before publishing their report, called "3D Printing In Space."
- Committee members included a mix of experts from U.S. laboratories, universities, military agencies.
- The report was examined by a second committee of experts, who marked it up with comments that had to be addressed before publication.

Sparks Fly as NASA Pushes the Limits of 3-D Printing Technology

http://www.spacedaily.com/reports/prnewswire-space-news.html?doc=201408291206PR_NEWS_USPR_DC00809 – August 29, 2014

- NASA has successfully tested the most complex rocket engine parts ever designed by the agency and printed with additive manufacturing, or 3-D printing
- Engineers designed a rocket engine injector that sends propellant into the engine
- The injector has design features that take advantage of 3-D printing.
- The printer built each part by layering metal powder and fusing it together with a laser, a process known as selective laser melting.
- This process allowed creation of an injector with 40 individual spray elements, all printed as a single component rather than manufactured individually.
- The part is **similar in size** to injectors that power small rocket engines and **similar in design** to injectors for large engines, as the RS-25 engine to power NASA's Space Launch System (SLS) rocket
- A goal was to demonstrate how 3-D printing could revolutionize rocket designs for increased system performance
- Using traditional manufacturing methods, 163 individual parts would be made and then assembled. But with 3-D printing technology, only two parts were required
- This method saved time and money and allowed engineers to build parts that enhance rocket engine performance and are less prone to failure.

Two rocket injectors were tested for five seconds each, producing 20,000 pounds of thrust.

- The device has complex geometric flow patterns that allowed oxygen and hydrogen to swirl together before combusting at 1,400 pounds per square inch and temperatures up to 3,590 °C (6,000 °F)
- Two separate companies were involved -- Solid Concepts in Valencia, California, and Directed Manufacturing in Austin, Texas. Each company printed one injector.
- NASA is working with industry to learn how to take advantage of additive manufacturing in every stage of space hardware construction from design to operations in space.
- Additive manufacturing not only helped engineers build and test a rocket injector with a unique design, but it also enabled them to test faster and smarter. Using Marshall's in-house capability to design and produce small 3-D printed parts quickly, the propulsion and materials laboratories can work together to apply quick modifications to the test stand or the rocket component.
- An in-house additive manufacturing capability allows NASA to look at test data, modify parts or the test stand based on the data, implement changes quickly and get back to testing.
- This speeds up the whole design, development and testing process and allows NASA to try innovative designs with less risk and cost to projects.
- Marshall engineers have tested increasingly complex injectors, rocket nozzles and other components with the goal of reducing the manufacturing complexity and the time and cost of building and assembling future engines. Additive manufacturing is a key technology for enhancing rocket designs and enabling missions into deep space. ##

China to launch second space lab in 2016: official

http://www.spacedaily.com/reports/China_to_launch_second_space_lab_in_2016_official

Sept. 10, 2014 – China will launch its second orbiting space laboratory in two years' time, the latest step in an ambitious space program Beijing says will one day land a Chinese taikonaut on the Moon.

Astronaut Yang Liwei, China's first man in space and now deputy director of the country's manned space programme, made the announcement at.

- The spacelab Tiangong-2 will be launched in 2016
- Then China will launch Shenzhou-11 and the Tianzhou-1 cargo spaceship to dock on the spacelab.
- Beijing plans to launch an experimental core space station module in 2018 and finish construction of the space station as now conceived around 2022.
- The rival International Space Station, operated by the US, Russia, Japan, Canada and Europe, is currently due to be retired in 2024.
- Several countries have already reportedly been in contact with Beijing about the possibility of collaborating in space. ##

China eyes working with other nations as station plans develop

www.spacedaily.com/reports/China_eyes_working_with_other_nations_as_station_plans_develop_99.html



Sept. 12, 2014 – China is open to cooperation with foreign nations on its manned space station project.

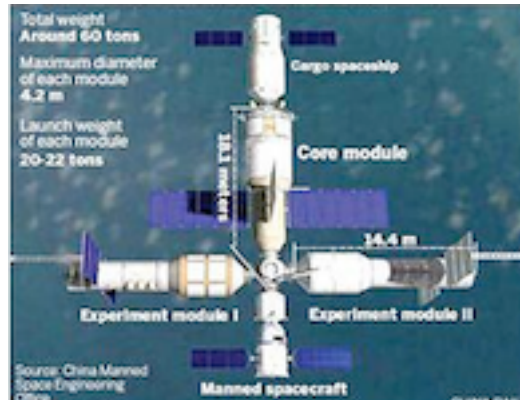
- A number of platforms can be used for international cooperative projects in our future space station were reserved when it was designed
- Adapters that can dock with other nations' spacecraft are a part of the design
- China is willing to deepen collaboration on its space station with other nations in a wide range of fields such as equipment development, applied technology and joint operation.
- China would share knowledge, experience and achievements in space activities with other countries, especially developing countries.
- The plan is to launch the space station core module in 2018 to test related technologies and engineering issues
- The whole station will become fully operational around 2022, a
- China has been in comprehensive cooperation with many foreign space agencies regarding aerospace medicine, applied sciences and astronaut selection and training.
- Chinese scientists and engineers have already conducted 17 life science experiments with the German Aerospace Center during the unmanned Shenzhou-8 spacecraft mission in 2011.
- China would be happy to help train astronauts for other countries and organizations and would also be glad to provide rides to foreign astronauts.
- After launching its manned space program in September 1992. China has sent 10 Shenzhou spacecraft – five of them manned – and the Tiangong-1 space laboratory into space.

- This is the first time that China has hosted the association's planetary congress, which enables astronauts from all spacefaring nations to meet and exchange information about human spaceflight operations and future plans. ##

China's Space Station Still on Track

Sept 14, 2014 – www.spacedaily.com/reports/Chinas_Space_Station_is_Still_On_Track_999.html

China recently disclosed some more developments in its space laboratory and space station program. Tiangong 2 is expected to launch in 2016. The large Space Station will be launched around 2022.



- Tiangong 2 is expected to use the same sort of short, stubby module as Tiangong 1, a small pressurized cabin with a single docking port.
- Tiangong 2 should receive a 3-member crew expedition, launched on the Shenzhou 11 spacecraft.
- The Tianzhou cargo spacecraft, too large and heavy for any Long March 2F variant, will use the Long March 7 rocket, still under development.
- The heavy modules for the space station will use the powerful Long March 5 rocket
- These new rockets should launch from the new Hainan Island launch site on, still under construction.
- There's a lot of untested infrastructure in this mix.
- More good news than bad news. The human spaceflight program is still on track, moving slowly. ##

LOW EARTH ORBIT

Satellite Towing Service Developed By Israel's 1st Space Startup | Video

<http://blogs.wsj.com/digits/2014/08/27/satellite-lost-in-space-well-tow-it-says-israeli-startup/>

August 26, 2014 – TEL AVIV— It's not a tractor beam, but a robotic space tow-truck, that could get the job done just as well. An Israeli startup has designed a micro-satellite that can dock with a wayward satellite and tug it into the right orbit.



The 'DeOrbiter' from Effective Space Solutions Ltd.

- Targets include malfunctioning satellites in Geo-Synchronous Orbit
- Effective Space Solutions Ltd. is talking with several manufacturers to build the tugboat
- “DeOrbiter,” once built and deployed, could rendezvous with in-orbit decommissioned satellites and propel them into new orbits, give them course corrections, or steer them towards a “graveyard orbit”
- This orbit would be some 300km above their usual height of 36,000 kilometers over the equator.
- At 250 kg, 5–10% the weight of an average communications satellite, the “DeOrbiter” will be outfitted with an ion thruster, a newer, longer-lasting power system easier to control than chemical thrusters.
- All of the micro-satellite’s in-orbit services require tricky rendezvous and docking capabilities at high speeds and sometimes with rapidly rotating objects of various non-uniform shapes.
- Docking the “DeOrbiter” to its target will be handled by a patent-pending grappling system.
- The DeOrbiter could recover two stranded Galileo Project satellites put in useless orbits
<http://online.wsj.com/articles/galileo-satellites-launched-into-wrong-orbits-1408827462?KEYWORDS=galileo>

The Company

- Founded in 2012 by veterans of the Israeli space industry, the company is raising money after securing seed funding of \$1 million from Israel-based venture fund Singulariteam Ltd., and 1.5 million shekels (\$420,300) from the Israel Space Agency.
- Actual production of the micro-satellite, plus launch and insurance costs could total \$25 million.
- Customers topay a fixed fee or share of potential revenues from prolonging a satellite’s life span.
- An operations center, location to be determined, will receive data from several ground stations.

There is a growing market for space-based, in-orbit satellite servicing.

- Intelsat S.A., a Luxembourg provider of fixed satellite services, in 2011 chose Canada’s MacDonald, Dettwiler and Associates Ltd. to service its satellites.
- US-based Vivisat LLC plans to offer in-orbit satellite servicing using its planned Mission Extension Vehicle, a small spacecraft expected to weigh around 2 tons.
- Even the US department of defense’s Defense Advanced Research Projects Agency (DARPA), is working on in-orbit satellite maintenance technologies through **The Phoenix program**. ##

MISSION TO PLANET EARTH

African countries advance plans for integrated Regional Space Program

<http://www.southerntimesafrica.com/articles.php?id=9991&title=African-countries-advance-plans-for--an-integrated-regional-space-programme--&type=71#.U7HUWECmU1L>

- **African Regional Space program and African Space Policy**
- **The African Union** is headquartered in **Addis Ababa, Ethiopia**.
- The countries involved met from 29–30 May 2014, in **Harare, Zimbabwe**

More: <http://climate-iiisd.org/news/amcomet-to-link-wmo-african-space-programmes/>

Singapore’s Nanyang Technical University launches Nano & Pico Satellites

July 9, 2014 – www.asianscientist.com/tech-pharma/ntu-launches-nano-pico-satellites-2014/

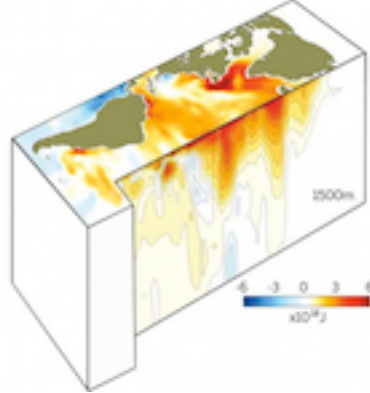


Singapore now has two new satellites orbiting in space, built by Nanyang Technological University (NTU). The nation's latest satellites, **VELOX-I** and **VELOX-PIII**, were launched into space on India's Polar Satellite Launch Vehicle PSLV C-23 June 30, 2014.

NTU has also built a new, state-of-the-art Mission Control Centre that will be the hub of operations for the NTU satellites. Located at NTU's Research Techno Plaza. ##

Earth's missing heat may be hiding in the deep Atlantic

<http://news.sciencemag.org/climate/2014/08/earths-missing-heat-may-be-hiding-deep-atlantic>



Aug 21, 2014 - There's a new lead in the hunt to explain **the global warming hiatus**.

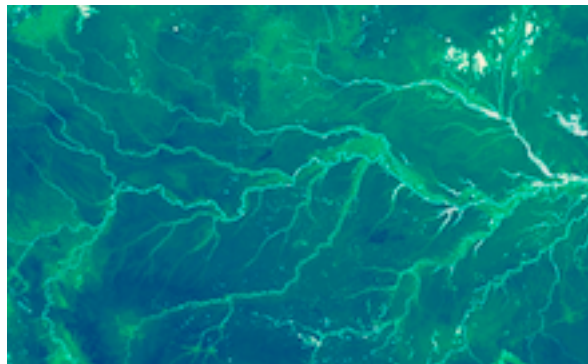
- The mystery is why average global surface air temperatures have remained essentially steady since 2000, even as greenhouse gases have continued to accumulate in the atmosphere.
- Many scientists believe the answer lies in the Pacific, which is sending massive slugs of cold water to the surface, helping cool the planet.
- A new investigation, published online today in Science, presents sea temperature data implying that most of the missing heat has been stored deep in the Atlantic. The work draws on tens of millions of ocean temperature and salinity measurements taken globally by buoys, floats, and ships since 1970.

Covering 24 depths from the sea surface down to 1500 meters, the data suggest that

- Over the last decade or so the Atlantic has been absorbing heat (red in the graphic above) that would have otherwise warmed the surface.
- Over the past 14 years, water below 300 meters in the North and South Atlantic oceans has stored more energy than the rest of the global oceans combined.

NASA Selects Instruments to Track Climate Impact on Vegetation

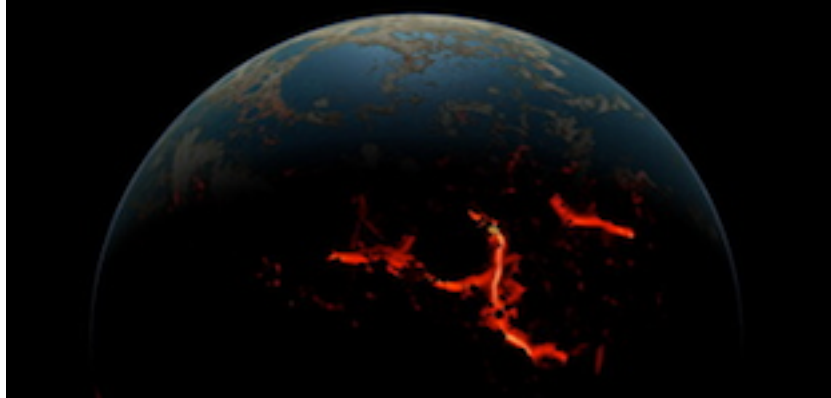
<http://www.nasa.gov/press/2014/july/nasa-selects-instruments-to-track-climate-impact-on-vegetation/> - July 30, 2014



- Two new spaceborne Earth-observing instruments will help scientists better understand how global forests and ecosystems are affected by changes in climate and land use change.
- This image of the Amazon rainforest is from a 2010 global map of the height of the world's forests based on multiple satellite datasets. Image Credit: **NASA Earth Observatory**

Early Earth: A Battered, Hellish World with Water Oases for Life

July 30, 2014 – <http://www.space.com/26685-early-earth-bombardment-water-oasis.html>



An artistic conception of the early Earth-moon system showing the Earth's surface after being bombarded with large impacts, causing magma extrusion on the surface, though some liquid water was retained. Image released on July 30, 2014.

- Earth formed about 4.5 billion years ago. The first 500 million years are known as **the Hadean Eon**. Little is known about it, since few rocks are known that are older than 3.8 billion years old.
- For much of the Hadean, Earth and the other inner solar system planets were pummeled with an extraordinary number of cosmic impacts. The exact timing and magnitude of the impacts that smashed Earth during the Hadean are unknown.
- A new study reveals that during the planet's infancy, Earth's surface was a hellish environment, but perhaps not as hellish as often thought
- In the past dozen years or so, a radically different picture of the Hadean Eon began to emerge. Analysis of minerals trapped within microscopic zircon crystals dating from this eon "suggested there was liquid water on the surface of the Earth back then.
- Scientists also looked at highly siderophile elements (elements that bind tightly to iron), such as gold, delivered to Earth as a result of these early collisions, and the amounts of these elements tells us the total mass accreted by Earth as the result of these collisions. Prior research suggests these impacts probably contributed less than 0.5 percent of the Earth's present-day mass.
- The researchers discovered that "the surface of the Earth during the Hadean was heavily affected by very large collisions, by impactors larger than 100 kilometers (60 miles) or so . Collisiona with objectsthat big melted a large volume of the Earth's crust and mantle, a large fraction of the surface,
- This suggests that Earth's surface was buried over and over again by large volumes of molten rock — enough to cover the surface of the Earth several times. Thus few rocks survive from the Hadean.
- However, researchers found that there were time gaps between these large collisions, There may have been some 20 or 30 impactors larger than 200 km (120 miles) over 500 million years so the time between such impactors was relatively long,
- Any water vaporized near these impacts "would rain down again,
- There may have been quiet tranquil times between collisions — and liquid water on the surface."
- Life emerging during the Hadean was probably resistant to the high temperatures of the time. ##

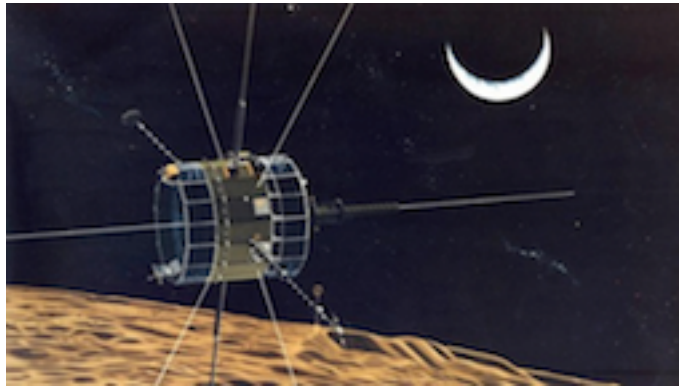
Crowd-funded “Re-assignment Saga” of “dead” ISEE-3 satellite continues:

July 3 – Success! Private Team Fires 36-Year-Old NASA Probe's Engine

[See previous report in TTSIQ #8 pp. 21-22]

<http://www.space.com/26438-isee3-spacecraft-engines-fired.html>

- **Background:** ISEE-3 (International Sun Earth Explorer) was launched in 1978 with intentions to look at how the sun's solar wind interacts with the Earth's magnetic field and chasing comets.
- It ceased operations in 1997.



Artist's impression of ISEE-3 on a lunar flyby (Image: NASA)

- With the help of over \$150,000 raised via crowdfunding, a private team reactivated the hibernating spacecraft and fired its thrusters July 2nd, 2014, for the first time in a generation.
- The recent maneuvers were commanded via the Arecibo Observatory in Puerto Rico, through a command center in California. While the group is made up heavily of former NASA employees, and others.
- ISEE-3 needs to be moved to put it in an advantageous position to communicate with Earth.
- Team to check how well its 13 scientific instruments function

July 18 – **ISEE-3 still has some fuel left**

<http://www.space.com/26570-vintage-nasa-spacecraft-still-has-fuel.html>

July 29 – **ISEE-3 “out of gas”**

<http://www.space.com/26674-vintage-nasa-spacecraft-out-of-gas.html>

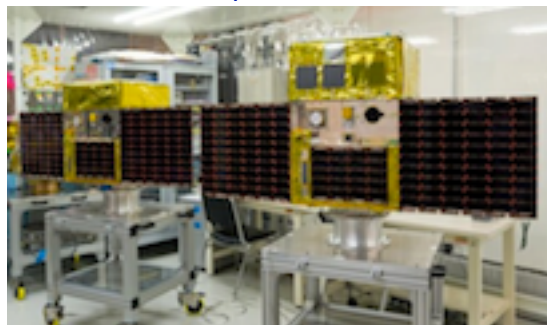
JULY 30 – **Vintage NASA Spacecraft to Tackle Interplanetary Science**

<http://www.space.com/26679-vintage-nasa-spacecraft-interplanetary-science-isee3.html>

- New science mission to start in August 10th
- Team initially hoped to park the vintage spacecraft at the Earth-Sun L-1 point. But controllers discovered there wasn't enough nitrogen pressurant left to help make course corrections.
- ISEE-3 was originally launched in 1978 to study interactions between the Earth's magnetic field and the solar wind, then had its mandate changed to see how the wind influences comet atmospheres. It flew through Comet Giacobini-Zinner in 1985 and also gathered data on Halley's Comet in 1986 before being put into hibernation in 1998. ##

Microsatellites Send Pictures From Space

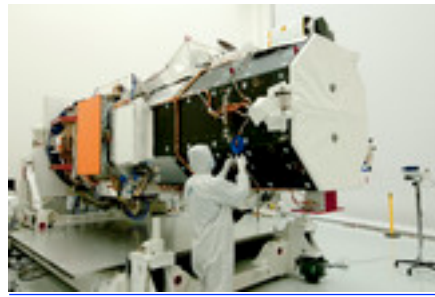
August 6, 2014 – www.asianscientist.com/tech-pharma/microsatellites-send-pictures-space-2014/



- Designed to be quickly developed and cost less than conventional satellites, microsatellites such as Hodoyoshi-3 & 4 could be the future of Earth observation.
- Hodoyoshi-3 and 4 are a proof-of-concept in innovative satellite development. By reducing the cost per satellite to less than three million US dollars and development time below two years,

DigitalGlobe Launches Most Powerful Commercial Earth-Watching Satellite

August 13, 2014 – www.space.com/26822-digitalglobe-launches-worldview3-earth-satellite.html



DigitalGlobe's WorldView-3 spacecraft, designed to peer through fog and smoke to image Earth's surface in detail unprecedented for a nongovernmental spacecraft, resolving features as small as 1 foot (31 centimeters) across.

The sharpest-eyed commercial Earth-watching satellite ever built soared into space on a mission to observe our home planet in spectacular detail. ##

NASA to Investigate Climate Impacts of Arctic Sea Ice Loss

www.nasa.gov/press/2014/august/nasa-to-investigate-climate-impacts-of-arctic-sea-ice-loss
www.space.com/26961-two-thirds-of-arctic-sea-ice-lost-since-1980-s-nasa-explains-video.html
<http://www.space.com/26983-nasa-arise-mission-arctic-ice-video.html>

August 14, 2014 ARISE (Arctic Radiation IceBridge Sea and Ice Experiment) is NASA's first Arctic airborne campaign designed to take simultaneous measurements of ice, clouds and the levels of incoming and outgoing radiation, the balance of which determines the degree of climate warming.



Microbes Beneath Antarctic Ice: What It Means for Alien Life Hunt

August 20, 2014 - <http://www.space.com/26884-microbes-antarctica-lake-alien-life.html>
www.space.com/26885-mineral-munching-microbes-found-deep-beneath-antarctic-ice-video.html



- Boring through ½ mile rock-hard Antarctic ice, researchers discover a completely isolated community of microorganisms living in Subglacial Lake Whillans.
- The finding could be an analog for subsurface life on Mars, Europa, Enceladus and other worlds.

From Space, at Night, North Korea is “missing” – while Seoul is ablaze

<http://eol.jsc.nasa.gov/sseop/images/EFS/lowres/ISS038/ISS038-E-38300.JPG>



North Korea is “**blacked out**” at night, in paranoid fear of “enemy bombers” while Seoul, in South Korea, now the world’s most populous metropolitan area shines bright! But North Koreans get to enjoy star-studded skies

NASA Selects Proposals for Advanced Energy Storage Systems

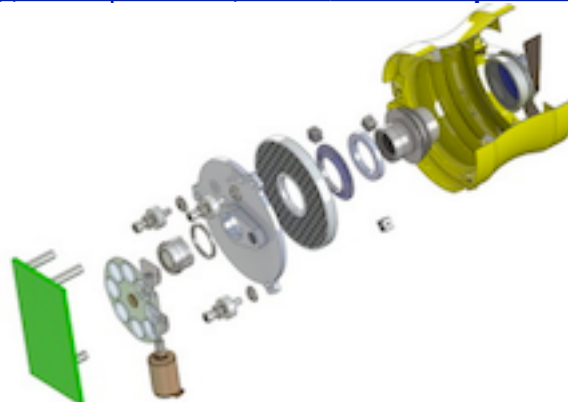
<http://www.nasa.gov/press/2014/august/nasa-selects-proposals-for-advanced-energy-storage-systems/> - August 7, 2014



- The **Scarab lunar rover**, above, is one of the next generation of autonomous robotic rovers that will be **used to explore dark polar craters at the lunar south pole**.
- The rover is **powered by a 100-watt fuel cell** developed under the Space Power Systems Project under Game Changing Development program.

NASA Is Building the World's First 3D-Printed Space Cameras

August 8, 2014 – <http://www.space.com/26769-first-3d-printed-space-cameras.html>



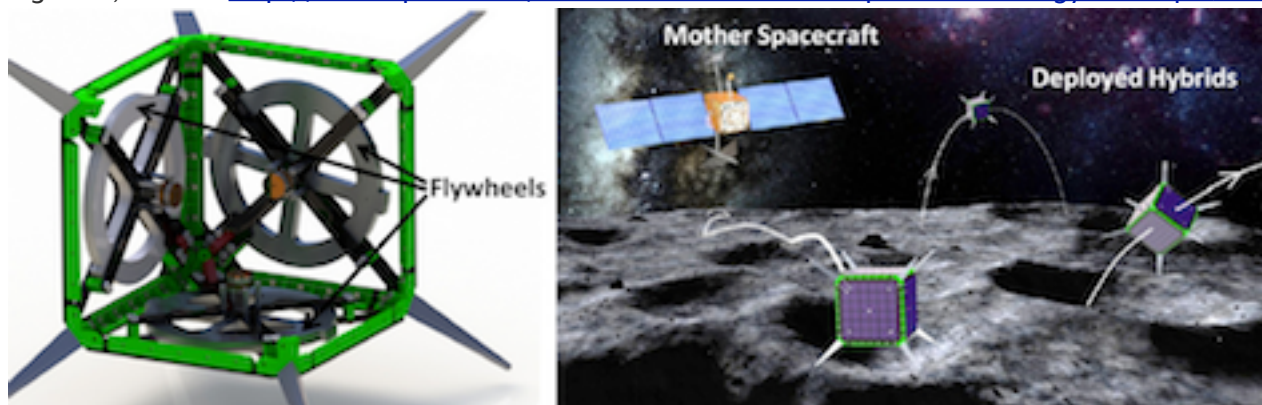
View of the cubesat with 3D printed parts.

- NASA is already using 3d printing to make rocket engine parts, a space pizza maker and even physical photos from the Hubble Space Telescope. By the end of September, a NASA engineer expects to complete the first space cameras made almost entirely out of 3D-printed stuff.

- He is building a 2-inch (50 mm) camera for a cubesat miniature satellite. It will have to pass vibration and thermal-vacuum tests next year to prove that it's capable of space travel. He is also using 3D printing to build a 14-inch (350 mm) dual-channel telescope.
- Both instruments are being built to demonstrate how 3D printing ("additive manufacturing") can be used as a boon for space exploration, trimming both the time and cost of traditional manufacturing.
- To build 3D-printed instruments, a computer-controlled laser melts down a pile of metal powder. It then fuses the melted metal into a specific configuration determined by a 3D computer design.
- The instruments are assembled layer by layer, an approach that makes it possible to incorporate tiny internal features and grooves impossible to build using traditional manufacturing.
- Not yet deep-space ready, additive-machined instruments can fly, with mitigated risks
- In the future, 3D printers could reduce the overall cost of building space exploring instruments. The 3D printed camera only requires four separate pieces, whereas a conventional camera would require between five and 10 times that number.
- The team is also working on a way to build 3D-printed metal mirrors. Mirrors are crucial parts of telescopes, and it may be possible to create them with powdered aluminum. Aluminum is notoriously porous, which makes it difficult to polish. If theory is correct, then a process called "hot isostatic pressing" could convert the aluminum into a gleaming mirror.
- The pressing technique involves taking a 3D printed aluminum mirror and placing it in a heated chamber under 15,000 pounds per square inch of pressure. The intense heat and pressure would lower the aluminum's surface porosity and create a polished mirror.
- This kind of mirror could be especially useful for infrared instruments that must operate at extremely cold temperatures. Infrared sensors are usually made out of several different materials. But if all the parts were made out of aluminum, it would be easier to control the instrument's temperature.

'Orbiting Rainbows' and 4 Other Wild Space Tech Ideas Win NASA Funding

August 6, 2014 - <http://www.space.com/26773-nasa-advanced-space-technology-concepts.html>



Proposed hybrid spacecraft/rover system designed to help explore small bodies such as asteroids was chosen to receive a Phase 2 grant from the NASA Innovative Advanced Concepts program in 2014.

- NASA has selected its latest batch of high-tech ideas for future space exploration.
 - All five concepts had previously received funding through the NASA Innovative Advanced Concepts program, or NIAC, roughly \$100,000 for up to a year to allow an initial analysis.
 - Now, the five space tech concepts have made it to Phase 2, with funding of up to \$500,000 eACH for additional development work over the next two years.
1. **Deep Mapping of Small Solar System Bodies with Galactic Cosmic Ray Secondary Particle Showers:** use subatomic particles to map asteroids and other small objects inside and out, FOR information useful for exploration and exploitation.
 2. **Orbiting Rainbows Phase II:** image faraway objects with high resolution by using orbiting clouds of dust as an enormous photographic aperture.

3. **Spacecraft/Rover Hybrids for the Exploration of Small Solar System Bodies:** tiny spacecraft from a mothership onto the surface of a low-gravity small moon or asteroid. The probes would be between 1 cm to 1 m (0.4 in to 3 ft) in size and use flywheels to hop or tumble across the surface.
4. **10-meter Suborbital Large Balloon Reflector:** Turn a big, inflatable reflector into a balloon-borne telescope capable of making observations from the stratosphere.
5. **Low-Mass Planar Photonic Imaging Sensor:** develop innovative new sensor technology that could make the telescopes on interplanetary spacecraft lighter and cheaper. ##

ASTRONAUTS

Astronauts Are Sleep-Deprived in Space

<http://www.space.com/26829-astronauts-space-station-sleep-deprivation.html>

Astronauts don't get enough sleep on orbit, a new study reveals – August 14, 2014

- 64 astronauts on 80 space shuttle missions, and 21 Space Station astronauts slept for just six hours per night on average, even though their schedules called for 8.5 hours of slumber.
- A study provided valuable data and insights into incidence and severity of sleep deficiencies in space, and has driven development of countermeasure approaches already being tested aboard the station,
- NASA is already attempting to fix the problem and continues to monitor for any ill effects
- Efforts are planned to understand more fully the spaceflight environment and the role that other factors play in reducing or promoting sleep such as workloads, sensory stimulation and stress
- We have long known that astronauts suffer from sleep deprivation on long missions but the new study provides more specifics than before.
- The results should also help combat fatigue here on Earth. For example, the lessons learned could help long-haul truck drivers, airline pilots and surgeons stay sharp for extended stretches on the job.
- NASA is also looking at making physical changes to the space station, such as installing new light bulbs that would be easier on the astronauts' circadian rhythms — the 24-hour cycle that regulates many body processes, including sleep patterns.
- These bulbs would shine different wavelengths later in the day, approximating what happens as dusk approaches on Earth. ##

ASTRONAUT CARRYING VEHICLES

NASA Picks SpaceX, Boeing to Fly US Astronauts on Private Spaceships

Sept. 14, 2014 <http://www.space.com/27169-nasa-picks-spacex-boeing-spaceships.html>

<http://www.space.com/27170-spacex-crew-transport-vehicle-progresses-to-manufacturing-phase-video.html>

<http://www.space.com/26060-spacex-dragon-v2-manned-spaceship-photos.html>

<http://www.space.com/13309-cst-100-photos-boeing-private-space-capsule.html>



SpaceX's Dragon Version 2 (left) and Boeing's CST-100 space capsule (right)

After a four-year competition, NASA has tapped the commercial spaceflight companies SpaceX and Boeing to ferry astronauts to the International Space Station from the United States, ending reliance on Russian Soyuz craft since 2011 when the last Space Shuttle was retired.

- The choice reflects a melding of old and new; Boeing has been an aerospace mainstay for decades, while billionaire entrepreneur Elon Musk founded SpaceX just a dozen years ago, in 2002.
- SpaceX and Boeing will split NASA's \$6.8 billion Commercial Crew Transportation Capability award, or CCtCap, set up in 2010 to encourage the development of private American manned spaceships.
- SpaceX will get \$2.6 billion for the Dragon and Boeing will receive \$4.2 billion for its CST-100
- NASA wants at least one American commercial vehicle to be up and running by late 2017.
- A domestic capability to and from low-Earth orbit could not only cut costs but also free the agency to work on getting people to more distant and difficult destinations such as Mars, Bolden said.
- Two other companies have been in the commercial crew competition: Blue Origin was developing a conical craft, the Space Vehicle, while Sierra Nevada's entry was the Dream Chaser space plane
- Both Boeing and SpaceX will be required to go through a rigorous certification process, which will include at least one manned demonstration mission to the space station.
- After completing certification, Dragon and the CST-100 will each fly from two to six crewed NASA missions to and from the space station. Each of these crewed flights will carry four astronauts.
- NASA will continue using both capsules as long as they meet the agency's requirements. ##

Blue Origin, Dream Chaser to get Second Chance – for Freight Deliveries

<http://www.nasa.gov/press/2014/september/nasa-expands-commercial-space-program-requests-proposals-for-second-round-of/>

Sept. 26, 2014 – On the heels of awarding groundbreaking contracts to U.S. commercial space companies to ferry American astronauts to the International Space Station, NASA has released a request for proposals (RFP) for the next round of contracts for private-sector companies to deliver experiments and supplies to the orbiting laboratory.

Under the Commercial Resupply Services 2 RFP, NASA intends to award contracts with **one or more companies for six or more flights per contract**.

As with current resupply flights, these missions would launch from U.S. spaceports, and the contracted services would include logistical and research cargo delivery and return to and from the space station through fiscal year 2020, with the option to purchase additional launches through 2024.

Delta 4 Heavy launcher for Orion Crew Capsule, Coming Together

Sept 26, 2014 – <http://www.space.com/27284-nasa-orion-test-flight-rocket.html>

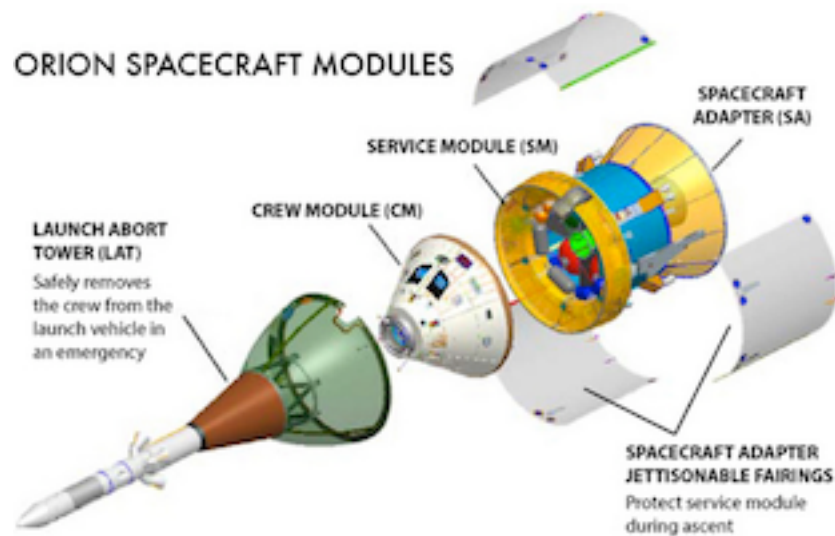


Left: Delta 4 Heavy (2 stages)



Right: Orion Capsule (cutaway)

<http://www.space.com/19292-nasa-orion-space-capsule-explained-infographic.html>



NASA Expands Commercial Space Program, Requests Proposals for Second Round of Cargo Resupply Contracts for International Space Station

<http://www.nasa.gov/press/2014/september/nasa-expands-commercial-space-program-requests-proposals-for-second-round-of/>

Sept 26, 2014 – On the heels of awarding contracts to Space-X and Boeing to ferry American astronauts to the International Space Station, NASA has released a request for proposals (RFP) for **the next round of contracts for private-sector companies to deliver experiments and supplies to the Station, as an alternative to supply by unmanned Russian Progress freighters**

- Contracts may be with **one or more companies for six or more flights per contract**.
- As with current resupply flights, these missions would launch from U.S. spaceports, and the contracted services would include logistical and research cargo delivery and return to and from the space station through fiscal year 2020, with the option to purchase additional launches through 2024.
- Earlier this year, the Obama Administration decided to extend the life of the International Space Station until at least 2024.
- Proposals are due November 14th. The awarded contracts will be firm-fixed price, indefinite-delivery/indefinite quantity.
- The European Space Agency has already flown all 4 of its cargo vessels to the station.
- NASA anticipates making a selection in May 2015.

“To push beyond low-Earth orbit and on to Mars, we rely on American industry to keep the station supplied through cargo deliveries.” – NASA

Among the contenders are those companies producing unmanned, freight only, vehicles:

List of companies that contended in the first round:

- http://en.wikipedia.org/wiki/Commercial_Crew_Development#Proposals_received
- Nb. First Round winners Space-X and Orbital Sciences can apply for second round contracts

List of cargo vessels that have served the Space Station to date:

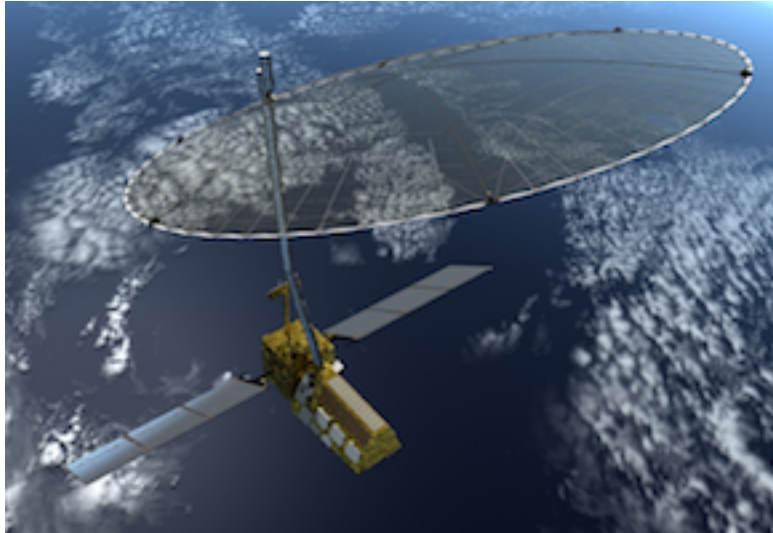
- http://en.wikipedia.org/wiki/List_of_unmanned_spaceflights_to_the_International_Space_Station

U.S., India to Collaborate on Mars Exploration, Earth-Observing Mission

<http://www.nasa.gov/press/2014/september/us-india-to-collaborate-on-mars-exploration-earth-observing-mission/>

[Editor: The part of this article dealing with Mars Exploration issues, will be found at the end of the "Mars" news section below]

- The joint NISAR Earth-observing mission will make global measurements of **the causes and consequences of land surface changes.**



The NASA-ISRO Synthetic Aperture Radar (NISAR) mission

- Potential areas of research include **ecosystem disturbances, ice sheet collapse, natural hazards.**
- The NISAR mission is optimized to measure subtle changes of the Earth's surface associated with motions of the crust and ice surfaces.
- NISAR will improve our understanding of key impacts of climate change and advance our knowledge of natural hazards.
- NISAR will be the first satellite mission to use two different radar frequencies (L-band and S-band) to measure changes in our planet's surface less than a centimeter across.
- This allows the mission to observe a wide range of changes, from the flow rates of glaciers and ice sheets to the dynamics of earthquakes and volcanoes.
- **NASA will provide the mission's L-band synthetic aperture radar (SAR),** a high-rate communication subsystem for science data, GPS receivers, a solid state recorder, and a payload data subsystem.
- **ISRO will provide the spacecraft bus, an S-band SAR, and the launch vehicle and associated launch services.**
- NASA had been studying concepts for a SAR mission in response to the National Academy of Science's decadal survey of the agency's Earth science program in 2007.
- The partnership with India has been key to enabling many of the mission's science objectives.
- NASA's contribution to NISAR is being managed and implemented by the agency's Jet Propulsion Laboratory (JPL) in Pasadena, California.
- **NASA and ISRO have been cooperating under the terms of a framework agreement signed in 2008.** This cooperation includes a variety of activities in space sciences such as two NASA payloads -- the Mini-Synthetic Aperture Radar (Mini-SAR) and the Moon Mineralogy Mapper -- on ISRO's Chandrayaan-1 mission to the moon in 2008.
- During the operational phase of this mission, the Mini-SAR instrument detected ice deposits near the Moon's northern pole.
- For more information on the NISAR mission, visit: <http://nisar.jpl.nasa.gov> ##



NEAR SPACE & SPACE TOURISM

Revolution in Spaceflight Requires New Spacesuits (Op-Ed)

<http://www.space.com/26978-commercial-spaceflight-requires-safety-of-new-space-suits.html>

<http://www.space.com/26981-how-to-try-on-a-real-spacesuit-in-brooklyn-video.html>

<http://www.space.com/26982-final-frontier-design-spacesuit-experience-photos.html>

Aug. 28, 2014 By Ted Southern, pres., co-founder of Final Frontier Design, a space suit design company
Both machine and garment, a spacesuit shields from the inhospitable conditions of space.

- They must withstand large pressure differentials while remaining flexible
- They must tolerate vast thermal variations inside and out, without being too heavy or stiff
- They must be ultra-reliable and easy to put on



New designs are necessary now more than ever as Commercial Space Tourism begins

- Dozens of private companies want to open this new frontier to anyone
- with drastically lower prices to reach orbit
- fast turnaround and reusable vehicles
- multiple choices for altitude, trajectory and purpose.

This entirely new, virtually unlimited market will depend on the creation of advanced spacesuits.

Boeing, Sierra Nevada, SpaceX, ULA, Orbital Sciences, Blue Origin are ready to serve this market

- Golden Spike, Bigelow Aerospace and Mars 1 are tackling interplanetary exploration.
- Virgin Galactic, XCOR and Starfighters Aerospace have set their sights on suborbital ballistic flight.
- Zero2Infinity and WorldView are creating high-altitude balloons that can rise more than 100,000 feet (30,000 meters).
- Zero G Corp has already flown hundreds of zero-G parabolic flights, and Project Perlan is planning on gliding to altitudes above 90,000 feet (27,000 m) within the next year.

A revolution in spaceflight: Several developments set the stage

- As personal computers have become more powerful, the complicated mathematics and science computations required for the incredible speeds, loads, temperatures and pressures of space travel have become accessible.
- Exotic materials and processes are now vastly more available within, thanks largely to the Internet
- The general policies of NASA and the outlook of the public are increasingly supportive of private space ventures.

Most people understand the great dangers inherent in human spaceflight.

- Many have lost their lives in what is just the first 53 years of human spaceflight.
- One tragic incident may ruin public perception of commercial space entirely.
- Loss of human life should be considered a regrettable, but necessary cost of pushing the boundaries
- NASA and the U.S. [Federal](#) Aviation Industry (FAA) should not interfere

NASA has a history of participating in the commercial space industry

- Fostering the sector's development with satellite deployments in the 1980s
- Encouraging competition among garage inventors with the Centennial Challenges program,
- Dedicating a significant portion of the agency's budget today to the Commercial Crew and Cargo Program Office (C3PO).
- Without NASA and FAA standards, recommendations and lessons learned, space entrepreneurs would make the same mistakes over and over again.

The suits that make space travel possible

Spacesuits are a key component of the new space industry, and they come with a proud and worthy legacy: No human has ever been killed in service while wearing such a suit in space. The spacesuit has become the icon for human flight, despite the enormous complexity of the rockets and vehicles that deliver spacesuits to relevant environments.

- Most people do not understand the differences between the Intra-Vehicular Activity (IVA) suit — worn for launch, re-entry and docking — versus the Extra-Vehicular Activity (EVA) suit — worn for space-walking or planetary walking.
- IVA suits, worn pressurized only during emergencies, must provide a stable air-pressure environment and does not need to withstand the thermal variations or long durations that EVA suits must endure, or need to be as mobile as EVA suits
- IVA suits should contain interfaces with parachutes, Earth survival equipment and water flotation devices, depending on the mission's flight path.
- EVA suits have remained an essential part of human spaceflight since the first spacewalks, emergencies outside the vehicle, and for scientific observation; lunar and planetary human missions would be futile if humans could not walk around outside the vehicle.
- The United States, Russia and China use IVA space suits for their flights.
- NASA originally flew the space shuttle with custom flight suits. After the Challenger tragedy, NASA reconsidered the risks to astronauts and integrated the ACES IVA suit into the space shuttle, giving astronauts an emergency pressure system in case of vehicle depress. Even the U.S. military requires pressure suits for high-altitude flights. \
- The revolution in commercial spaceflight rocketry and vehicle design, is also happening in life-support systems, training and operations — and in spacesuits.
- Regulatory standards like space suits for human spaceflight would increase knowledgeable consumer confidence, drive innovation and reduce costs, and only add to the experience of the consumer.
- What space tourist wouldn't want to wear a spacesuit? What commercial company wouldn't want to include these safety measures for its crew, let alone its high-net-worth customers?
- Current commercial IVA space suit designs market for less than half the cost of NASA's ACES suit, while putting a premium on safety, aesthetic, user comfort and reliability.
- Beyond IVA suits for the current commercial market, there is a clear need for less expensive, less complex and more functional EVA suits for both NASA and the commercial space industry.
- Companies like Golden Spike and Mars One should be eager to explore inexpensive EVA suit options that do not eat up significant portions of their budgets
- Even NASA is now considering new space suit providers for the EVA suits of the future.
- Competition in this long closed industry is sure to further reduce costs and improve functionality. ##

MORE ON SPACESUITS

<http://www.space.com/26977-final-frontier-design-spacesuit-experience.html>

<http://www.space.com/26947-final-frontier-design-spacesuit-interview.html> (with video)

<http://www.space.com/26981-how-to-try-on-a-real-spacesuit-in-brooklyn-video.html>

Virgin Galactic, Land Rover Launch Contest to Send People into Space

Sept. 12, 2014 – <http://www.space.com/27127-land-rover-virgin-galactic-space-competition.html>
"Off-Earth roading"

- The car company Land Rover is partnering with the private spaceflight company Virgin Galactic to send the most adventurous people it can find into space.
- In concert with the launch of its 2015 Discovery Sport SUV, Land Rover representatives will look in 29 countries for "the world's most adventurous spirits." They will then select a winner (along with his or her three friends) by the end of this year.
- Aspiring astronauts are invited to produce a 30-second video, or to send a still image, showing their "spirit of adventure" — as well as to select three friends to go with them to space.
- All entries should be submitted to Land Rover's Website: <https://gotospace.landrover.com/us>
- The so-called "Galactic Discovery" competition was also highlighted in a film with "a group of the world's greatest-living adventurers."
- The companies are planning future "development of immersive experiences" for its customers, as well as science, technology, engineering and mathematics education programs to encourage students to pursue careers in those fields. ##

Waypoint 2 Space Crowdfunding Project to Bring Spacewalks Down to Earth

<http://www.space.com/27269-spacewalk-simulator-crowdfunding-project-mets.html>

www.space.com/22714-train-like-an-astronaut-nasa-s-physical-fitness-program-video.html

<https://www.kickstarter.com/projects/waypoint2space/spacewalking-on-earth>

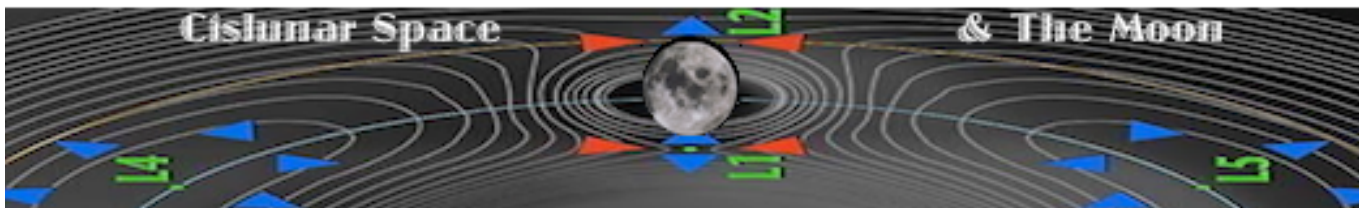


Sept. 25, 2014 – Most of us will never get the chance to go on a spacewalk, but a simulated version of the out-of-this-world experience may soon be available to the general public.

A Spacewalk Simulator

Waypoint 2 Space, a Houston-based company that trains people for commercial spaceflight, has launched a Kickstarter campaign to build a spacewalk simulator. Kickstarter will run through Nov. 8.

- The Modular EVA Training System (METS) will be open to amateur spacewalkers in March 2015.
- METS will hold a spacecraft training module 3.7 m (12 ft) long and 3 m (10 ft) wide.
- You can pretend to be on an EVA maintenance job outside the Space Station
- Trainees enter the model spacecraft and experience the illusion of weightlessness.
- The mock spacecraft will be enclosed in dark room, with only trainees' spacesuit lights providing any illumination.
- METS will rotate horizontally and vertically, and star fields projected on the walls will move, to give trainees the sensation they are actually moving through space
- Final Frontier Design has also developed a spacesuit experience that allows anyone to try on a pressurized spacesuit and bounce around. ##



CISLUNAR SPACE & Earth–Moon Lagrange Points

THE MOON

We insist on capitalizing “Moon” when it refers to Earth’s satellite. Read why:

<http://www.moonsociety.org/info/capital-M-for-Moon.html>

Destination Moon: The 350–Year History of Lunar Exploration (Infographic)

<http://www.space.com/26541-moon-exploration-350-year-history-infographic.html>

July 16, 2014 – In pictures and diagrams, this infographic traces the revolution in human perception of the Moon, from the “queen of night” to a solid world

- In 1609, Galileo looked through his crude telescope and saw a world of mountains, valleys, and craters – a world solid like Earth, and thus a destination
- In 1697 Isaac Newton realized that space travel was theoretically possible
- In 1867 Jules Verne wrote about a possible trip “From Earth to the Moon”
- In 1903 Russian physicist Konstantin Tsiolkovsky worked out the equations of Rocket Propulsion
- In 1929 German physicist Herman Oberth sketched out a vehicle that could carry humans to the Moon
- In the 1940s rockets were developed for wartime use sparking Wernher von Braun’s visions of trips to the Moon and Mars, circulated in Colliers and other illustrated magazines
- in the 1960s the Apollo program which led to the first men on the Moon July 20, 1969

Lunar Pits and Lava Tubes Could House Astronauts | Video

Lunar Reconnaissance Orbiter has found some 200 lava tub pit openings

<http://www.space.com/26575-lunar-pits-and-lava-tubes-could-house-astronauts-video.html>

Naturally occurring pits and tubes, caused by ancient movement of molten rock, could provide safe harbor against meteorites, thermal shock, radiation and dust. Now LRO has found some 200 pits. Some “pits” may not be openings to lengthy lavatubes, but still provide shelter.

Electric Sparks May Alter Evolution of Lunar Soil

http://www.space-travel.com/reports/Electric_Sparks_May_Alter_Evolution_of_Lunar_Soil_999.html

August 25, 2014 – The Moon appears to be a tranquil place, but modeling done by University of New Hampshire (UNH) and NASA scientists suggests that, over the eons,

Periodic storms of solar energetic particles may have significantly altered the properties of the soil in the Moon’s coldest craters through the process of sparking

- This finding could change our understanding of the evolution of planetary surfaces.
- The charging may create sparking, or electrostatic breakdown, and this “breakdown weathering” process has possibly changed the very nature of the Moon’s polar soil
- This suggest thsat permanently shadowed regions, which hold clues to our solar system’s past, may be more active than previously thought.
- Decoding the history recorded within these cold, dark craters requires understanding what processes affect their soil.

- The investigators built “a computer model to estimate how high–energy particles detected by the Cosmic Ray Telescope for the Effects of Radiation (CRaTER) instrument on board NASA’s Lunar Reconnaissance Orbiter (LRO) can create significant electric fields in the top layer of lunar soil.”
- The scientists also used data from the Electron, Proton, and Alpha Monitor (EPAM) on the Advanced Composition Explorer.
- CRaTER and EPAM both detect high–energy particles, including solar energetic particles (SEPs).
- SEPs, after being created by solar storms, stream through space and bombard the Moon. These particles can buildup electric charges faster than the soil can dissipate them and may cause sparking, particularly in the polar cold of permanently shadowed regions–unique lunar sites as cold as minus 240 degrees Celsius (minus 400 degrees Fahrenheit) that may contain water ice.
- Electrons, released from the soil grains by strong electric fields, race through the material so quickly that they vaporize little channels
- Repeated sparking with each large solar storm could gradually grow these channels large enough to fragment the grains, disintegrating the soil into smaller particles of distinct minerals.
- The next phase of this research will involve investigating whether other instruments aboard LRO could detect evidence for sparking in lunar soil, as well as improving the model to better understand the process and its consequences.
- If breakdown weathering occurs on the Moon, then it has important implications for our understanding of the evolution of planetary surfaces in the solar system, especially in extremely cold regions that are exposed to harsh radiation from space. ##

Chinese scientists prepare for Lunar Base Life Support System

www.spacedaily.com/reports/Chinese_scientists_prepare_for_lunar_base_life_support_system_999.html

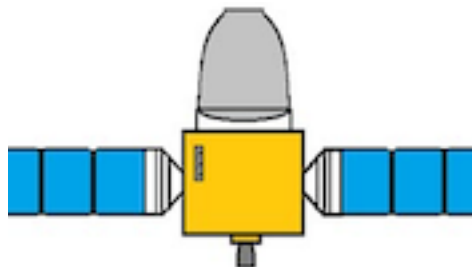
July 1, 2014 – In a 105–day manned airtight test, in which the bio–regenerative life support systems of Lunar Palace 1 sustained the lives of three trial volunteers who drank recycled purified water, ate worms and food they grew themselves, conducted experiments in the enclosed capsule from Feb. 3 to May 20.

- Lunar Palace 1 comprised a 58–sq–m (625 sq. ft) vegetation cabin and a 42–sq–m (452 sq. ft.) living cabin with three bedrooms, a dining room, a bathroom, and a waste disposal room.
- 55% of the food for three volunteers was generated inside the bio–system
- Lunar Palace 1 differs from Biosphere 2. The Chinese system is directed towards the needs of humans, carefully choosing what plants, animals, and micro–organisms to be included.
- Lunar Palace 1 does not attempt to perfectly mirror the environment on the Moon, whose low gravity and high radiation are not factored into the capsule
- The plan is to build two mini Lunar Palace 1 systems – a monitoring station on the Moon and one on Earth – so the two sets of data can be compared. They hope to continually improve and perfect the system over the time before it will be needed. ##

More Tasks for China's Moon Mission – Speculation

Aug. 11, 2014 – www.spacedaily.com/reports/More_Tasks_for_Chinas_Moon_Mission_999.html

- Later this year – no announced target date – China will launch a robotic spacecraft to the Moon and back. A bell–shaped re–entry capsule will be carried by a boxy spacecraft out to the Moon, without landing, and then return for a soft landing on Earth.
- Little information and no diagrams or photos of the entire spacecraft have been released other than photographs of the re–entry module in photographs, but little else. The design below is speculative



- China's official explanation is that this will be a test of technology needed on a future Chinese mission to return rock samples from the Moon.
- China could also be testing technology for a future manned mission to the Moon as the re-entry capsule is a scale replica of the capsule used on China's Shenzhou astronaut spacecraft.
- China could fly this mission in a free-return trajectory to the Moon. This means that the spacecraft would fly around the far side of the Moon and use the Moon's gravity to sling it back to Earth.
- A story published by China's state news agency Xinhua claims that the spacecraft will actually enter orbit around the Moon.
- How long will the spacecraft stay in lunar orbit? It could literally be weeks. The spacecraft must simulate the time it would take for another robotic spacecraft to land on the Moon, collect samples, place those samples in a small launch vehicle and fly them to a rendezvous in lunar orbit. ##

China to test Recoverable Moon Orbiter

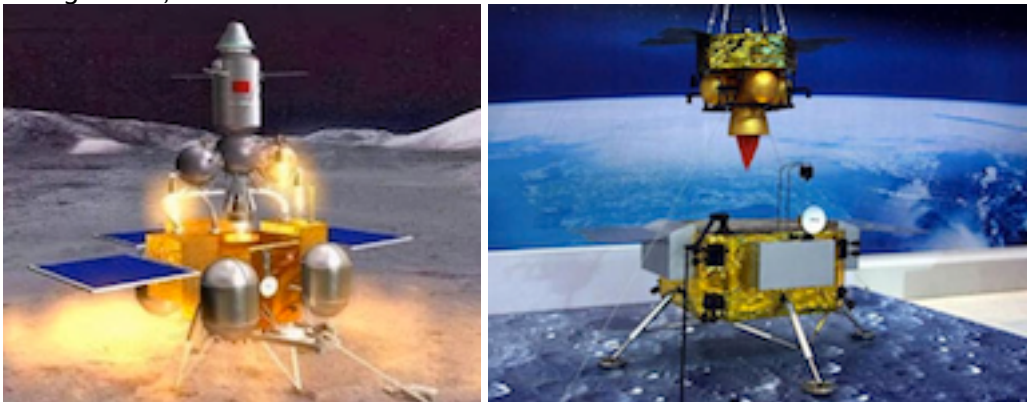
August 12, 2014 www.space-travel.com/reports/China_to_test_recoverable_moon_orbiter_999.html
<http://www.space.com/27011-china-moon-orbiter-recoverable-prototype-launch.html>



- The launch is aimed at testing the technologies that are vital for the success of Chang'e-5.
- An experimental recoverable moon orbiter has arrived the Xichang Satellite Launch Center.
- It will be one of the test models for China's new lunar probe Chang'e-5, which will be tasked with landing on the moon, collecting samples and returning to Earth.
- The orbiter to be launched into lunar orbit and return to Earth at a velocity of 11.2 km per second.
- The more sophisticated Chang'e-5 mission, including unmanned sampling and returning, requires technological breakthroughs in moon surface takeoff, sampling encapsulation, rendezvous and docking in lunar orbit, as well as high-speed Earth reentry ##

China Plans to Bring Back Lunar Soil

http://www.space-travel.com/reports/China_Aims_for_the_Moon_Plans_to_Bring_Back_Lunar_Soil_999.html - August 28, 2014



- Chinese scientists are developing a recoverable lunar robotic spacecraft Chang'e 5 that is to reach the Moon by 2017 with a mission to deliver samples of rock and soil back to Earth

- The creation of Chang'e 5 is part of the Chinese Lunar Exploration Program
Three operational phases

Phase 1 – orbital missions with the first and second lunar orbiters of the series being successful

Phase 2 – soft landers and rovers (still in progress). Chang'e 3, carrying a lunar rover designed to explore and map the Moon's surface in a 3-month mission, successfully landed on the Moon in December, 2013.

- A younger generation test vehicle, Chang'e 4, is set to take off later this year to pave the way for the third phase sample-return mission.
- A lunar test orbiter that served as back-up to Chang'e 3, will have its configuration changed to test new equipment as well as its abilities in flight sequence control
- This will allow scientists to perfect orbit design of lunar vehicles, and practiceg to keep the craft orbitally stable.
- Upon returning to Earth with lunar rock and soil samples, Chang'e 5 will be falling through the planet's atmosphere at 11.2 km/s, a feat China has not yet achieved

Phase 3 – Lunar sample return missions:

- **Chang'e 5** ncludes the 2nd generation orbiter base structure, a lander, an ascender and a returner.
- The lander will carry equipment enabling it to preform soft landings as well as to collect lunar rock and soil samples from as deep as 2 meters below the Moon surface.
- The explorer is set to return to Earth before 2020.
- This third phase will require many breakthroughs in key technologies, such as moon surface takeoff, sampling encapsulation, rendezvous and docking in lunar orbit, and high-speed Earth re-entry. ##

Apollo 11's Vintage Tech: The Most Amazing Moon Landing Innovations

July 24, 2014 – <http://www.space.com/26630-apollo-11-vintage-tech-innovations.html>

- The Apollo 11 landing was on the cutting-edge of technology in 1969. It was a demonstration of how much could be accomplished with so little. For example:
- The computing technology of the average cell phone far exceeds the combined computing power of the two spacecraft that got humans to the Moon and back home safely.
- The hand-stitched, walkable spacesuits that Neil Armstrong and Buzz Aldrin wore on the moon when they stepped onto its face for the first time 45 years ago this month were not used before landing on the lunar surface

How the Moon got its Lemon Shape

July 30, 2014 – <http://www.space.com/26684-moon-lemon-shape-tidal-forces.html>

Earth's powerful gravity tugged the Moon into its oddball shape long ago, shortly after both bodies formed, a new study published online today (July 30) in the journal Nature suggests.

- Tidal forces exerted during the early days of the solar system can explain most of the Moon's large-scale topography, including its slight lemon shape
- The moon's near side is dominated by dark volcanic deposits, while the far side is not,
- The Moon formed from debris blasted into space when a mysterious planet-size body slammed into the young Earth about 4.5 billion years ago. The Moon was born hot, and it came into existence quite close to our home planet. (The moon has been slowly spiraling away ever since.)
- The newborn Moon was thus sculpted by Earth's gravity.
- Scientists have posited for more than a century that tidal forces helped shape the molten moon, causing bulges that froze into place when it cooled down and solidified. The new study provides a much more detailed understanding of how this likely happened.

- Topographic data gathered by NASA's Lunar Reconnaissance Orbiter and information about the moon's gravity field collected by NASA's twin GRAIL (Gravity Recovery and Interior Laboratory) spacecraft gave us a more global view of the Moon, focused on areas outside of its biggest impact craters.
- The data strongly implicate tidal effects as a key shaper of the Moon. For example, tidal forces pulled on the lunar crust, stretching it out and heating it up in places.
- This process thinned out the crust at the lunar poles and thickened it in the regions that lined up with Earth, thus sculpting the moon into a "lemon" with two small bulges: one on the side facing Earth, and one on the side directly opposite.
- Such tidal heating could have occurred only when the Moon's crust was floating on a sea of molten rock, largely decoupled from the rest of the body, when the moon was not completely solid, in the first 100 to 200 million years of lunar thermal evolution.
- Also contributing to the Moon's overall shape were more straightforward tidal deformations, and rotational forces, which cause spinning bodies to flatten at the poles and bulge out near the equator.
- When the Moon cooled, the changes wrought by all of these processes were frozen in place.
- Interestingly, the long axis of the Moon doesn't point directly toward Earth as it likely did long ago; instead, it's offset by about 30 degrees. This probably happened when volcanic activity, impact cratering and other events made the Moon's interior a much less homogeneous place. ##

TECHNOLOGIES USEFUL OR NEEDED ON THE MOON

For Stronger Aluminum, Add Carbon Fibers

July 25, 2014 - www.asianscientist.com/in-the-lab/add-carbon-fibers-stronger-aluminium-2014/

Nanotechnology-enabled **carbon fiber reinforced aluminium (FRA) is stronger than aluminium and yet lighter than steel.** FRA has been jointly developed by the Hong Kong University of Science and Technology (HKUST) and aluminium manufacturer UC RUSCAL. ‘

- FRA could lead to building safer, cheaper, more energy-efficient envelope systems, and easier to mount.
- Carbon fiber and aluminum. If used together with a phase-change material (PCM), creates a smart building envelope system which will effectively reduce indoor temperature fluctuation, and halve the labor costs and construction time compared to conventional systems built of steel and cement.
- Aluminum's use in construction today is confined largely to window frames due to its soft texture. In contrast, steel is strong with high loading but is heavy, expensive and prone to rust.
- The research team changed the composition of carbon fiber by using nanotechnology
- This breakthrough is set to create a whole range of new materials with much wider applications.
- The new carbon-fiber aluminum can be used to produce. **a greener, cheaper and lighter building envelope** that minimizes the escape of air through gaps between the building envelope and the structure, thus saving energy on air conditioning or heating.

[Aluminum is abundant on the Moon. The principal source of carbon on the Moon is the solar wind.

It is possible that if carbon sourcing is sufficient, FRA may become a leading medium for building habitat and other modules on the Moon, including pressurized components of vehicles. PK]

Related 2007 research in the Netherlands:

<http://www.tgdaily.com/trendwatch-features/34052-revolutionary-aluminum-composite-stronger-and-lighter-than-carbon-fiber>

Waterless Concrete for the Moon

<http://thefutureofthings.com/6233-waterless-concrete-for-the-moon/>

Substituting sulfur for water: Dr. Houssam Toutanji, a professor at the University of Alabama in Huntsville, has recently published an article which deals with a concept of creating concrete structures on the lunar surface without the use of water. Since regular concrete requires water, it is currently unlikely that conventional concrete structures will be built on the Moon; – Traditional concrete comprises a mixture of cement, water, and aggregates. Although recent studies have shown evidence for water in

the Moon's interior, such resources [difficult to recover in the near term] may be more valuable for astronauts' consumption than for building structures.

However, Toutanji's new inventive idea might hold the key to future lunar settlements. Refer to "Unconventional Approach" in the October issue of Civil Engineering Magazine shows that lunar soil could be used as the aggregate, and **sulfur as a binding agent** for future lunar concrete. Toutanji has spent years studying the characteristics of cementitious materials and anticipates that concrete will play a major role in constructing facilities on the lunar surface due to the Moon's surface harsh environment. The reason is that survival in such conditions requires solid, durable, materials.

- The high cost of transporting materials from Earth gives a high value for any useable resources found on the Moon. Thus NASA has been searching for resources on the surface of the Moon.
- "Waterless concrete," also known as sulfur concrete is not a true concrete in the traditional sense
- However, this well-established, albeit expensive, building material can resist corrosive environments in highly acidic or salty areas, and apparently the Moon offers several of its basic compounds.
- Creation of the waterless concrete requires the melting of sulfur, to serve as a thermoplastic material
- The compounds are mixed it with an aggregate which is then poured, molded, and allowed to harden.
- **Sulfur concrete usually contains 12% to 22% sulfur by mass and 78% to 88% aggregate by mass**
- The aggregate can include both coarse and fine particles.
- Sulfur melts at about 119 C (246 F) and stiffen above 148 C (298F)
- The sulfur and aggregate must be mixed and heated at a temperature of 130–140 C. (266–284 F)
- In addition, fiberglass can be used as a reinforcement of sulfur concrete, in order to improve its tensile and flexural strength.
- **Fiberglass** could be produced directly from the lunar soil or from the by-products obtained in extracting such metals as aluminum and titanium.

Editor: Using fiberglass may be best in the lunar highlands. In the mare basins, however, basalt fiber should do as well or better. ##

MANNED MOON MISSIONS

Manned Moon Mission to Cost Russia \$2.8 Billion

http://www.space-travel.com/reports/Manned_Moon_Mission_to_Cost_Russia_2_8_Bln_999.html

Aug. 5, 2014 – A manned mission to the Moon will cost Russia **100 billion rubles** (about \$2.8 billion).

A mission to the Moon has become one of Russia's top priorities in space.

- An estimated cost of an automatic lunar station to be completed in five or six years is 10 billion rubles (about \$280 million).
- The manned lunar mission, for which automatic lunar stations are necessary, will cost ten times more

Lunar missions currently under development under the Luna-Resource project

Luna-25 Lander (Luna-Glob project) slated for launch in 2016 and land at the Moon's South Pole

Luna-26 Orbiter which will monitor the Moon for two years by 2018

Luna-27 Lander with a drill to search for water ice in 2019

How much Gravity is enough?

Sep 05, 2014 – http://www.spacedaily.com/reports/How_much_gravity_is_enough_999.html

Keeping upright in a low-gravity environment is not easy, and NASA documents abound with examples of astronauts falling on the lunar surface.

A new study by an international team of researchers led by York University professors Laurence Harris and Michael Jenkin, suggests that the reason for all these Moon mishaps might be because its gravity isn't sufficient to provide astronauts with unambiguous information on which way is "up".

[Editor: The Apollo Moon walkers had to carry a backpack which weighed more than their bodies, by a factor as large as 2 times – rather destabilizing without practice!]



How much can humans adapt to new environments? Human history suggests "one hell of a lot!"

Author's arguments: "The perception of the relative orientation of oneself and the world is important not only to balance, but also for many other aspects of perception including recognizing faces and objects and predicting how objects are going to behave when dropped or thrown," says Harris.

"Misinterpreting which way is up can lead to perceptual errors and threaten balance if a person uses an incorrect reference point to stabilize themselves."

An Experiment

Using a short-arm centrifuge provided by the European Space Agency, the international team simulated gravitational fields of different strengths, and used a York-invented perceptual test to measure the effectiveness of gravity in determining the perception of up. The team found that the threshold level of gravity needed to just influence a person's orientation judgment was about 15 per cent of the level found on Earth – very close to that of the Moon's 16+%.

The team also found that Martian gravity, at 38 per cent of that on Earth, should be sufficient for astronauts to orient themselves and maintain balance on any future manned missions to Mars. ##

Editor: a centrifuge, especially a short-armed one, introduces many confusing factors. This study should be dismissed as absurd. After all, some astronauts and/or cosmonauts have spent as much as a year in ZERO-G, which for the percentophyles, does not even register.

How did the Apollo astronauts who spent several days on the Moon, do? Please do remember that they had to wear those destabilizing heavy backpacks when out on the surface.

The only valid experiment is to see how human pioneers fare after long terms on the Moon, and indeed, how infants born on the Moon, grow up in lunar gravity. The above study, in our opinion, does not quite make "High School" grade, but does do a good bit of "misinterpreting," to use the authors' own word. ##

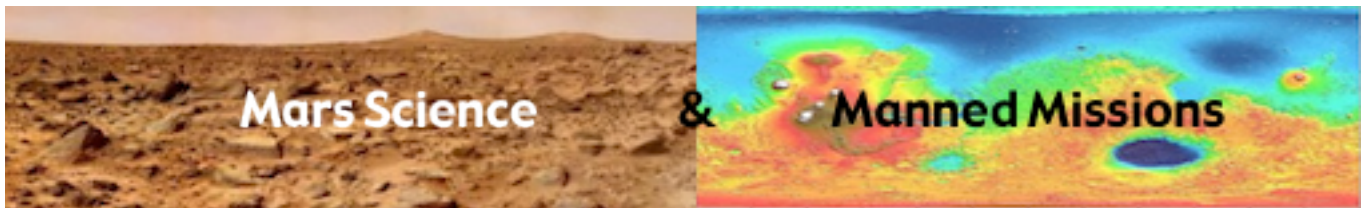
Lunar explorers will walk at higher speeds than thought

www.space-travel.com/reports/Lunar_explorers_will_walk_at_higher_speeds_than_thought_999.html

Sept. 19, 2014 – Anyone who has seen the movies of Neil Armstrong's first bounding steps on the moon couldn't fail to be intrigued by his unusual walking style. But, contrary to popular belief, **the astronaut's peculiar walk was not the result of low gravity.** Wyle Science, Engineering and Technology scientist John De Witt explains that **the early space suits were not designed for walking**, so the astronauts adapted their movements to the restrictions of the suit.

- Michael Gernhardt, the head of NASA's Extravehicular Activity Physiology, Systems and Performance Project, wants to learn more about how humans move in low gravity, including the speed at which we break from a walk into a run, to design a modern space suit that permits freer movement.
- The only way to test the effects of true lunar gravity on our movements while based on Earth is to hop aboard NASA's adapted DC-9 aircraft – which reduces the gravity on board by performing swooping parabolic flights – and get running. But such flights are very short.

Editor: The reader can decide for him/herself whether these tests are definitive. In our opinion, when it comes to gravity, there isn't anything like the real thing – centrifugal force excluded..



MARS ANALOG EXERCISES

MARS SCIENCE

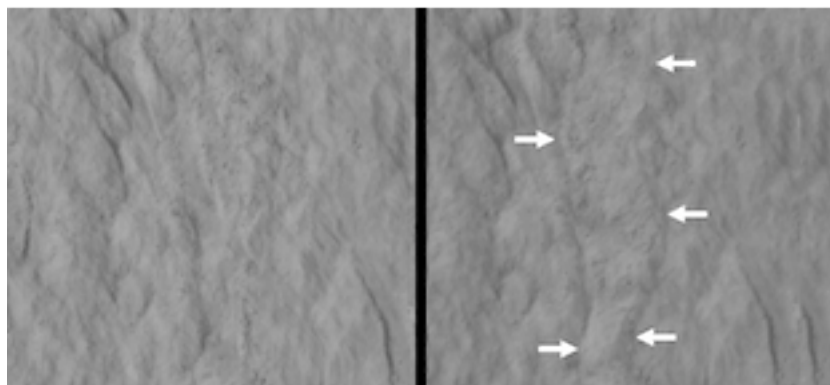
Salt on Mars May Turn Ice into Liquid Water

July 2, 2014 - <http://www.space.com/26424-mars-salt-turns-ice-water-video.html>
<http://www.space.com/26425-how-does-mars-make-liquid-water-video.html>

- A new study in a simulated Mars environment shows that a type of salt there may melt the ice it touches – similar to what takes place on Earth when salt is used to melt the ice on slippery roads
- The new simulated Martian experiment, indicates that a similar process could be in action on Mars.
- Some pictures taken by NASA and ESA orbiters show “gullies” on Mars.
- 2008 pictures from the Phoenix lander seem to show droplets on the surface and on the lander's legs.
- If water does flow on the planet, it improves the chances that we will find life on Mars.
- Phoenix’ polar landing site shows a salt called calcium perchlorate, also found in the Atacama Desert in Chile. It could have been stirred up from subsurface salt by the thrusters that landed the craft on the surface. The Curiosity rover found similar occurrences while roving closer to the Martian equator.
- Researchers created similar conditions inside metal cylinders, chilled to temperatures similar to what is found on Mars: -21 to -120 °C (-5 to -185 °F). Atmospheric pressure set to 1% of Earth's and humidity at 100%. Tests of the perchlorate alone, on top of a Martian-like soil did not show any evidence of water, ruling out the existence of deliquescence, which would see water form after vapor is vacuumed from the surrounding air.
- Placing the perchlorates on water ice, created liquid water even in temperatures of -73 °C (-100 °F)
- The experiment showed that small amounts of liquid water could exist across a large swath of Mars' surface and shallow subsurface, from polar regions to mid-latitudes, for several hours a day during the spring and early summer.
- Microbes have been found in similar conditions in salty waters in Antarctica. ##

NASA Spacecraft Observes Further Evidence of Dry Ice Gullies on Mars

<http://www.nasa.gov/press/2014/july/nasa-spacecraft-observes-further-evidence-of-dry-ice-gullies-on-mars/>



This pair of images covers one of many sites on Mars where researchers use the HiRISE camera on NASA's Mars Reconnaissance Orbiter to study changes in gullies on slopes. Changes such as

the ones visible in deposits near the lower end of this gully occur during winter and early spring on Mars. Full image and caption: <http://www.nasa.gov/jpl/mro/pia18400/>

July 10, 2014 – Repeated high-resolution observations by Mars Reconnaissance Orbiter indicate gullies on Mars' surface are formed by the seasonal freezing of carbon dioxide, not by liquid water.

- As recently as 2009, gullies on Mars seemed to indicate activity of liquid water;
- As we were able to get many more observations, we started to see more activity and pin down the timing of gully formation and change, and determined that **this activity occurs in winter**.
- Thirty-eight of 356 gully sites showed active gully formation: new channel segments and increased deposits at the downhill end of some gullies.
- Dry Ice, not water as the agent, and now, not long ago
- The timing of this activity coincided with seasonal carbon dioxide frost and temperatures that would not have allowed for liquid water.
- Frozen carbon dioxide, “dry ice”, does not exist naturally on Earth, but is plentiful on Mars. It has been linked to active processes on Mars such as carbon dioxide gas geysers and lines on sand dunes plowed by blocks of dry ice.
- One mechanism by which carbon dioxide frost might drive gully flows is by gas that is sublimating from the frost providing lubrication for dry material to flow.
- Another may be slides due to the accumulating weight of seasonal frost buildup on steep slopes.
- Although the findings about gullies point to processes that do not involve liquid water, possible action by liquid water on Mars has been reported in the past year in other findings from the HiRISE team. Those observations were of a smaller type of surface flow feature. ##

Water Shaped Mars' Highlands, New Red Planet Map Shows

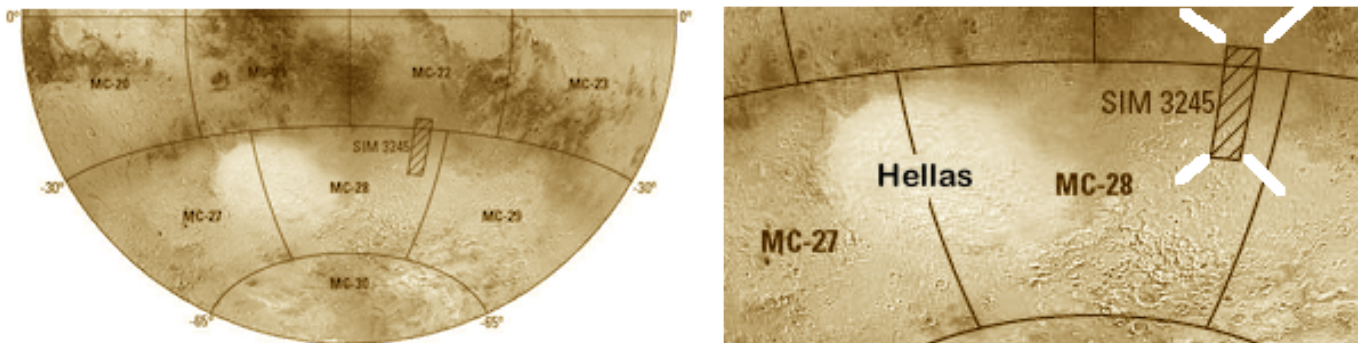
July 07, 2014 – <http://www.space.com/26454-mars-map-highlands-liquid-water.html>

<http://i.space.com/images/i/000/040/429/original/mars-map-southern-highlands-water.jpg?1404759033>

An incredibly detailed new map of Mars' southern highlands shows how profoundly liquid water sculpted the region long ago.

- A complicated sequence of geologic processes that have served to modify ancient, **rugged highland terrains surrounding the Hellas impact basin** and shows evidence for the persistent effects of water and ice in degrading the Martian surface.

The new map covers the area on Mars from 27.5–42.5 °S and 110–115 °E. The map sheds light on the evolution of two canyon systems in the southern highlands, Waikato Vallis and Reull Vallis. Both may have formed when underground water came to the surface, collapsing the ground.



Most highland peaks and the walls of many impact craters show evidence that ice-rich sediments flowed downhill, forming features that resemble rock glaciers on Earth

- Water-related activity in the area may be active today.
- Free [copy of](http://pubs.usgs.gov/sim/3245/) the 118-megabyte Mars map from USGS website: <http://pubs.usgs.gov/sim/3245/> ##

Huge Meteorite on Mars Discovered by NASA's Curiosity Rover

July 15, 2014 – <http://www.space.com/26533-curiosity-mars-rover-meteorite-photos.html>
<http://i.space.com/images/i/000/040/650/i02/mars-rover-curiosity-meteorites.JPG?1405462043>



Above: the huge iron meteorite "Lebanon" (2.1 meters ~7 ft wide) and its smaller companion "Lebanon B." The two meteorites were found by Curiosity May 25, 2014.

- Mars' surface may be a better parking lot for incoming meteorites than Antarctica's glacial deserts
- Very sluggish erosion processes due to weather than the driest deserts on Earth
- With no vegetation, meteorites remain on the surface intact indefinitely.
- Foraging for meteorites will be a popular hobby among Martian pioneers.

How Wheel Damage Affects Mars Rover Curiosity's Mission Rough Road Ahead: Rocky Mars Terrain Challenges Curiosity Rover

July 09, 2014 – <http://www.space.com/26472-mars-rover-curiosity-wheel-damage.html>
<http://www.space.com/26643-mars-rover-curiosity-wheel-damage.html>



- Without mechanics on Mars, NASA cannot take the Curiosity rover into the shop for repairs. The rover has accumulated some wheel damage since touching down in August 2012.
- Controllers had expected some holes in the wheels with time, but the magnitude is surprising.
- The damage does not imperil the rover's mission
- Handlers are employing a number of troubleshooting measures to keep the robot rolling
- Curiosity can still reach and explore its ultimate science destination: the foothills of Mount Sharp.
- Each of Curiosity's six aluminum wheels is independently actuated and geared
- The wheels were built for climbing in soft sand and rolling over rocks.
- However, the amount of wear and tear on the wheels is surprising.
- Damage comes in several forms: punctures in the wheel skin between the "grousers" traction bars in a zigzag pattern on the wheels that help improve wheel performance and provide a better traction.

- The entire skin between two grousers could get punched if there are enough cracks on both sides.
- The two front wheels have worn differently than the two middle wheels.
- "Caprock," is quite resistant to weathering and erosion, so controllers try to avoid that kind of rock
- We had not previously encountered this kind of hard, embedded rock on Mars before
- The mission team is carefully picking Curiosity's path forward, aided by images Mars Reconnaissance Orbiter, looking for places that have a thin covering of sand.
- The wheel damage is not related to driving distance, but to terrain type,
- Avoid the patches of broken-up fragments of hard sandstone, and to drive in the valleys made of softer rock and sometimes partially filled with sand.
- Tests in JPL's "Mars Yard" show that driving Curiosity backward produces dynamic forces lower in magnitude, "sort of like pulling your roll-aboard baggage over a curb rather than pushing it,"

The team is confident that it can avoid the most damaging terrain, taking a somewhat longer route to Mount Sharp that has us driving in more sand, There will still be rough spots that we must drive across because there is no way around them.

As the rover chalks up more mileage, another concern is that a wheel could split apart. If that happens, the wheel might flop back and forth. And with every turn, it could hit exposed cables that go from the rover through the axle to the motor – a worst-case scenario that could lead to Curiosity having to drag the damaged wheel. The team does not want to risk getting shorts in those cables. ##

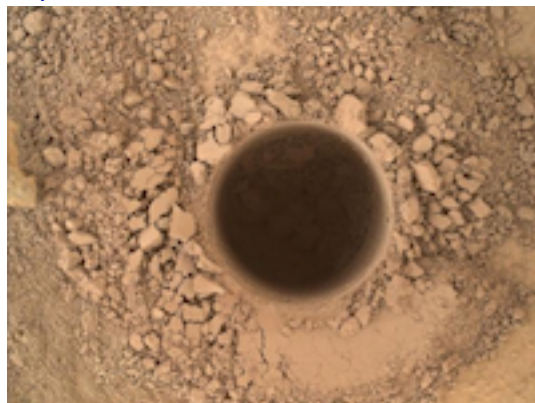
Curiosity Rover Packs Up Drill, Hits the Martian Road Again

August 26, 2014 – <http://www.space.com/26955-mars-rover-curiosity-driving-mount-sharp.html>

- Mars rover Curiosity has passed up a potential drilling target, "Bonanza King," as not stable enough and instead has resumed the long trek towards 5 km high Mount Sharp begun over a year ago.
- As Curiosity climbs up through the mountain's foothills, it will read the history of Mars' changing environmental conditions.
- By the end of the year, after 3.2 km (2 mi) it will reach its targeted entry point near the mountain's base.
- Rough terrain has taken a toll on Curiosity's metal wheels, obligating the robot's handlers to search for a smoother, less punishing route through Gale Crater
- From now on, it will drive backwards to avoid more damage to its wheel treads.
- The route was to be through a sandy swale called Hidden Valley, with fewer sharp, wheel-puncturing rocks. But this Valley proved a bit too sandy for Curiosity, whose wheels couldn't find much purchase there. The rover quickly left the valley and will now find a new route to Mount Sharp.
- Curiosity has drilled into three rocks since August 2012. Analysis of samples collected during the first two drillings showed that a region near Curiosity's landing site called Yellowknife Bay was a lake-and-stream system that could have supported microbial life billions of years ago. ##

Curiosity drills first hole into the base of Mount Sharp

Sept. 26, 2014 – <http://www.space.com/27274-mars-rover-curiosity-drill-mount-sharp.html>



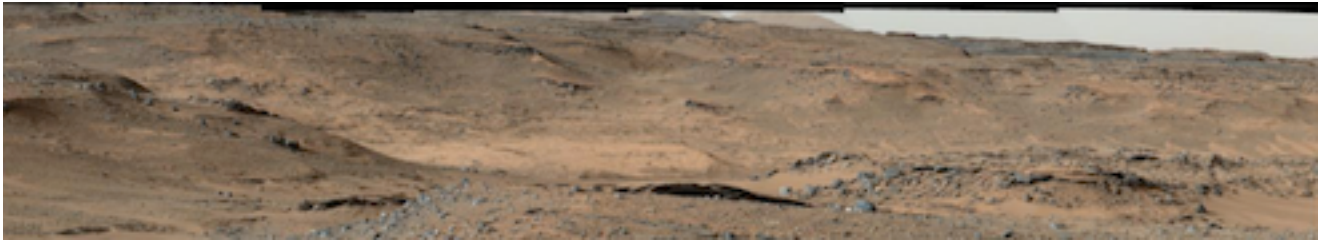
NASA's Mars rover has taken its first bite out of the giant mountain that it came to explore, drilling 6.7 cm (2.6 in) into an outcrop at base of the mountain that rises 5.5 km (3.4 mi). Curiosity collected samples of powdered rock, with the aim of delivering them to the rover's onboard instruments for analysis.

- This drilling target is at the lowest part of the base layer of the mountain,
- From there NASA plans to examine the higher, younger layers exposed in the nearby hills
- This first look at rocks we believe to underlie Mount Sharp will help form a picture of the environment at the time the mountain formed, and how it grew. ##

360° scan of Rolling Hills of Mars as seen in Earthlight by Curiosity – Video

<http://www.space.com/27120-rolling-hills-of-mars-as-seen-in-earthlight-video.html>

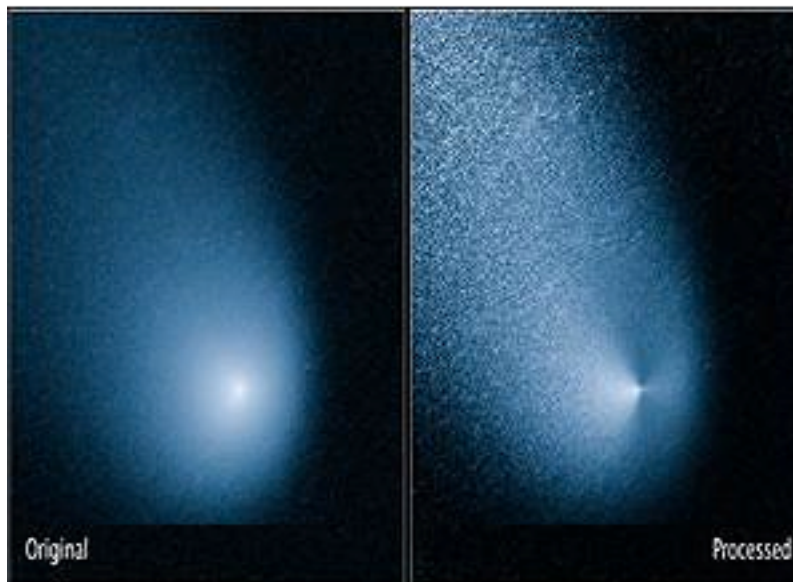
The Amargosa Valley as it would appear to humans if placed on Earth.



Atmospheres of Mars and passing Comet Siding Spring could collide

www.spacedaily.com/reports/Colliding_Atmospheres_Mars_vs_Comet_Siding_Spring_999.html

Video: <https://www.youtube.com/watch?v=2R4yj7DtQbM&feature=youtu.be>



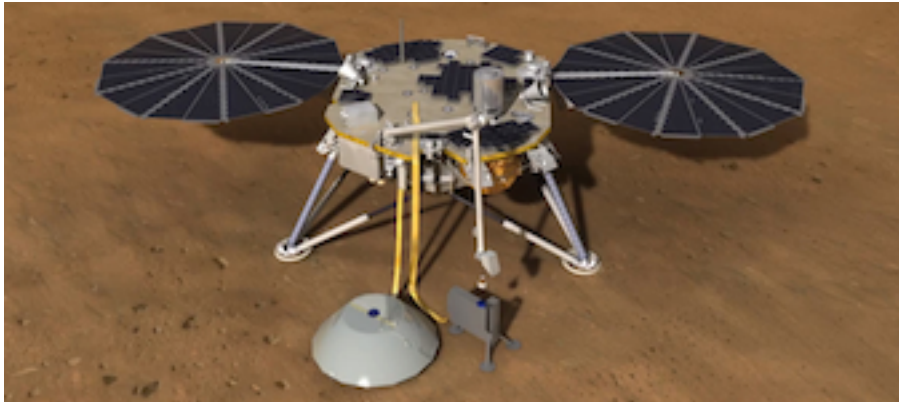
A new ScienceCast video examines what might happen if the **atmosphere** of Comet Siding Spring hits the **atmosphere** of Mars.

August 13, 2014 – On October 19, 2014, Comet Siding Spring will pass by Mars only 132,000 km away--which would be like a comet passing **about 1/3 of the distance between Earth and the Moon.**

- The nucleus of the comet won't hit Mars, but the atmosphere of the comet will interact with the atmosphere of Mars.
- This could lead to some remarkable effects—including **Martian auroras.**
- The timing couldn't be better . NASA's MAVEN probe will be arriving in Sept. 2014 barely a month before the comet's closest pass. ##

How NASA's Next Mars Lander Will Peer Deep Into Red Planet's History

Aug 15, 2014 - <http://www.space.com/26820-nasa-mars-insight-mission-planet-history.html>



A still from an animation shows NASA's new InSight Mars Lander lowering a drill onto Mars to analyze the planet's interior.

InSightMars (short for **I**nterior exploration using **S**eismic **I**nvestigations, **G**eodesy and **H**eat **T**ransport) is now under construction. It will probe the inner workings and early stages of Mars' development billions of years ago.

The Mars lander's scientific payload consists of two chief instruments:

- The **Seismic Experiment for Interior Structure** provided by the French Space Agency.
- A **Heat Flow and Physical Properties Package** provided by the German Space Agency.

NASA is looking for "the same rock-abundance measurements used on Phoenix. Same with the slope requirements," "not too sloped, not too rocky" ##

NASA Prepping Mars Probes, Rovers for Close Comet Flyby

<http://www.space.com/26690-mars-comet-flyby-spacecraft-preparation.html> - July 31, 2014



NASA's Mars Atmosphere and Volatile Evolution mission (MAVEN) is closing in on the Red Planet. At the same time, an interloper, comet Siding Spring, is also approaching. Although the comet's nucleus will miss Mar's, Siding Spring's coma of dust particles might be wide enough to reach the planet.

- Scientists and spacecraft engineers have been studying the prospect that the comet's near miss with Mars might spew particles that could harm an international flotilla of spacecraft orbiting the planet.
- The comet nucleus will make its closest approach to Mars on October 19, and the planet's pass through the coma will take several hours.
- As a new arrival at Mars, **MAVEN** will slip into orbit on September 21, U.S. time.
- A few days later, India's Mars Orbiter Mission, **Mangalyaan-1** will also power itself into Mars orbit.

- The two spacecraft add to an already existing fleet of Mars orbiters: Europe's **Mars Express**, and NASA's **Mars Reconnaissance Orbiter** and **Mars Odyssey**.
- The dust risk appears to be much less than originally thought when the comet was first discovered,
- Based on observations of the comet's coma and on models of dust-lifting and subsequent movement, it is likely that the dust cloud from the comet won't even reach Mars surface.
- Mars is right outside the edge of where the cloud is predicted to be at the time of passage by Mars.
- If it the comet's coma expand a little more and encompass Mars, the predicted abundance of dust grains is thought to be significantly less than first expected, and not a significant risk to spacecraft.
- Some damaging features of the comet might not show up in images or might not have been observed
- Scientific models that project comet activity are informed estimates created by analyzing average properties and processes.
- There could easily be unseen jets of dust that we aren't aware of that could get to Mars. As a result, we are still taking mitigations to minimize the potential damage of any dust.
- MAVEN science instruments will probe the upper atmosphere of Mars before and after the encounter, he said, in order to see what effects the comet has on the Martin atmosphere
- We expect any effects from dust and gas to be primarily focused on the upper atmosphere
- Time of greatest risk: Dust particles ejected from the comet appear to be less of a hazard to Mars spacecraft than once feared, ##

TWO NEW MARS SCIENCE MISSIONS

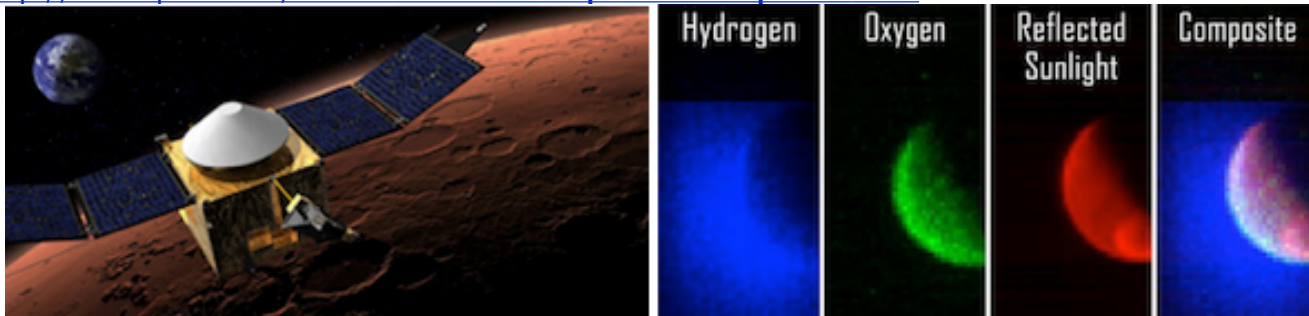
NASA's Maven Orbiter Arrived in Mars Orbit Sept 21st

Sept. 21, 2014 - <http://www.space.com/27217-nasa-mars-maven-spacecraft-arrival.html>

<http://www.nasa.gov/press/2014/september/nasa-s-newest-mars-mission-spacecraft-enters-orbit-around-red-planet/>

<http://www.space.com/27221-sniffing-mars-atmosphere-like-never-before-nasa-gsfc-chief-scientist-explains-video.html>

<http://www.space.com/27255-maven-mars-probe-first-photos.html>



Artist view of Maven in orbit -- First photos in select filters

The **Mars Atmosphere and Volatile Evolution (MAVEN)** mission will take measurements with its **Neutral Gas and Ion Mass Spectrometer (NGIMS)** that have never been collected before

The goal is to gain insights into how Mars' Atmosphere evolved and how it lost most of its mass and changed chemically in the process. This will shed light on the question whether or not Mars was once more hospitable to the rise and evolution of life. ##

India's 1st probe beyond the Moon, Mangalayaan-1, arrives in Mars Orbit

Sept 23, 2014 - Nb."MOM" - Mars Orbiter Mission

http://www.marsdaily.com/reports/Indias_Mission_to_Mars_New_Contender_in_Asian_Space_Race_or_Technological_Breakthrough_999.html

<http://www.space.com/27242-india-mars-mission-arrival.html>

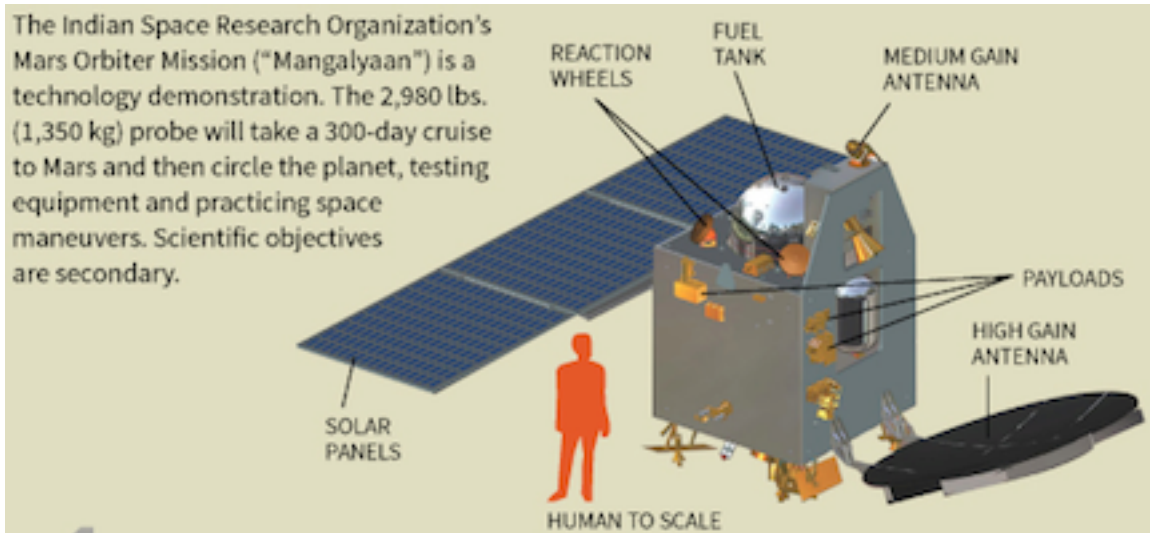
<http://www.space.com/27239-india-s-first-mars-probe-orbit-insertion-animation.html>

<http://www.rediff.com/news/report/live-webcast-of-prime-minister-narendra-modis-msg-reception/20140919.htm> "

<http://www.planetary.org/blogs/emily-lakdawalla/2014/09240910-reflecting-on-the-success-of-mom.html>

<http://www.pbs.org/newshour/bb/indias-low-budget-space-program-may-offer-lesson-for-u-s/>

<http://www.space.com/27263-why-india-s-mars-mission-is-cheaper-than-nasa-s-video.html>



Probe's first photo of Martian surface

Rejoicing at ISRO Mission Control in Bangalore, India

- India's first Mars Orbiter Mission (MOM) entered orbit around Mars on September 24, after a 10-month journey.
- **Complex route** from Earth to Mars:
<http://www.seradata.com/SSI/wp-content/uploads/2013/11/MangalyaanflightplanSMALL.jpg>
- The Indian Space Research Organization (ISRO pronounced "is-row") points out that India is the first nation to insert a spacecraft into Mars orbit on its first attempt. India is also the first Asian country to reach Mars. China's Mars Mission was an attempt to piggyback a ride to Mars on Russia's which never got out of Earth orbit.
- India now joins the United States, Russia, and Europe, an elite club.

Mission Goals

- The probe will remain in orbit hopefully for a year or more.
- Mangalyaan-1 ("Mars-1" in Hindi) has instruments to measure the Martian atmosphere
- The probe is in a different kind of orbit from some of the previous missions, "**measuring different parts of the atmosphere, in different ways.**"
- **Looking for methane gas**; which may exist in the Martian atmosphere and may provide evidence that life may have once existed on the surface of Mars or could still exist under the surface of the planet.
- It has a **camera for taking pictures of the surface, looking at changes in the surface – dust storms and sand dunes and the like.**
- While the mission is mostly geared at demonstrating Indian technology in order to prove they can get there and operate successfully, it may well provide fresh scientific insights into Mars. ##

Russia To Construct Landing Pad For ExoMars Mission

http://www.marsdaily.com/reports/Russia_to_Construct_Landing_Pad_for_Russian_European_ExoMars_2018_Space_Mission_999.html – August 7, 2014

- Russia will create a landing deck and provide a range of unique scientific equipment for a new Russian-European Mars mission
 1. The Russian Space Research Institute (RSRI) is devising two instruments for TGO: the Atmospheric Chemistry Suite (ACS) spectrometric compass – designed to analyze the Martian atmosphere and climate using three spectrometers
 2. The Fine Resolution Epithermal Neutron Detector (FREND) which will register albedo neutrons that occur in the soil of Mars, triggered by galactic and solar cosmic rays and also constructs high-resolution global ice distribution maps of Mars' top soil
- Both instruments are now in the final stage of construction and are to be handed over to the European team at the end of 2014 to place them on the TGO orbiter.



- Main tasks of this Mars rover are a geological study of the planet and the search for traces of life in the planet's subsurface around the landing area. in addition to launch vehicles and scientific gear. ##

NASA Mars-bound 'Flying Saucer' Aerobrakes From Supersonic Speed

<http://www.space.com/26778-nasa-flying-saucer-parachute-supersonic-video.html>

<http://www.space.com/26383-nasa-flying-saucer-test-ldsd.html>



August 8, 2014 – The LSD vehicle's onboard motor propelled the craft eve higher into the sky, taking it up to Mach 4 for the June 2014 test.

- It had to be tested at an altitude on Earth where air pressure is as relatively light as it will be on Mars where its superior aerobraking services will be needed for loads significantly greater in weight than the 1-ton Curiosity. ##

Robotic Rock Climbers Could Uncover Clues to Mars' Past

http://www.marsdaily.com/reports/Robotic_Rock_Climbers_Could_Uncover_Clues_to_Mars_Past_999.html

Aug 7, 2014 – Gullies and canyons with steep cliffs are seen all over Mars.

- A robot that can scale the faces of steep cliffs to find signs of life, could help examine places otherwise difficult or impossible for astronauts to safely reach
- Since 2001, the Association Planete Mars, the Mars Society French chapter, has experimented with probes capable of being lowered down faces of steep cliffs using cables.
- The goal is for astronauts to manually operate a **Cliff Reconnaissance Vehicle (CRV)** or **Cliffbot** instead of dangling off rock faces themselves. ##

EXOLANCE – A Mars Mission Designed to Find Life, if it's there

<http://exploremars.org/exolance/the-mission/> – <https://www.indiegogo.com/projects/exolance>



ExoLance, a project of ExploreMars.org, incorporates a delivery system originally designed for military purposes. It uses **small, lightweight penetrator probes (Arrows)** to deliver a life detection experiment several meters below the Martian surface.

- Each arrow impacts the surface,
- It deposits a transmitter at the surface to communicate with an orbiter,
- It kinetically “drills” to five or more meters to deliver the life-detection equipment.
- It combines experiments of the 70s Viking landers **with bunker-busting weapons technology**.
- The ExoLance dispenser – or “Quiver” – will be integrated into the same aeroshell as the lander.
- It will deploy the individual Arrows as the main lander is braking from supersonic speed.

ExoLance Development & Testing

Within 12–14 months of completing ExploreMars.org’s \$250,000 Indiegogo funding campaign, we will

- Build ExoLance prototypes
- test them at a test range in the New Mexico desert
- Testing both the delivery system (from an aircraft)
- And the ground penetrating arrows.
- Verify the average depth of penetration
- Testing the necessary parameters for a viable life detection experiment within the arrows.

Once the concept is sufficiently tested and the viability of the mission concept proven, we will approach NASA, other space agencies, and commercial providers to carry ExoLance on one or more future Mars missions.

ExoLance will be developed in two phases:

- **Phase: delivery system**
- **Phase II will develop the microbial life detection experiments**

ExoLance Project Initial Computer Simulations Released – August 29, 2014

(Letter from Chris Carberry, Executive Director of ExploreMars.org)

“Aerojet Rocketdyne has been performing computer modeling of the ExoLance penetrators as they impact the Martian surface. While the full results will not be available for another few weeks, initial results, based on data from the Deep Space 2 penetrators that were sent to Mars in 1999

(<http://mars.jpl.nasa.gov/msp98/ds2/fact.html>)

<http://exploremars.org/exolance/exolance-modeling-for-penetration-effectiveness/>

"These tests will serve as a base-point as the Aerojet Rocketdyne team tests various configurations for the ExoLance penetrator concept. The sophistication of the modeling is really quite extraordinary. Each 3D simulation requires 80 processors and over a week to perform. These models will go a long way to prove the ExoLance project's viability. These initial test results bode well for the whole project." ##

BIOMEX: Exploring Mars in Low Earth Orbit (ExoLance Project)

<http://exploremars.org/exolance/the-mission/> - August 8, 2014



- Astrobiologists study how organisms might survive in numerous environments, from the surface of Mars to the ice-covered oceans of Jupiter's moon, Europa. Earth is our only example of an inhabited planet, and studying the limits of habitability on Earth is a major component of astrobiology research.
- Locations like the Antarctic Dry Valleys or deep-sea vents in the Pacific aren't the only places in which astrobiologists study life as we know it. Low Earth orbit provides an opportunity to observe Earth-life in the harsh conditions of space.
- July 24th, 2014, a new astrobiology experiment began its journey from the Baikonur Cosmodrome in Kazakhstan to the International Space Station (ISS). BIOMEX (Biology and Mars Experiment) is one of four experiments that make up the EXPOSE-R2 facility, which will be mounted on the exterior of the ISS Zvezda module.
- BIOMEX contains twelve different experimental packages that are designed to help determine life's potential on Mars.
- Various filters are also being used on the sample chambers to test exposure to different levels of radiation.

Life on Mars? Implications of a newly discovered mineral-rich structure (In a meteorite found on Earth determined to come from Mars)

http://www.marsdaily.com/reports/Life_on_Mars_Implications_of_a_newly_discovered_mineral_rich_structure_999.html - August 20, 2014

- A new ovoid structure discovered in the Nakhla Martian meteorite is made of nanocrystalline iron-rich clay, contains a variety of minerals, and shows evidence of undergoing a past shock event from impact, with resulting melting of the permafrost and mixing of surface and subsurface fluids.
- Scientists present the competing hypotheses in a fascinating article published in *Astrobiology*, a peer-reviewed journal - available Open Access on the *Astrobiology* website.
- While the authors do not believe the formation of this structure involved biological materials, that is a possible hypothesis, and they note that evidence exists supporting the presence of niche environments in the Martian subsurface that could support life.
- search strategy revealed a significant amount of information about the potential for life to inhabit the subsurface of Mars."

NASA's Robot Army of 'Swarmies' Could Explore Other Planets

Aug 25, 2014 – <http://www.space.com/26935-nasa-robot-swarmies-army-space-exploration.html>
<http://www.space.com/24021-space-robot-selfies-photos-top-10.html>

NASA is developing a band of autonomous robots called "swarmies" that use radio waves to communicate with each other and may one day be used to explore the moon or Mars.

- A troop of new NASA robots could race across distant planets as a space exploration vanguard.
- The autonomous robots, dubbed "swarmies," are much smaller than other [NASA robots](#) like the Mars rover Curiosity. Each comes equipped with a webcam, Wi-Fi antenna, and GPS system for navigation.



Left: The self-driving swarmie robots could be used to search alien surfaces one day

Right: The RASSOR robot is programmed for digging and mining

- They function in a way similar to an ant colony. When one ant stumbles across a food source, it sends out a signal to the rest of the colony, and the ants work together to cart the food back to the nest.
- Kennedy Space Center engineers developed software that directs the swarmies to fan out in different directions and search for a specific, predetermined material, like ice-water on Mars. Once one of the rovers finds something interesting, it can use radio to call its brethren over to help collect samples.
- We now realize much smaller, simpler robots can work together and achieve a complex task. One can roll over and die and it's not the end of the mission because the others can still accomplish the task.
- Finding a way to send humans on Moon or Mars exploration missions is complicated and expensive and those kinds of missions are still a long way off. Sending versatile robots is an easier alternative.
- NASA is working on a new generation of autonomous robotic explorers. including a slithering a snake robot to explore Mars and deep-diving robots that could explore the oceans of Jupiter's moon Europa.
- Swarmie tests are still in the preliminary stages: engineers are only driving them around parking lots.
- Currently, robots are only programmed to hunt for barcoded slips of paper. Soon, swarmie tests will also include RASSOR — a mining robot to dig into alien surfaces and search for interesting or valuable materials. The test will determine how well the swarming software controls other robotic vehicles.
- Swarmies might also find a use on Earth, for example, in rescue missions.
- The robots would also make perfect pipeline inspectors. ##

U.S., India to Collaborate on Mars Exploration, Earth-Observing Mission

<http://www.nasa.gov/press/2014/september/us-india-to-collaborate-on-mars-exploration-earth-observing-mission/>

[Editor: The part of this article dealing with Earth-observing issues, will be found at the end of the "Earth Orbit and Mission to Planet Earth" news section above]

Sept. 30, 2014 – In a meeting in Toronto, NASA Administrator Charles Bolden and K. Radhakrishnan, chairman of the Indian Space Research Organisation (ISRO), signed 2 documents to launch a **NASA-ISRO satellite mission to observe Earth** and establish a pathway for **future joint Mars missions**.

- NASA and ISRO have been cooperating under the terms of a framework agreement signed in 2008.
- This cooperation includes a variety of activities in space sciences such as two NASA payloads -- the Mini-Synthetic Aperture Radar (Mini-SAR) and the Moon Mineralogy Mapper -- on ISRO's Chandrayaan-1 mission to the moon in 2008. During the operational phase of this mission, the Mini-SAR instrument detected ice deposits near the moon's northern pole.
- For more information on NASA's Mars exploration program, visit: <http://www.nasa.gov/mars>



ASTERIODS

Legislation seeks to promote Use of Asteroid Resources

www.spacepolitics.com/2014/07/10/legislation-seeks-to-promote-use-of-asteroid-resources/

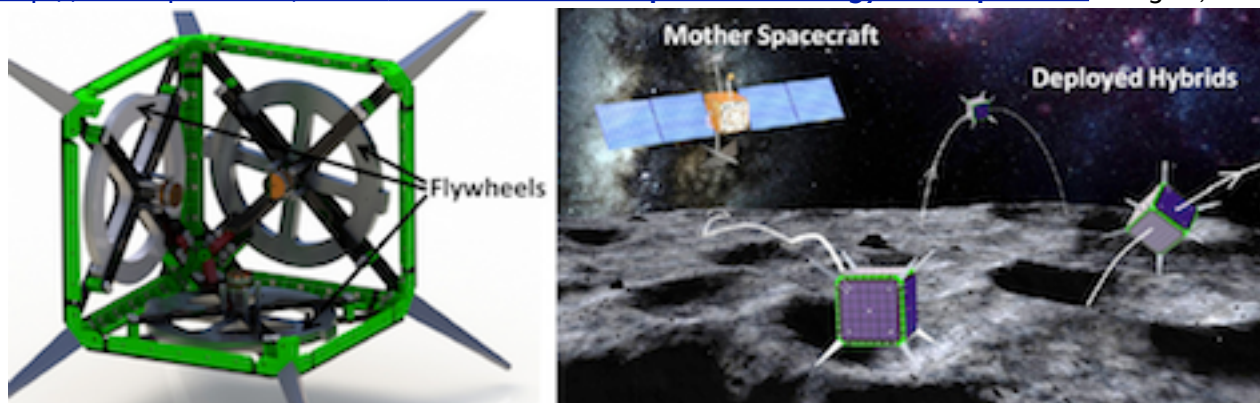
By Jeff Foust on 2014 July 10

The American Space Technology for Exploring Resource Opportunities In Deep Space (ASTER-OIDS) Act of 2014, HR 5063, is a bill introduced by two members of the House Science Committee seeks to promote

- **Commercial asteroid ventures,**
- **Securing property rights** for resources extracted from asteroids by American companies.
- **Facilitate commercial exploration and utilization** of asteroid resources to meet national needs
- **Discourage government barriers** to asteroid resources ventures, and
- **Promote the right of American companies involved** in those activities to both explore and utilize asteroids as well as transfer and sell them. ##

'Orbiting Rainbows' and 4 Other Wild Space Tech Ideas Win NASA Funding

<http://www.space.com/26773-nasa-advanced-space-technology-concepts.html> -Aug. 8, 2014



A proposed hybrid spacecraft/rover system designed to help explore small solar system bodies such as asteroids will receive a Phase 2 grant from the NASA Innovative Advanced Concepts program in 2014

Deflecting Near Earth Asteroids with Paint

September 2, 2014 – <http://www.thespacereview.com/article/2589/1>

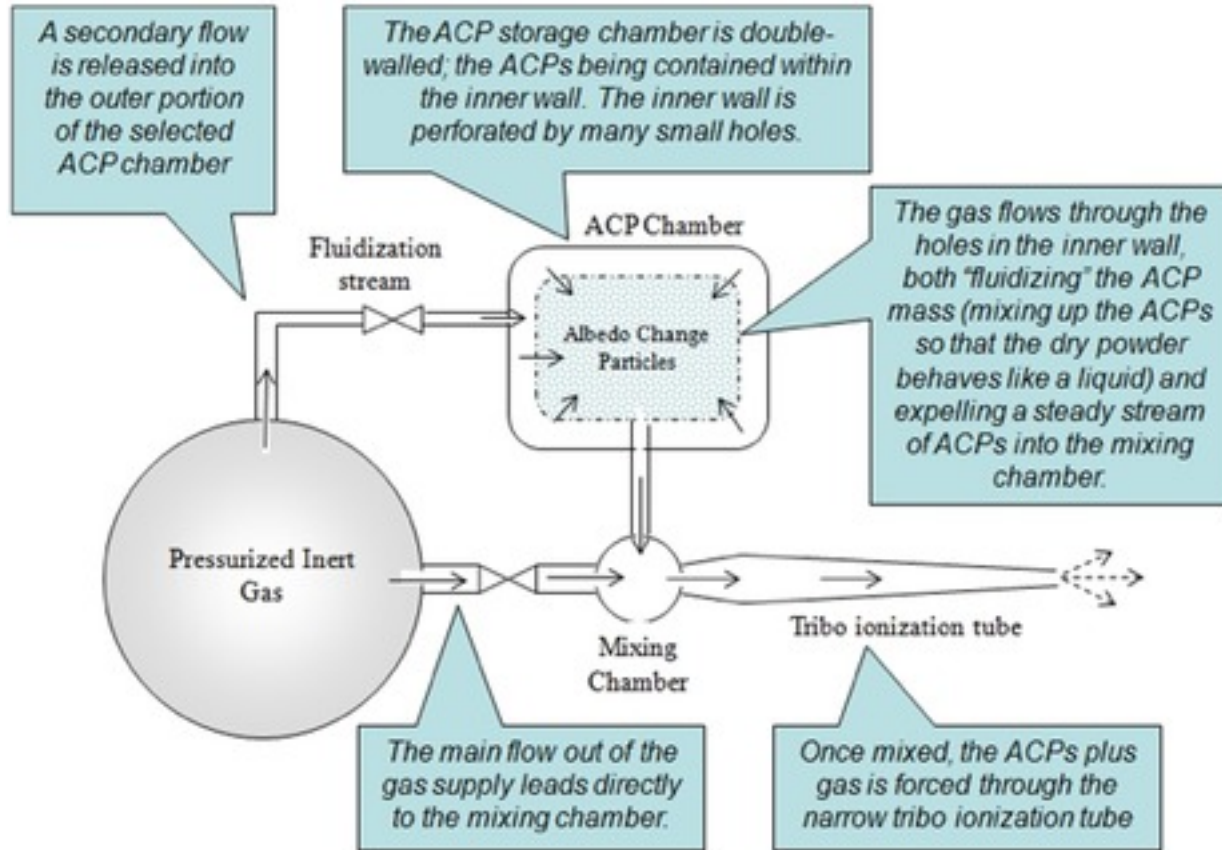
Near Earth asteroids (NEAs), with orbits that intersect the Earth, pose the threat of collisions with devastating consequences. At the Scientific Preparatory Academy for Cosmic Explorers (SPACE) and its-sister research company, the Experimental Center for Applied Physical Systems LLC, they have proposed an innovative “slow push” technique by painting part of an asteroid either white or black.

Changing the asteroid’s surface color alters its reflectivity, or albedo, which ultimately modifies the Yarkovsky Effect on the asteroid. The Yarkovsky Effect is a force linked to the uneven thermal distribution on a rotating body, which generates a force imbalance between the dawn side and the dusk side as the thermal photons leave the surface.

http://en.wikipedia.org/wiki/Yarkovsky_effect

The design and implementation of the Surface Albedo Treatment System (SATS) is a 3-step process.

1. an initial study \ the Apophis Mitigation Technology (AMT)
2. a low Earth orbit (LEO) flight test of a spacecraft housing the SATS system, with an anticipated launch date of 2018.
3. an asteroid exploration and mitigation mission called the Apophis Exploration and Mitigation Platform (AEMP) to the NEA 99942 Apophis, with an anticipated launch in 2021 and arrival at Apophis in 2022.



Over the last five years, we have designed the SATS payload, performed simulations, and conducted ground experiments. SATS is composed of four main components as shown in Figure 2: an inert gas chamber, an ACP (Albedo Change Particles) chamber, a mixing chamber, and a triboionization tube. The core design requires modifying a powder painting gun commonly used for industrial powder coating, which is commonly used for painting car rims, furniture, door knobs, and a variety of other terrestrial objects. A modified Nordson Corporation power painting tribodispenser is been developed for use in space.

SATS would work in space as follows:

1. Pressurized inert gas forces power through a narrow passageway, where the dispenser wall material is an electric donor and the ACPs are electron acceptors.
2. Dispenser releases dry, negatively charged ACPs onto the positively charged asteroid surface.
3. Solar radiation melts and cures the powder, bonding particles firmly to each other and the surface.

Designing the SATS requires both ground experiments and particle flow and interspace simulations. The ground test differs from the LEO experiment by the presence of gravity and its smaller scale. Every effort is implemented to simulate space conditions, including vacuum and sunlight. A vacuum chamber has been built and an UV projector models sunlight. The apparatus is composed of a pressurized gas source, a fluidized bed (hopper), a hose connecting the hopper to the mixing chamber, a main ionization tube, and a nozzle. A schematic of the setup can be seen in Figure 3 below.

Editor: For more on this interesting concept, read the article! ##

US Military's Meteor Explosion Data Can Help Scientists Protect Earth

Sept/ 16, 2014 - <http://www.space.com/27158-us-military-meteor-explosion-data.html>



Artist's view of 2013 fireball explosion over Chelyabinsk, Russia
— termed a "superbolide" event. Credit: Don Davis

The U.S. Air Force and NASA have ironed out problems that prevented scientists from obtaining a steady stream of military tracking data on meteor explosions within Earth's atmosphere. Ever since the meteor explosion over Chelyabinsk, Russia, in February 2013, scientists have been hungry for data that can help them assess the threat of fireballs, meteors and near-Earth objects (NEOs).

Meteor detonations within Earth's atmosphere can be seen by U.S. military sensors on secretive spacecraft. Using this government data, in early 2013, NASA's Jet Propulsion Laboratory (JPL) launched a new website to share the details of meteor explosion events. But earlier this year, the site became stagnant, with no new updates. Due to budget cuts and personnel reductions, NASA's military partner was no longer able to carry out the work.

Repairing the meteor explosions pipeline

However, documents are now in place to ensure that the site is updated with a constant stream of data on meteor explosions, also known as bolides. In January 2013, the Air Force Space Command's Air, Space and Cyberspace [Operations](#) directorate formalized its work with NASA's Science Mission directorate with a memorandum of agreement (MOA).

Trove of data

One big reason why the military data on bolides is so important is that there is increasing evidence that Earth is on the receiving end of a sizable amount of natural asteroid/comet material, otherwise known as "spacefall." Now there is a separate SMC team at Schriever Air Force Base in Colorado that's responsible for the processing and dissemination of the data. By reviewing military-sensor data collected over the years, scientists hope to better understand spacefall rates. However, all of the data isn't available just yet.

When available, the data will give scientists a better idea of the population of very small asteroids that regularly encounter Earth. That will help researchers estimate how many larger objects may exist.

The data from the JPL Fireball website - <http://neo.jpl.nasa.gov/index.html> - helps correlate government sensor observations of fireballs with infrasound detections by the International Monitoring System (IMS), a network overseen by the Comprehensive Nuclear-Test-Ban Treaty Organization.

Independent check

Researchers can calibrate the current global detection efficiency of the IMS. This U.S. government sensor-infrasound comparison also provides an independent check on the fireball energies and flags unusual events. Timely release of this information on the JPL website now also permits rapid follow-up of interesting bolides to facilitate time-sensitive studies, such as meteorite or airborne dust recovery, for the first time.

To view the "Fireball and Bolide Reports" website, overseen by NASA's Near-Earth Object Program, visit <http://neo.jpl.nasa.gov/fireballs/>. ##

COMETS

Europe's Rosetta Spacecraft Arrives at Comet – Aug 6, 2014

<http://www.space.com/26716-rosetta-spacecraft-comet-orbit-arrival-explained.html>

<http://www.space.com/26740-rosetta-spacecraft-comet-arrival.html>

<http://www.bbc.com/news/science-environment-28659783>

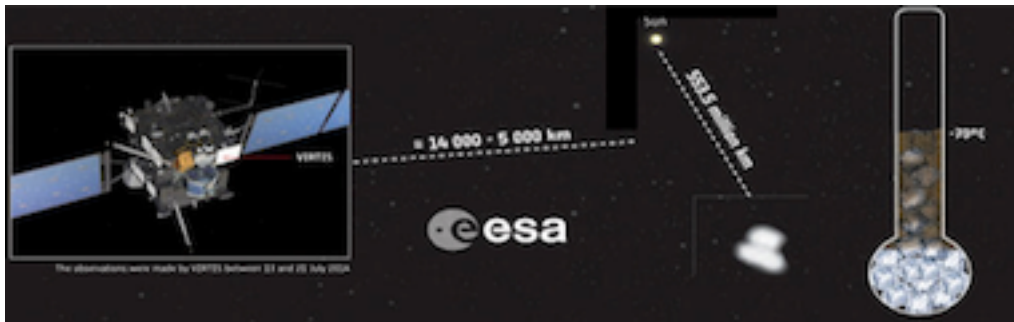
www.space.com/26433-rosetta-probe-snaps-spinning-comet-nucleus-video.html

<http://www.space.com/26834-rosetta-probe-comet-3d-photos.html>

<http://www.space.com/26831-comet-cherry-gerry-snapped-from-64-miles-above-video.html>

http://www.esa.int/Our_Activities/Space_Science/Rosetta/

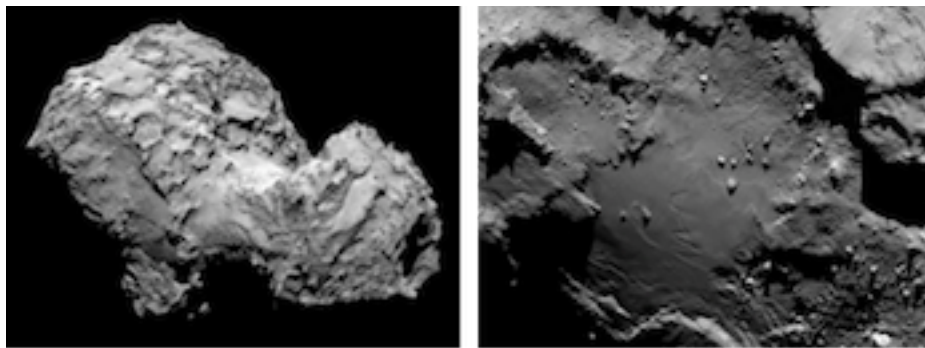
<http://www.space.com/26843-rosetta-spacecraft-takes-comet-temperature.html>



<http://www.universetoday.com/113712/stunning-images-from-rosetta-show-closeup-views-of-comet-67pchuryumov-gerasimenko/>

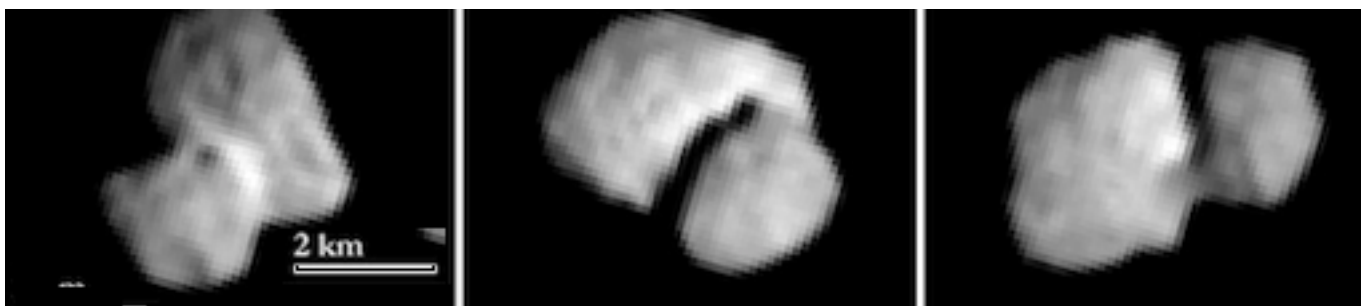
<http://www.space.com/26754-rosetta-comet-spacecraft-5-amazing-facts.htm>

www.esa.int/Our_Activities/Space_Science/Rosetta/Highlights/Postcards_from_Rosetta



www.space.com/26632-rosetta-probe-vs-comet-cherry-gerry-size-comparison-video.html

<http://www.space.com/26689-rosetta-probe-comet67p-neck-photos.html>

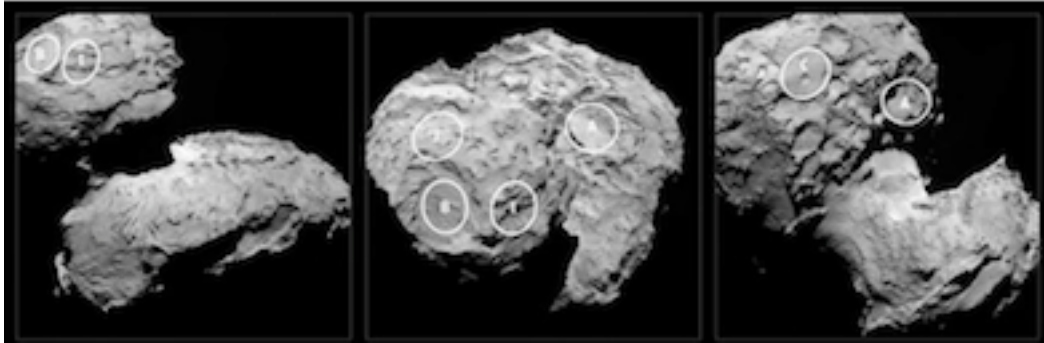


<http://www.space.com/27040-probing-a-comet-tools-rosetta-is-using-video.html>

Landing Site Options on comet 67P/Churyumov–Gerasimenko Narrow

http://www.esa.int/Our_Activities/Space_Science/Rosetta/Rosetta_Landing_site_search_narrows

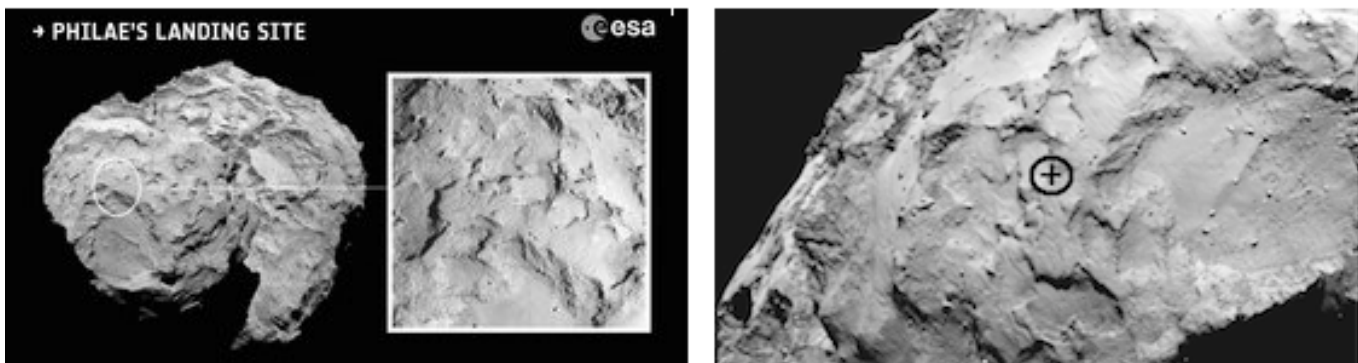
<http://www.space.com/26936-comet-cherry-gerry-landing-sites-narrowed-to-five-video.html>



Using detailed information collected by Rosetta during its first 2 weeks at the comet, five locations have been identified as candidate sites for the Philae lander in November. Measurements of surface temperature, mass and gravity by the probe are considered.

ESA picks Landing Spot for Philae Lander

http://www.esa.int/Our_Activities/Space_Science/Rosetta/J_marks_the_spot_for_Rosetta_s_lander



Sept 15, 2014 – Rosetta’s lander Philae will target Site J, on Comet 67P Churyumov–Gerasimenko:

- Unique scientific potential, With hints of activity nearby,
- The decision was unanimous, with minimum risk to the lander compared to the other candidate sites.
-

Rosetta probe to deploy Comet Lander November 12

www.esa.int/Our_Activities/Space_Science/Rosetta/Rosetta_to_deploy_lander_on_12_November

The 100 kg lander is planned to reach the surface on 12 November, where it will perform in-depth measurements to characterise the nucleus on location, in a totally unprecedented way.

Choosing a suitable landing site was not an easy task. Close-up images revealed a beautiful but dramatic world – scientifically exciting, but with a shape that makes it operationally challenging. “None of the candidate landing sites met all of the operational criteria at the 100% level, but Site J is clearly the best solution.”

At this site, ESA will make the first ever analysis of a this body, giving us an unparalleled insight into the composition, structure and evolution of a comet. Site J in particular offers us the chance to

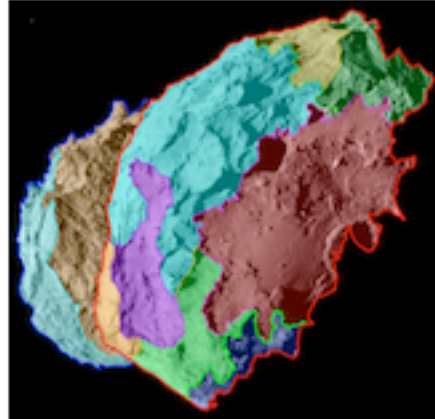
- Analyse pristine material,
- Characterise the properties of the nucleus,
- And study the processes that drive its activity.”

First Color Map of the Comet

<http://www.space.com/27139-rosetta-spacecraft-comet-map.html>

Sept 12, 2014 – Since arriving in orbit about the comet, the probe has captured detailed views of the comet's landscape — jagged cliffs, craters and boulders. Scientists have drawn their colorful map of the object, showing the different regions of the 4 km (2.5-mi-long) comet as seen by Rosetta.

A newly released map depicts the "belly" and part of the "head" of comet 67P/Churyumov-Gerasimenko.



This map shows several morphologically different regions. The lander is expected to achieve the first controlled touchdown on a comet nucleus. Its instruments should obtain the first images from a comet's surface and make the first in situ analysis to find out what it is made of.

European Probe Snaps Spectacular Comet Close-Ups (Photos, Video)

<http://www.space.com/27247-amazing-rosetta-comet-photos.html>

www.space.com/27232-comet-s-dust-streams-and-grains-captured-by-rosetta-probe-video.html

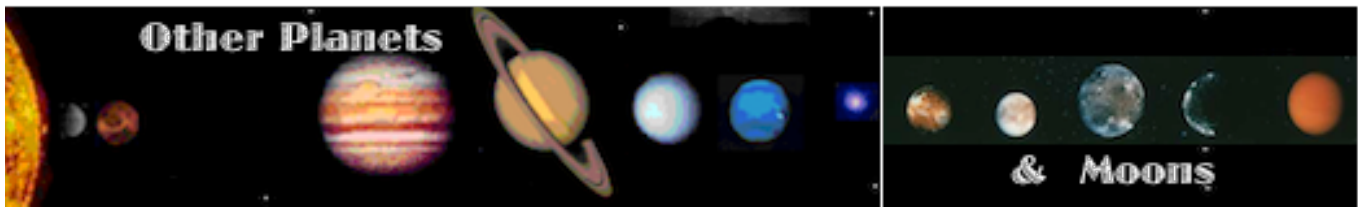
Set 23, 2014 – Europe's Rosetta spacecraft has returned some of the most detailed images yet of the comet it caught last month after a decade-long chase through deep space.

- Mission scientists stitched into a single mosaic four new comet photos taken at a distance of 28.6 km (17.7 mi) from the center of Comet 67P/Churyumov-Gerasimenko.
- The mosaic shows ridges on 67P's "neck" and many cliffs and boulders scattered across the surface.
- Some of the photos overlap, so the same comet features can be seen in multiple images.



Hmm! Looks like a 2-headed monster from this viewpoint.

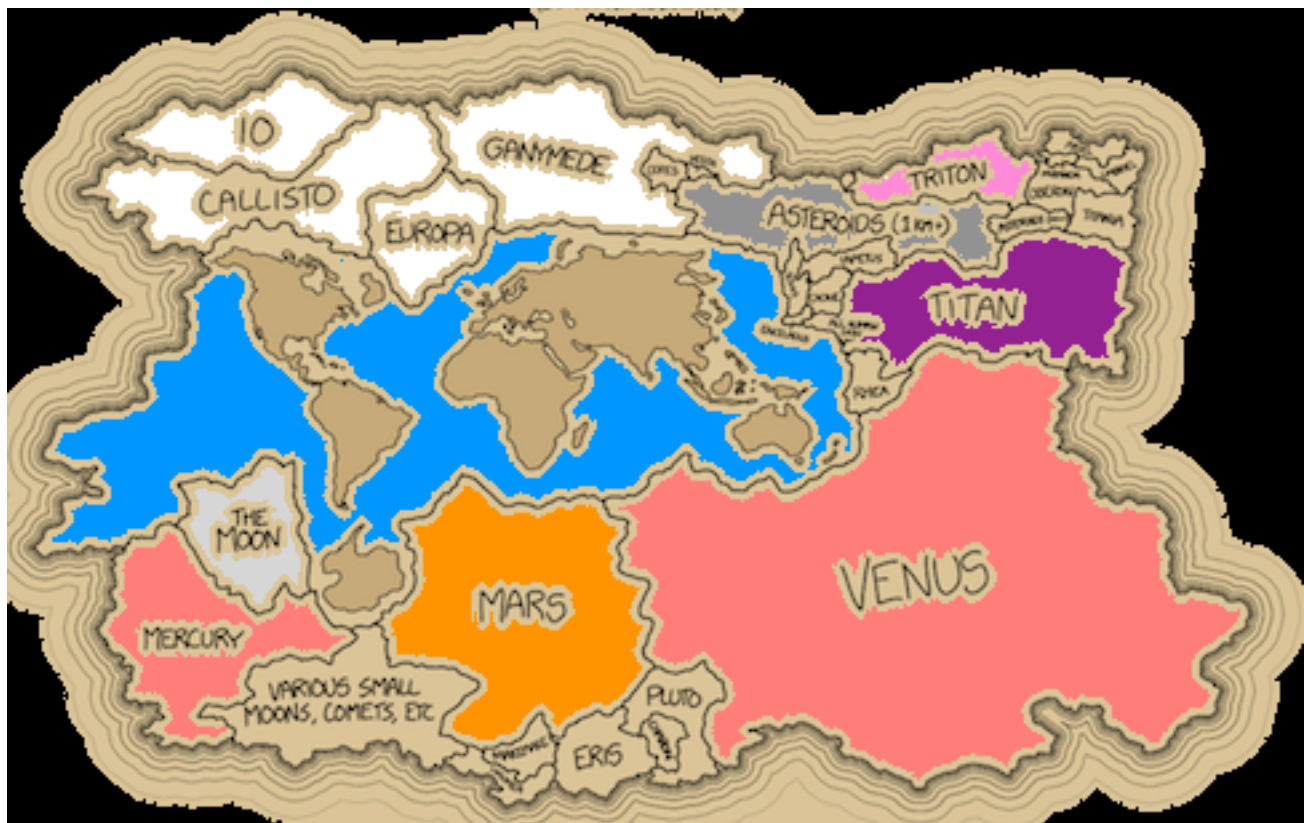
- A program called Microsoft ICE was used to stitch the four new Rosetta photos together.
- The mission plan calls for Rosetta to drop a lander called Philae down onto the comet on Nov. 11.
- Philae will land on the smaller of 67P's two lobes to study the comet's surface and analyze its composition and atmosphere.
- Philae also has a drill, which it will use to take samples.
- ESA officials expect that Rosetta will fly with and study the comet until December 2015.
- They hope the mission provides insight into how comets change as they approach the sun.##



“Space without the space”

An assembled Jig saw puzzle of all the solar system planets and major moons, showing their relative surface areas

<http://xkcd.com/1389/> - <http://xkcd.com/1389/large/>



Colors added by the TTSIQ editor

Thanks to Ben Huset of the Minnesota Space Frontier Society for this

Editor's comment: Nice try, but it is faulty.

- The Moon has as much surface as Africa and Australia put together or as North and South America together minus Greenland
- Mars has as much surface area as all Earth's continents together
- Neither comparison is realized in this innovative jig saw puzzle. - PK

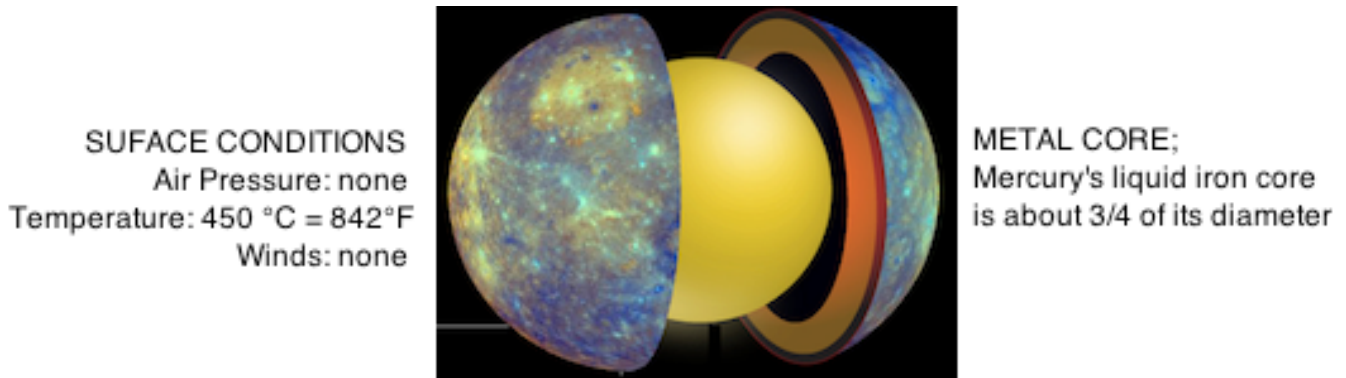
MERCURY

Did a Huge Impact Shape Mercury's Core?

<http://www.space.com/26447-mercury-composition-giant-impact.html> – June 6, 2014

The mysterious makeup of the solar system's innermost planet may be due to a massive "hit and run" collision billions of years ago. A colossal but glancing smashup with "a roughly Earth-size planet" could have stripped away much of proto-Mercury's rocky mantle, explaining why this small world has such a huge iron core today.

- Mercury's core makes up about 60 percent of its mass.
- The figure is about 30 percent for Earth, Venus and Mars. Mercury does not fit this "norm."



Before MESSENGER (MErcury Surface, Space ENvironment, GEOchemistry, and Ranging) entered orbit around Mercury in March 2011, many scientists assumed a giant impact had blasted off the planet's mantle, leaving Mercury's crust depleted of light elements.

But MESSENGER found unexpectedly high abundances of

- moderately volatile elements potassium and sulfur
- high concentrations of sodium and chlorine
- suggesting a different type of giant impact suffered in the early days of the Solar System.

In a new study, computer models found that you get a planet like Mercury most often when the impactor is 4.5 times as massive as Mercury is now, hitting a protoplanet that is 0.85 times the mass Earth has now at about three times their mutual escape velocity at an angle of about 34 degrees.

Both target body and impactor would start re-accreting material even as they go their separate ways. The vast majority of the material — mostly lighter elements from the mantle — will fall back onto the target body. The impactor will thus end up being more metal-rich than it was before, but still have a lot of volatiles in it.

There are still a lot of questions the new model doesn't answer.

Where would the larger body which hit today's Mercury have come from? And where is it now?.

{Editor: Venus? All of these scenarios including the formation of our Moon by collision of "Theia" with Earth remind one of the scorned hypotheses of Velikovsky. http://en.wikipedia.org/wiki/Immanuel_Velikovsky

At least we could humbly eat pie and name one of these mysterious impactors after Velikovsky!]

12th Batch of Messenger Data Released; Water Ice Exploration Tool Unveiled

http://www.spacedaily.com/reports/Twelfth_Batch_of_MESSENGER_Data_Released_Water_Ice_Exploration_Tool_Unveiled_999.html – Sept 12, 2014

- Data collected during MESSENGER's 31st to 36th month in orbit around **Mercury** were released. Data are now available through the 6th full Mercury solar day of MESSENGER orbital operations.
- All NASA planetary missions archive their data in the PDS, providing documented, peer-reviewed data
- This 12th delivery of MESSENGER data extends formatted raw and calibrated data available for the craft's science instruments and radio science investigation from Sept. 18, 2013, to March 17, 2014.

- The ACT-REACT QuickMap interactive Web interface to MESSENGER data has been updated to incorporate the full coverage of the Mercury Dual Imaging System (MDIS) orbital data and the Mercury Atmospheric and Surface Composition Spectrometer (MASCS) Visible and Infrared Spectrograph (VIRS) measurements included in this delivery.
- QuickMap can be accessed via http://www.nasa.gov/mission_pages/messenger/main/index.html
- The MESSENGER team has unveiled a version of the public QuickMap interface tailored for students and educators -- the Water Ice Data Exploration (WIDE) tool, which highlights the sequence of data acquired over four decades, culminating in MESSENGER's observations, which led to **confirmation that water ice is present in Mercury's north polar region in permanently shadowed polar craters.**
- The WIDE suite consists of a video presentation from a mission scientist and engineer, a pencil-and-paper activity, and an introductory version of QuickMap, the interactive data-mapping tool.
- Each of these individual parts examines Mariner 10 flyby data from the 1970s, Earth-based radar data from the early 1990s, and MESSENGER flyby and orbital data from several instruments to show the progression of evidence in support of this conclusion. ##

VENUS

ESA hangout: How to surf the Venus atmosphere

http://www.esa.int/Our_Activities/Space_Science/Venus_Express/Venus_Express_rises_again
www.esa.int/spaceinvideos/Videos/2014/05/Venus_Express_aerobraking (VIDEO) - 11 July 2014

After a month surfing in and out of the atmosphere of Venus down to just 130 km (81 mi) from the planet's surface, ESA's Venus Express is about to embark on a 15 day climb up to the lofty heights of 460 km (280 mi).

Since its arrival at Venus in 2006, the spacecraft has been conducting science observations from an elliptical 24-hour orbit that took it from a distant 66 000 km (41,000 mi) over the south pole - affording incredible global views - to altitudes around 250 km (155 mi) at the north pole, just above the top of the planet's atmosphere [and over the northern "continental" rise **Ishtar Terra.**]

After eight years in orbit and with fuel running low, **an aerobraking campaign** was planned as a final assignment, during which the probe would dip progressively lower into the atmosphere.

From May 15, the spacecraft's altitude was allowed to drop naturally from the effect of gravity, culminating in a month 'surfing' between 131-135 km (81-84 mi) above the surface.

This allowed ESA to measure the effects of atmospheric drag on the spacecraft, **indicating how the density of the atmosphere varies on local and global scales.** The additional drag exerted by the denser atmosphere at lower altitudes reduced the spacecraft's orbital period by more than an hour.

Small changes in the spacecraft's acceleration were recorded due to

- Atmospheric density along its orbital path.
- Between the day and night side of the planet
- A difference in atmospheric density of **about thousand times between 165 km and 130 km**
- Rapid heating of the spacecraft experienced as it skimmed through the upper reaches of the atmosphere during each orbit at about 36 000 km/h (22,370 m/h).

During several of the 100-second long passages through the atmosphere, the solar panel temperature sensor reading increased by over 100°C (100°F). Analysing the spacecraft's response to such rapid heating is useful for planning future spacecraft system and subsystem design.

By 26 July, Venus Express' altitude should be a steady 460 km (286 mi) and allowed to decay naturally, eventually sinking into the atmosphere by December, ending its mission. But it is possible that the remaining fuel will run out during the thruster burns required to raise its orbit. In this case, it will no longer be possible to communicate with the craft and its orbit will once again decay. ##

JUPITER & ITS MOONS

Radio Signals from Jupiter Could Aid Search for Alien Life on its moons

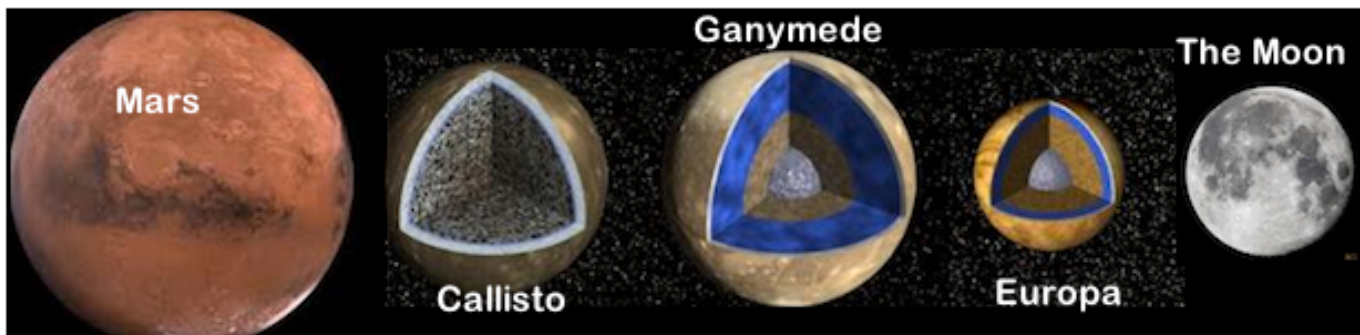
July 2, 2014 0- <http://www.space.com/26419-jupiter-radio-waves-alien-life.html>

Video: www.space.com/9933-touring-jupiter-big-moons-io-ganymede-europa-callisto.html

Jupiter generates powerful radio signals that researchers could use to scan its three large icy moons – Europa, Ganymede and Callisto – for sub-surface oceans that could be home to extraterrestrial life. Why? there is life virtually wherever there is liquid water on Earth.

Europa, a bit smaller than the Moon, appears to have the greatest potential to sustain life. Magnetic readings captured by Galileo provided compelling hints that it has an ocean, and radio scans by the probe suggest a water-rich layer beneath the surface between 80–170 km (50–105 mi) deep and suggest its ocean could be loaded with enough oxygen to support millions of tons worth of marine life.

Scientists want to analyze Europa's ocean directly, perhaps with missions to bore into Europa's icy shell using heat to melt through the ice and robot subs to explore the ocean. But we still don't know for sure how thick this ice shell is, and that complicates any plans to penetrate it. Models based on the amount of heat the shell receives from the Sun and Europa itself, predict it to be roughly 30 km (18 mi) much thicker than we had first hoped. But analyses of the Galileo spacecraft's data suggest the shell is no more than 15 km (9 mi) thick, and maybe as little as 4 km (2.5 mi) thick, much less challenging.



Ice-penetrating radar, with low-frequency signals less than 30 megahertz, is the most promising technique to directly confirm the existence of any ocean hidden within icy moons, by looking for signals that indicate buried objects and boundary between the icy crust and the hidden ocean, and between such an ocean bottom and Europa's rocky core.

The radio waves researchers would like to use are decametric: wavelengths tens of meters long. One problem is interference from powerful decametric radio bursts from Jupiter itself, signals more than 3,000 times stronger than any leaking into the solar system from the rest of the galaxy. Jupiter's decametric waves come from clouds of electrically charged particles trapped in Jupiter's magnetic field. A mission probing Jupiter's moons would need a relatively strong transmitter to overcome Jupiter's loud radio signal, a massive device that might be difficult to power and fit aboard a spacecraft.

Instead of trying to overpower Jupiter's radio signals, researchers now suggest using the giant planet's decametric radio waves to scan these moons. The mission would need to bring along a very low-power system to detect rrioting signals reflected by the moons and any hidden oceans. They would bring just a receiver, positioning it t between Jupiter and the arget icy moon.

The probe would then monitor decametric emissions from Jupiter as well as echoes of those signals reflected off the icy moon using technology already developed.

By comparing the signals from Jupiter with the echoes from its moon, the researchers can determine the thickness of the moon's icy shell and the depth of its ocean. Analyzing both distant radio emissions and their echoes, is known as **interferometric reflectometry**

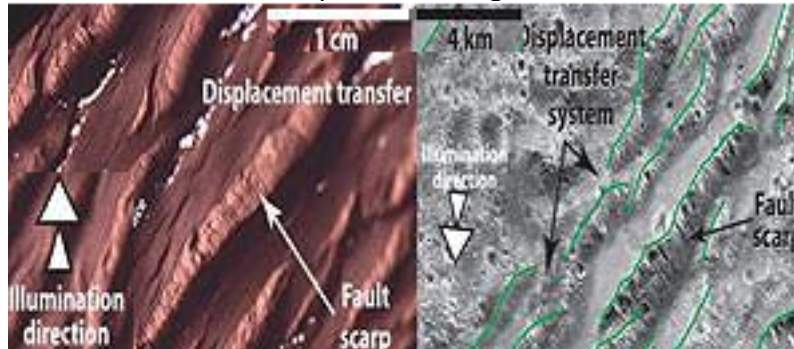
The scientists now plan to mmake observations from Earth of Jupiter's decametric radio emissions as they reflect off the icy moon surfaces – making unnedesary an expensive dedicated mission to the Jupiter system. They expect measurements close to the sensitivity of current ground-based radio observatories. This could provide valuable information about the surface properties of the three moons.

Observation of a subsurface ocean will not be able to tell us whether there are living organisms in Europa, but it could provide strong evidence for such a possibility. ##

Models suggest stretching forces shaped Ganymede's surface

www.spacedaily.com/reports/Laboratory_models_suggest_that_stretching_forces_shaped_Jupiter_Moons_surface_999.html

July 9, 2014 – Processes that shaped the ridges and troughs on the surface of Ganymede are likely similar to tectonic processes seen on Earth. A team of researchers led by Southwest Research Institute (SwRI) subjected physical models made of clay to stretching forces that simulate tectonic action.



An image of a tabletop-size analog model (left) shows details of fault systems created by stretching that visually match a Galileo image of faulted terrain on Ganymede (right)

Larger image: <http://www.swri.org/press/2014/Images/ganymede.jpg> .

Physical analog models simulate geologic structures in laboratory settings so that the developmental sequence of various phenomena can be studied as they occur. The team created complex patterns of faults in their models, similar to **ridge and trough features** seen on Ganymede. A "wet clay cake" material possessing brittle characteristics to simulate how the icy moon's lithosphere – the outermost solid shell, responds to stresses by cracking. "From the experiments, it appears that a process in which the crust breaks into separate blocks by large amounts of extension is the primary mechanism for creating these distinct features." A dedicated mission to Ganymede is not needed.

SwRI researchers previously have used physical analog models to examine the process by which pit crater chains – a series of linear pits, or depressions – develop on Mars, and how magma in the Martian subsurface deforms the surface of the Red Planet. ##

NASA Seeks Proposals for Europa Mission Science Instruments

www.nasa.gov/press/2014/july/nasa-seeks-proposals-for-europa-mission-science-instruments/
<http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId=%7BD663DD46-1929-9482-24BA-D5BCDBAA10BC%7D&path=open>

July 15, 2014 RELEASE 14-186 Compiled from NASA's Galileo spacecraft data, this colorized surface image of Europa shows the blue-white terrains which indicate relatively pure water ice. These features may offer a way to investigate the habitability of the moon's interior ocean.



Image area measures approximately 101 by 103 miles (163 km by 167 km)

Reddish Bands on Europa; The blue-white terrains indicate relatively pure water ice, whereas the reddish areas contain water ice mixed with hydrated salts, potentially magnesium sulfate or

sulfuric acid. The reddish material is associated with the broad band, as well as some of the narrower bands, ridges, and disrupted chaos-type features. It is possible that these surface features may have “communicated” with a global subsurface ocean layer during or after their formation.

Full image/captions – www.nasa.gov/content/reddish-bands-on-europa/#.U8uwOxa9U_s

Announcement of Opportunity

NASA seeks proposals about science instruments for a future mission to Europa to address fundamental questions about the icy moon and the search for life beyond Earth – instruments which may provide a big leap in our search to answer the question: “are we alone in the universe?”

NASA will select about 20 proposals in April 2015., then provide approximately \$25 million for selectees to advance instrument formulation and development as part of a Phase A concept study. About eight instruments could be built for flight and science operations.

Proposed instruments must be compatible with a spacecraft that would either orbit or perform multiple flybys of Europa. Instruments must address the science goals for Europa's exploration outlined in the National Resource Council's (NRC) Planetary Decadal Survey which **ranked a mission to Europa among NASA's highest priority scientific pursuits.**

It listed five key science objectives in priority order that are necessary to improve our understanding of the potentially habitable moon:

1. Characterize the extent of the ocean and its relation to the deeper interior
2. Characterize the ice shell and any subsurface water, including their heterogeneity, and the nature of surface-ice-ocean exchange
3. Determine global surface, compositions and chemistry, especially as related to habitability
4. Understand the formation of surface features, including sites of recent or current activity, identify and characterize candidate sites for future detailed exploration
5. Understand Europa's space environment and interaction with the magnetosphere.

NASA places high priority on a future lander mission to Europa. Current data is not sufficient to identify landing sites and design a landing system capable of safely reaching the surface.

NASA has a reconnaissance goal to characterize scientifically compelling sites, as well as hazards, for a potential future landed mission to Europa.

Any mission to Europa must address the harsh radiation environment that would require unique protection of the spacecraft and instruments. And the spacecraft must meet planetary protection requirements intended to protect Europa's potentially habitable ocean. These requirements are very strict and involve ensuring that a viable Earth organism is not introduced into the Europa ocean.

Europa's ocean is estimated to hold more liquid water than all of Earth's oceans combined.

Europa and Jupiter's other moons have been visited by other spacecraft, but were each limited to a single distant flyby. Galileo, launched in 1989, was the only mission to make repeated visits to Europa, passing close by the moon almost a dozen times.

Cost reduction of a future Europa mission is a priority, NASA seeks concepts for a mission to Europa that would cost less than \$1 billion, excluding the launch vehicle, which could still meet as many of the science priorities as possible. Recent NASA studies have focused on **an orbiter mission concept and a multiple flyby mission concept** as the most compelling and feasible.

Deadline for proposals is October 17. ##

Europa: Best Bet for Alien Life? – an interview with Bill Nye

Aug 22, 2014 – <http://www.space.com/26905-jupiter-moon-europa-alien-life.html>

- At roughly 800 million km (500 million mi) from the Sun, on average, Europa doesn't look like a particularly inviting place for life to thrive.
- But beneath its icy crust lies a liquid ocean, shielded from harmful radiation, with more water than Earth contains. This ocean makes Europa one of the solar system's best bets to host alien life.
- Europa has all the elements thought to be key for the origin of life: water, energy, and organic chemicals, the carbon-containing building blocks of life.

Looking for life

- Just as a layer of ice over a pond allows the water beneath it to stay liquid through the freezing winter, Europa's icy crust shields its enormous ocean despite the moon's great distance from the sun.
- As Europa travels around Jupiter, the massive planet bends and flexes the satellite, generating interior heat that keeps its water from freezing completely.
- Beneath Europa's surface, active volcanoes may also heat the water, providing vents where bacterial life may thrive as it does in Earth's ocean depths
- It may be possible for a probe to get through Europa's crust, a few kilometers thick. Europa's variable ice shell may be that thin in places.
- A second potential site for life exists in Europa's subsurface lakes (similar to those in Antarctica). Some bubbles of energy from beneath the surface don't make it all the way through the crust but instead melt some of its ice. The lakes that form from the meltwater last hundreds of thousands, even millions of years, and some of these lakes contain more water than all of North America's Great Lakes.
- NASA's Hubble Space Telescope has discovered a third region where scientists could search for the ingredients for life: geysers of water vapor erupting from Europa's southern hemisphere, possibly allowing a flyby probe to sample the moon's subsurface sea from afar.

An upcoming mission

- The 2011 U.S. National Research Council issues a Planetary Science Decadal Review ranked the exploration of Europa as one of the highest-priority missions. But NASA Planetary Science program budget cuts and a focus on the inner solar system have kept any mission concept from coming to fruition.
- However, NASA's 2015 budget request includes funding to plan a potential Europa mission.
- NASA has asked researchers to propose scientific instruments for a mission to Europa.\
- A flyby spacecraft would be easier to implement than an orbiter.
- Another mission option could include a vehicle that would transport a number of tiny "CubeSats" (mini satellite payloads) and deposit them on the surface to do a variety of experiments.

Funding the voyage

- The cost of doing planetary science at Europa is less than \$2 billion
- In general, robotic missions have a relatively low costs and a high return in planetary science.
- Spinoff science and technology resulting from the study of Europa would also be a benefit.
- Exploring Europa doesn't mean that life would be discovered immediately.
- What could be definitively measured, however, is whether the water vapor spewing from the planet contains amino acids, the building blocks of life.
- Figuring out whether Europa harbors life would probably require returning samples from the plumes or elsewhere on this moon to be studied on Earth, where they could be studied in depth. But humans have not yet managed to return samples from Mars, which is much closer than Europa, so accomplishing this for Europa may not happen until the more distant future.

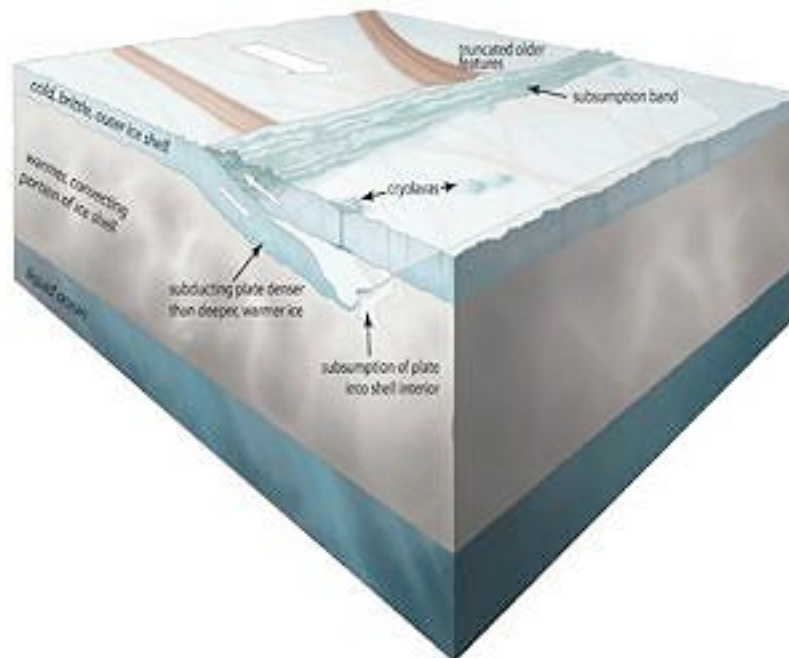
Evidence of "Diving" Tectonic Plates on Europa

www.spacedaily.com/reports/Scientists_Find_Evidence_of_Diving_Tectonic_Plates_on_Jupiters_Moon_Europa_999.html

Sep 09, 2014 – Scientists have found evidence of plate tectonics on Jupiter's moon Europa. This indicates the first sign of this type of surface-shifting geological activity on a world other than Earth. Researchers have clear visual evidence of Europa's icy crust expanding. However, they could not find areas where the old crust was destroyed to make room for the new.

- While examining Europa images taken by NASA's Galileo orbiter in the early 2000s, planetary geologists discovered some unusual geological boundaries.
- Plate tectonics is the scientific theory that Earth's outer layer is made up of plates or blocks that move, which accounts for why mountain and volcanoes form and earthquakes happen.
- The surface of Europa is riddled with cracks and ridges. Surface blocks are known to have shifted in the same way blocks of Earth's outer ground layer on either side of the San Andreas fault move past each in California.

- Many parts of Europa's surface show evidence of extension, where wide bands miles wide formed as the surface ripped apart and fresh icy material from the underlying shell moved into the newly created gap -- a process akin to seafloor spreading on Earth.



This conceptual illustration of the subduction process (one plate is forced under another) shows how a cold, brittle, outer portion of Europa's 20–30 km (2–19 mi) thick ice shell moved into the warmer shell interior and was ultimately subsumed. A low-relief subsumption band was created at the surface in the overriding plate, alongside which “cryolavas” may have erupted.

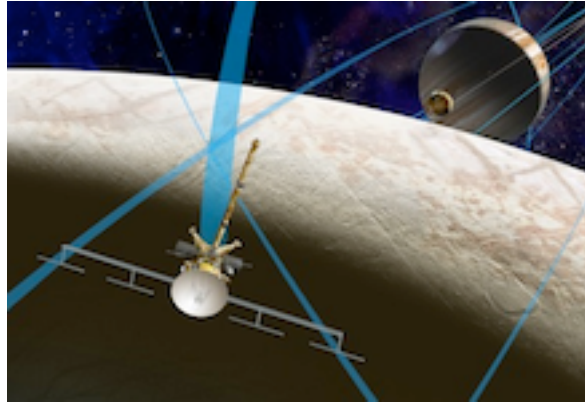
Large image: http://www.nasa.gov/sites/default/files/14-241_0.jpg

- On Earth, as new surface material forms at mid-ocean ridges, old material is destroyed at subduction zones, regions where two tectonic plates converge and overlap as one is forced under the other.
- Despite the degree of extension evident on Europa's surface, researchers had not been able to determine how the surface could accommodate all the new material.
- Scientists studying Europa often reconstruct the moon's surface blocks into their original configuration to get a picture of what the surface looked like before the disruption occurred.
- About 20,000 km² (7,700 mi²) of the surface were missing in Europa's high northern latitudes.
- Further evidence suggested the missing terrain moved under a second surface plate -- a scenario commonly seen on Earth at plate-tectonic boundaries.
- Ice volcanoes were spotted on the overriding plate, possibly formed through melting and absorption of the slab as it dove below the surface, and a lack of mountains at the subduction zone, implying material was pushed into the interior rather than crumpled up as plates mashed against each other.
- The scientists believe the subducted area was absorbed into Europa's ice shell, which may be up to 30 km (20 mi) thick, rather than breaking through it into Europa's underlying ocean.
- On Europa's relatively young surface -- about 40–90 million years old, on average -- scientists have seen evidence of material moving up from under the shell but, until now, no mechanism had been found for moving material back into the shell, and possibly into the large ocean below the ice.
- If Europa has a global plate tectonic system, it may be more Earth-like than we imagined
- This implies “two-way communication between the exterior and interior” -- a way to move material from the surface into the ocean
- This process has significant implications for Europa's potential as a habitable world.
- In July, NASA issued an Announcement of Opportunity (AO) for proposals for science instruments that could be carried aboard a future mission to Europa.
- Europa's global sub-ice crust ocean covers contains more water than all of Earth's oceans combined.

- NASA's Galileo spacecraft, launched in 1989, discovered evidence of a saltwater ocean beneath the icy surface. The mission officially was ended when Galileo plunged into Jupiter's atmosphere in September 2003 to prevent an impact with Europa. ##

A Generational Opportunity for Europa – Op Ed Article

<http://www.thespacereview.com/article/2561/1>

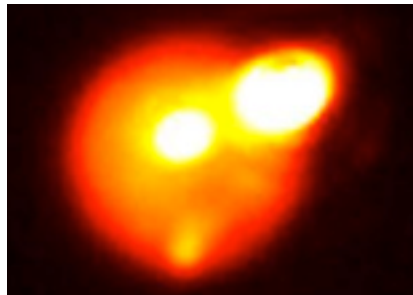


Giant Volcanoes Rock Jupiter's Moon Io (Photos)

<http://www.space.com/26732-jupiter-moon-io-volcano-eruption-photos.html>

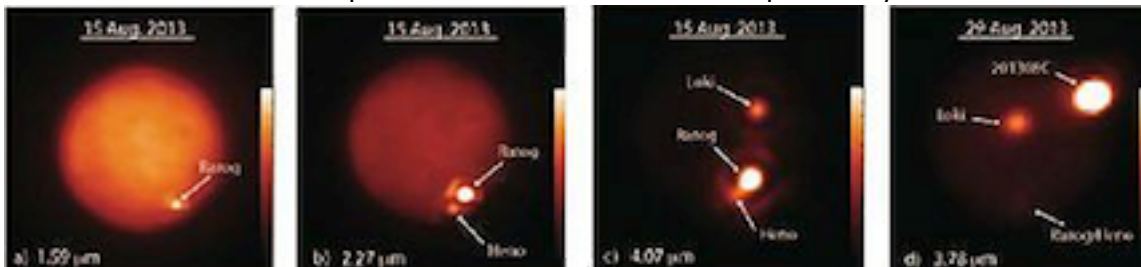
http://www.spacedaily.com/reports/Extreme_Volcanism_Image_Captures_one_of_the_Brightest_Volcanoes_Ever_Seen_in_the_Solar_System_999.html

http://www.spacedaily.com/reports/A_Hellacious_Two_Weeks_on_Jupiters_Moon_Io_999.html



August 29, 2013, an outburst on Jupiter's moon, Io, captured in the photo above, was one of the largest yet observed on Io, the most volcanically active body in the solar system.

- Io is the only solar system body besides Earth known to feature volcanoes of hot, molten rock.
- Astronomers imaged three monster eruptions on Io over a two-week span in August 2013
- Researchers spotted and studied the blasts using a variety of instruments in Hawaii, including the Keck II and Gemini North telescopes and NASA's Infrared Telescope Facility



- These images show Jupiter's moon Io obtained at different infrared wavelengths (in microns, μm , or millionths of a meter) with the W. M. Keck Observatory's 10-meter Keck II telescope on Aug. 15, 2013 (a–c), and the Gemini North telescope on Aug. 29, 2013
- The amount of energy being emitted by these eruptions implies lava fountains gushing out of fissures at a very large volume per second

- The new observations will help scientists better understand Io, and they could shed light on the extreme volcanism that shaped the surfaces of Earth and Venus during the solar system's early days.

SATURN

Saturn-Titan Cassini Probe to End Mission in Epic 'Grand Finale' in 2017

July 01, 2014 - <http://www.space.com/26409-nasa-cassini-grand-finale-saturn.html>



"The proximal orbits" - Cassini Grand Finale

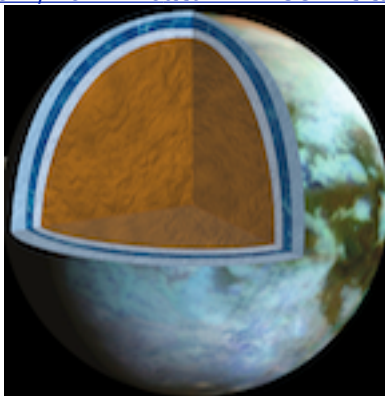
NASA's Cassini spacecraft will zip between Saturn and its innermost set of rings 23 times during the final phase of the probe's mission in 2016-2017, ending when the probe intentionally dives into Saturn's atmosphere.

- Cassini launched toward Saturn in October 1997 and arrived in orbit June 30, 2004.
- Cassini also dropped the **Huygens** lander onto Saturn's huge moon **Titan** in January 2005.
- Cassini also detected plumes of water ice blasting from geysers at the south pole of the moon **Enceladus**, suggesting the Saturn satellite harbors an ocean of liquid water beneath its icy shell.
- During the 22 Grand Finale super-close orbits, the probe will map Saturn's gravity and magnetic fields in detail, assess how much material is in the planet's iconic rings and take up-close pictures of Saturn and the rings. ##

Editor: Future missions to Titan are assured. Titan is perhaps the most intriguing world in the Solar System beyond Earth itself. Europa would be its main rival.

Sub-surface Ocean on Titan Could be as Salty as the Dead Sea

www.nasa.gov/press/2014/july/ocean-on-saturn-moon-could-be-as-salty-as-the-dead-sea/
<http://www.space.com/26444-saturn-moon-titan-salty-ocean.html>



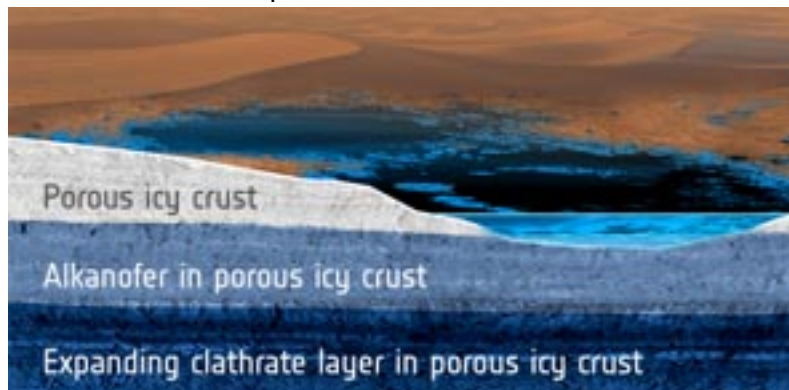
July 2, 2014 RELEASE 14-185 – **The ocean inside Titan might be as salty as the Earth's Dead Sea.** Using the Cassini data, researchers presented a model structure for Titan, resulting in an improved understanding of the structure of the moon's outer ice shell.

- Titan's **icy shell is rigid and in the process of freezing solid.** A relatively high density is required for Titan's ocean in order to explain the gravity data – probably an extremely salty brine of water mixed with **dissolved salts likely composed of sulfur, sodium and potassium** with a salt content roughly equal to the saltiest bodies of water on Earth.
- This may change the way we view this ocean as a possible abode for present-day life, but conditions might have been very different there in the past.
- **The thickness of Titan's ice crust varies slightly from place to place.** This can best be explained if the moon's outer shell is stiff, as if the ocean were slowly crystalizing, and turning to ice.
- This freezing process would have important implications for the habitability of Titan's ocean, as it would limit the ability of materials to exchange between the surface and the ocean.
- **A rigid ice shell also suggests that any outgassing of methane into Titan's atmosphere must happen at scattered "hot spots"**
- Titan's methane does not appear to result from convection or plate tectonics recycling its ice shell.
- Titan's present atmosphere contains about five percent methane. Some process, geological in nature, must be replenishing the gas. The study indicates that the restoration of Titan's methane is localized and intermittent. A future mission will be needed to find localized methane sources. ##

Titan's subsurface reservoirs modify methane rainfall

www.spacedaily.com/reports/Titans_subsurface_reservoirs_modify_methane_rainfall_999.html

Sept 3, 2014 – The international Cassini mission has revealed hundreds of lakes and seas spread across the icy surface of Saturn's moon Titan, mostly in its polar regions. These lakes are filled not with water but with hydrocarbons also found naturally on Earth and includes methane. While most of the liquid in the lakes is thought to be replenished by rainfall from clouds in the moon's atmosphere, the cycling of liquid throughout Titan's crust and atmosphere is still not well understood.



- A recent study probed the hydrological cycle of Titan by examining how Titan's methane rainfall would interact with icy materials within underground reservoirs.
- The formation of materials called clathrates changes the chemical composition of the rainfall runoff that fills these hydrocarbon reservoirs, leading to the formation of reservoirs of propane and ethane that may feed into some rivers and lakes.
- We knew that a significant fraction of the lakes on Titan's surface might be connected with hidden bodies of liquid beneath Titan's crust, but we did not know how they would interact.
- We have modeled the moon's interior in great detail, and have a better idea of what these hidden lakes or oceans could be like.
- We modeled how a subsurface reservoir of liquid hydrocarbons would diffuse throughout Titan's porous icy crust. This diffusion could cause a new reservoir – formed from clathrates – to form where the bottom of the original reservoir meets layers of non-porous ice.
- Clathrates are compounds in which water forms a crystal structure with small cages that trap other substances like methane and ethane.

- On Earth, clathrates that contain methane are found in some polar and ocean sediments. On Titan, the surface pressure and temperature allow clathrates to form when liquid hydrocarbons come into contact with water ice, a main component of the moon's crust. These clathrates could remain stable as far down as several kilometers below the surface of Titan.
- Clathrates cause fractionation – in this case, they trap and split molecules into a mix of liquid and solid phases. Astronomers have suggested that clathrates may be responsible for many unusual phenomena on Titan, including the depletion of the heavy noble gases in the moon's atmosphere, and variations in the moon's polar radius.
- Titan's subsurface clathrate reservoirs would interact with and fractionate the liquid methane within the original underground hydrocarbon lake, slowly changing its composition. Eventually, subsurface lakes that had come into contact with the clathrate layer would mainly be composed of either propane or ethane, depending on the type of clathrate that had formed.

Two kind of Lakes on Titan?

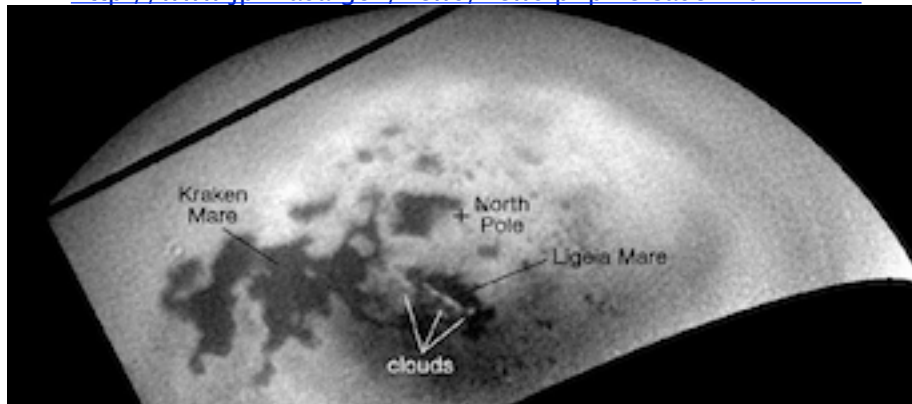
- Lakes fed by these propane or ethane subsurface reservoirs would show the same kind of composition, whereas those fed by rainfall would be different and contain methane, nitrogen, and trace amounts of argon and carbon monoxide. Thus we would be able to look at the composition of the surface lakes and learn something about what is happening deep below.
- The Cassini Solstice mission, an extension of Cassini that runs until 2017, will give scientists a chance to explore Titan's surface lakes even more closely by performing an additional 54 close flybys of the Saturnian moon.
- Understanding Titan's hydrological cycle is an important objectives of Cassini's extended mission.
- Because the seasons on Titan are changing, we can soon explore the lake-filled region at its north pole, and maybe spot seasonal phenomena we haven't seen before.
- This is crucial to getting a better understanding of what lies hidden beneath Titan's surface. ##

Rare Sight: Clouds Move across Titan's Ligeria Mare (Video, Photos)

<http://www.space.com/26814-saturn-moon-titan-clouds-cassini.html> – Aug. 13, 2014

http://www.spacedaily.com/reports/Cassini_Tracks_Clouds_Developing_Over_a_Titan_Sea_999.html

<http://www.jpl.nasa.gov/news/news.php?release=2014-274>



Cassini viewed renewed cloud activity in Titan's northern polar region. Image taken July 21, 2014.

Ligeria Mare is a big hydrocarbon sea near Titan's north pole. Does the clouds' appearance signal the beginning of summer weather patterns? or if it is an isolated occurrence?

How Titan's Haze Help Us Understand Life's Origins

http://www.spacedaily.com/reports/How_Titans_Haze_Help_Us_Understand_Lifes_Origins_999.html

Where did life on Earth come from? There are several theories.

- Maybe comets came bearing organic material, or life was transported from another planet such as Mars, or something happened in the chemistry of our planet that made life possible.
- Luckily for researchers, there is a possible laboratory in our solar system to help us better understand the "prebiotic" environment conditions on Earth before life arose.

- That location is Titan, the largest moon of Saturn. NASA's Voyager 1 and Voyager 2 spacecraft flew by Saturn in the 1980s, revealing a moon completely socked in with haze, totally different from Earth's airless, cratered Moon.

The 2004–current Cassini–Huygens mission to Saturn and Titan

- Cassini has done hundreds of flybys of Titan and peered at its surface by penetrating the clouds with radar.
- The European Space Agency's Huygens lander, piggybacking a ride on Cassini, also made a soft landing on the moon in 2005.

A big research question is the composition of Titan's haze.

- A new study is trying to recreate substances in the atmosphere called tholins, organic aerosols which are produced when radiation bakes the nitrogen and methane-rich atmosphere. In some cases, organics are considered precursors to life.
- "The study of organic chemistry on Titan's surface would extend our understanding of the diversity of prebiotic chemistry, and perhaps life's origin on Earth" said Dr. Chao He, a chemist at the University of Houston (now moved to Johns Hopkins University) who led the study. The results were published as "Solubility and stability investigation of Titan aerosol analogs: New insight from NMR analysis" in the journal *Icarus*.

Dissolving tholins

- The study of Titan's tholins help us understand the basic properties of organic materials on Titan. Questions include how they are structured, whether the aerosols can be dissolved in liquid in Titan's surface or atmosphere, and how stable the organics could be.
- Titan's tholins are thought to contain chemical precursors of life
- Studying the molecule's structure helps scientists better understand whether life's possible precursors have formed on Titan.
- If they have formed, the solubility study helps to hint where to find them on Titan, and the stability study suggests the most capable detection methods.

Experiments

- Tholins are created by making a mix of 5% methane and 95% nitrogen in a reaction chamber at room temperature. The mixture is exposed to an electrical discharge for 72 hours, which then created a muddy substance – the tholin – on the walls of the vessel.
- The substances so produced had a similar optical appearance to what Cassini observed in Titan's atmosphere.
- Researchers then investigated how well the tholins would dissolve in several solvents including polar solvents (methanol, water, dimethyl sulfoxide and acetonitrile) and non-polar solvents (pentane, benzene and cyclohexane).
- Polar solvents have different electrical charges between atoms (such as +charged oxygen and –charged hydrogen, in water) while non-polar solvents have similar electrical charges between atoms. Generally, polar solvents dissolve polar compounds best and non-polar solvents dissolve non-polar compounds best.
- The tholins preferentially dissolve in polar solvents, suggesting little or none of the substance would be dissolved in the lakes or oceans on Titan, which consist of non-polar ethane/methane. Thus, the tholins should be on the surface of the land or at the bottom of the lakes and oceans.
- **Picking future landing sites**
The Huygens probe only survived on the surface of Titan for a few hours, but there are proposals to do extended missions. One proposal is to send a submarine to explore Titan's lakes. Such a mission would be decades away to launch, if funding were approved.
- Titan's surface sees an average surface temperature of $-179\text{ }^{\circ}\text{C}$ ($-290\text{ }^{\circ}\text{F}$). Heating tholins to look at their structure, might have to be avoided.
- Liquid chromatography–mass spectrometry (LC–MS) and nuclear magnetic resonance spectroscopy (NMR) can both provide detailed structural information of organic mixtures nondestructively.
- **Greater search for life's origins**
Several nitrogenated organic molecules in Titan tholins, some of which are very important to the prebiotic chemistry and the origin of life.

- Understanding what is happening on Titan, may shed light on the rest of the Solar System.
- This research focuses on the astrobiology on potential environments and helps to understand the basic properties of organics on Titan.
- It also provides the basis for the development of in situ analysis of methods and instruments for a Titan mission and other outer planet exploration.
- in 2007 scientists discovered that the tholins form at much higher altitudes than previously believed, at greater than 1,000 km (621 mi) as opposed to a few hundred k above the surface
- The results also revealed an unexpected high number of negative ions in Titan's clouds, as well as detecting benzene, an element that is required to put together tholins.
- Negative ions may play an unexpected role in making tholins from carbon-nitrogen precursors.
- A more recent finding Titan's atmosphere is likely older than that of Saturn. This suggests that the moon did not arise from the ringed gas giant, but instead was created separately in the gas and dust floating around the young Solar System while the Sun and planets were being formed. ##

Weird 'Island' on Titan Puzzles Scientists

Sept 30, 2014 - <http://www.space.com/27293-saturn-moon-titan-sea-mystery.html>

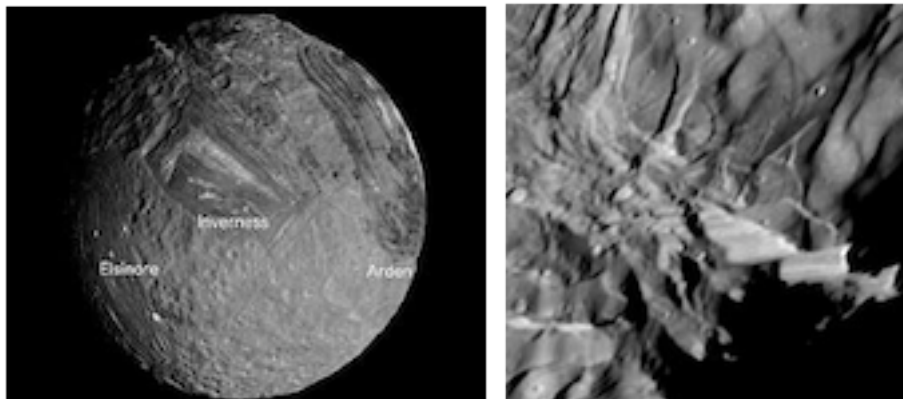
NASA's Cassini spacecraft has spotted an odd islandlike feature in Ligeia Mare, one of Titan's largest hydrocarbon seas. Scientists don't know what to make of the feature, which has apparently doubled in size over the past year or so, from about 78-155 square kilometers (30-60 square miles) .

- This enigmatic feature is an exciting example of ongoing change on Titan. Cassini scientists hope they will be able to continue watching the changes unfold and gain insights on in that strange sea.
- Cassini first detected this "island" with its radar gear in July 2013, then saw it again in August of this year. Observers are confident that the feature is real rather than an artifact of data.
- The Ligeia Mare "island" is apparently not the result of evaporation, since the sea's larger shoreline is relatively constant in the two observations.
- So what is it? Waves, bubbles or something solid floating on the surface or suspended just below?
- The feature's appearance and evolution may be tied to the ongoing arrival of summer to Titan's northern hemisphere, researchers said. (Ligeia Mare lies near Titan's north pole.)
- The existence of Titan's seas has led some scientists to speculate that life may be able to survive on Titan's surface. If so, it would be very different than life on Earth, intimately tied to liquid water. ##

URANUS & ITS MOONS

Miranda: An Icy Moon Deformed by Tidal Heating

http://www.spacedaily.com/reports/Miranda_An_Icy_Moon_Deformed_by_Tidal_Heating_999.html



Sept 22, 2014

Left: Miranda: Mosaic of southern hemisphere of Miranda, the innermost regular satellite of Uranus, with radius of 236 km. Projection centered on the south pole. L>R Elsinore, Inverness, Arden coronae.

Right: Close-up view of [Verona Rupes](#), a large fault scarp on Miranda, possibly 5 km (3.1 mi) high
Miranda stats and more: [http://en.wikipedia.org/wiki/Miranda_\(moon\)](http://en.wikipedia.org/wiki/Miranda_(moon))

Sep 22, 2014 – Texas-sized Miranda, a small, icy moon of Uranus, is one of the most visually striking and enigmatic bodies in the solar system. Despite its relatively small size, Miranda appears to have experienced an episode of intense resurfacing that resulted in the formation of at least three remarkable and unique surface features – polygonal-shaped regions called coronae, all in the southern hemisphere.

- Each corona is at least 200 km (125 mi) across. Arden corona, the largest, has ridges and troughs with up to 2 km (1.25 mi ~ 6,500 ft) of relief. Elsinore corona has an outer belt that c. 80 km (50 mi) wide, relatively smooth, and elevated above the surrounding terrain by approx. 100 m (300 ft). Inverness corona has a trapezoidal shape with a large, bright chevron at its center.
- The northern hemisphere of Miranda was never imaged by the Voyager 2 spacecraft, so it is unknown whether additional coronae exist.
- Numerical models suggest that convection in Miranda's ice mantle likely formed the coronae.
- During convection, warm buoyant ice rose toward the surface, driving concentric surface extension beneath the locations of the coronae, causing the formation of extensional tectonic faults.
- This style of convection-driven resurfacing is similar to plate tectonics on Earth.
- The internal energy that powered convection probably came from tidal heating as Miranda moves closer to and further from Uranus in its eccentric orbit, causing the tidal forces from Uranus to vary, periodically stretching and squeezing Miranda and generating heat in its ice shell. ##

NEPTUNE & ITS MOONS

PLUTO & BEYOND

Pluto-bound New Horizons Update

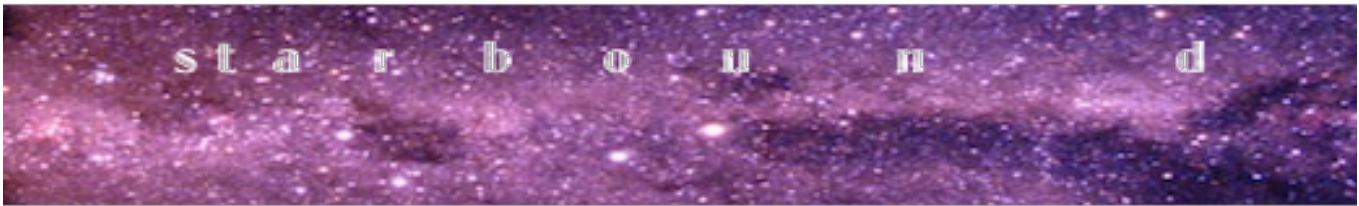
http://www.nasa.gov/mission_pages/newhorizons/main/

08.25.14 – NASA's New Horizons spacecraft has traversed the orbit of Neptune. This is its last major crossing en route to becoming the first probe to make a close encounter with distant Pluto on July 14, 2015.

- New Horizons seeks to understand where Pluto and its moons “fit in” with the other objects in the solar system, such as the inner rocky planets (Earth, Mars, Venus and Mercury) and the outer gas giants (Jupiter, Saturn, Uranus and Neptune).
- Pluto and its largest moon, Charon, belong to a third category known as “ice dwarfs.” They have solid surfaces but, unlike the terrestrial planets, a significant portion of their mass is icy material
- Pluto closest approach is scheduled for July 14, 2015. As part of an extended mission, the spacecraft is expected to head farther into the Kuiper Belt to examine one or two of the ancient, icy mini-worlds in that vast region, at least a billion miles beyond Neptune's orbit.

Science Payload

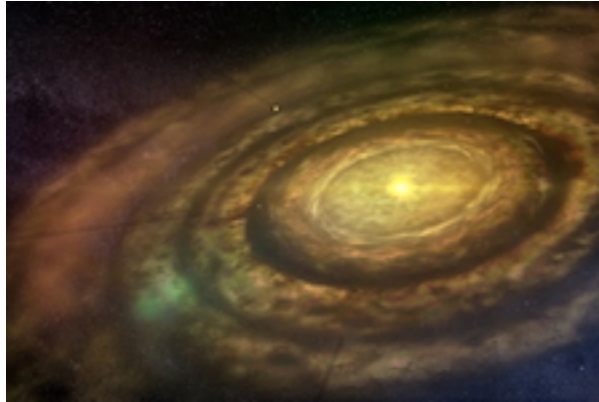
- **Ralph:** Visible and infrared imager/spectrometer; provides color, composition and thermal maps.
- **Alice:** Ultraviolet imaging spectrometer; analyzes composition and structure of Pluto's atmosphere and looks for atmospheres around Charon and Kuiper Belt Objects (KBOs).
- **REX (Radio Science EXperiment):** Measures atmospheric composition and temperature; passive radiometer.
- **LORRI (LOng Range Reconnaissance Imager):** Telescopic camera; obtains encounter data at long distances, maps Pluto's far side and provides high resolution geologic data.
- **SWAP (Solar Wind Around Pluto):** Solar wind and plasma spectrometer; measures atmospheric “escape rate” and observes Pluto's interaction with solar wind.
- **PEPSSI (Pluto Energetic Particle Spectrometer Science Investigation):** Energetic particle spectrometer; measures the composition and density of plasma (ions) escaping from Pluto's atmosphere.
- **VBSDC (Venetia Burney Student Dust Counter):** Built and operated by students at U. Colorado; it measures the space dust peppering New Horizons during its voyage across the solar system. ##



OUR CLOSEST STAR: THE SUN

Solar System Evolution: Peering Back at the Sun's Cosmic Womb

August 7, 2014 - <http://www.space.com/26762-solar-system-evolution-sun-formation.html>



This illustration depicts a protoplanetary disc around a newborn star.

- The solar system coalesced from a huge cloud of dust and gas that was isolated from the rest of the Milky Way for up to 30 million years before the sun's birth nearly 4.6 billion years ago, a new study published online in the journal *Science* suggests.
- This cloud spawned perhaps tens of thousands of other sister stars as well,
- We expect that planetary systems can survive very well early interactions with many stellar siblings
- Becoming more intimate with the stellar nursery where the sun was born can help us [set] the sun within the context of the other billions of stars that are born in our galaxy, and the solar system within the context of the larger a solar planetary systems family of extrasolar planetary systems currently being discovered,
- Because radioactive materials decay from one isotope to another at precise rates, this information allows researchers to determine when the cloud that formed the solar system segregated out from the greater galaxy and when it ceased absorbing newly produced material from the interstellar medium.
- The team's calculations suggest that the solar system's raw materials were isolated for a long time before the sun formed — perhaps as long as 30 million years
- With the anticipated discovery of "Earthlike" planets in habitable zones, the development of a unified model for the formation and evolution of our solar system is timely,

Dating The Solar System

August 11, 2014 - <http://www.asianscientist.com/in-the-lab/dating-solar-system-2014/>

- By measuring a abundance of ^{182}Hf , (hafnium) researchers have dated to formation of heavy radioactive isotopes to 30 million years before the Sun was born.
- We can now tell with confidence the final one percent of gold, silver and platinum, were added to the solar system matter roughly 100 million years before the birth of the sun.
- Understanding the timescales and processes leading to the formation of our solar system is key to relate its birth environment with that of other planetary systems in the galaxy.

We Live Within A Supernova Remnant – New Evidence | Video

<http://www.space.com/26941-we-live-within-a-supernova-remnant-new-evidence-video.html>

<http://www.space.com/26943-sony-playstations-calculate-black-hole-motion.html> ??????

DATE 2014 – Data from instruments aboard a NASA sounding rocket corroborates the claim that about 10 million years ago a cluster of supernova explosions blew a bubble in the interstellar medium. Today Earth resides in that bubble.

Tiny 'Nanoflares' May Solve Sun Mystery

August 14, 2014 – <http://www.space.com/26806-nanoflares-solar-flares-sun-mystery.html>

Small "nanoflares" erupting from the Sun might be the key to unlocking a cosmic mystery. The Sun's outer atmosphere, or corona, can reach temperatures 1,000 times higher than at the surface of the star, but physicists previously had no explanation for why this temperature discrepancy is so great

- Relatively tiny flares may be the "smoking gun" that explains this mysterious cosmic occurrence.
- The new study provides the first direct proof that nanoflares keep the Sun's corona at a temperature of millions of degrees, far hotter than its visible surface, which is about 6,000 °K (10,000 °F)



Smaller solar flares, "nanoflares," are responsible for extreme heating of the sun's outer atmosphere

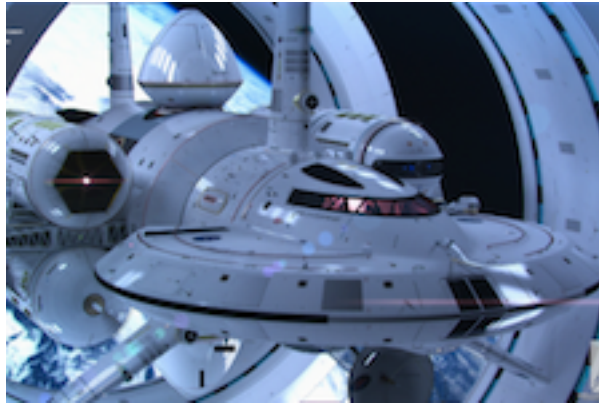
- "The nanoflare model" has been around for a while. With better instrumentation, we hoped to find the evidence that was predicted by the model.
- Nanoflares happen because of jugs magnetic fields located throughout the Sun's corona. These loops are anchored in the photosphere, the Sun's visible surface
- They move around due to turbulence in the photosphere. Sometimes the field lines cross, and they become twisted and tangled.
- When this happens in the presence of plasma, current sheets form, and the "stress" builds until the magnetic field "breaks," releasing lots of energy very quickly. This kind of crossing of magnetic fields can happen thousands of times a second over the whole solar surface, and this transfers energy to the plasma in the corona. That energy transfer could explain the corona's extra heat.
- Earlier evidence for this was indirect. The model based on nanoflares was still missing a piece of the puzzle which came from the **Extreme Ultraviolet Normal Incidence Spectrograph** mission, which picked up light emitted by a special kind of highly ionized iron, called Fe XIX. The temperature of the plasma is about 8.9 million degrees Kelvin, or about 16 million degrees Fahrenheit.)
- The EUNIS instruments also spotted another form of ionized iron, Fe XII, that occurs at a temperature of 1.6 million °K, or about 2.9 million °F.
- The ratio of the two ions showed that the corona is heated by short bursts, rather than a continuous input of energy, because that ratio -- the brightness of Fe XIX relative to its cousin Fe XII -- would only occur under certain physical conditions.
- One of the predictions of the nanoflare model is there should be fairly widespread but faint emission of plasma at about 10 million °K [18 million °F],
- One reason for this doubt is that the emission from the ionized iron was so hard to see because it was faint. Another is that the corona is "optically thin," meaning that at some wavelengths, it's basically translucent, like stained glass. So the nanoflares, many occurring simultaneously and overlapping, tend to "wash out." ##

Proton Fusion, the Sun's Power Source, Explained (Infographic)

August 27, 2014 – www.space.com/26956-proton-fusion-sun-power-source-infographic.html

An idea about how to create a “Warp Drive” – Video

<http://sciencealert.com.au/news/20141106-25657-2.html>



The design involves “a sleek ship nestled at the center of two enormous rings, which create the warp bubble”

Dr. Harold “Sonny” White is working on the warp drive program at NASA’s Johnson Space Center. He has spent his career working on ways to propel spacecrafts to faster than the speed of light, and this model would do so by bending the space around it, making the distance shorter. This future “Enterprise” wouldn’t break Einstein’s theory of relativity, as within its little bubble it wouldn’t be moving faster than light.”

More images of the concept:

<https://www.flickr.com/photos/123021064@N05/sets/72157644113972600/>

Nb. The Editor remains extremely skeptical, believing that the concept involves essential contradictions.

If it worked, on the return trip, you could conceivably arrive “home” years before you had left, perhaps before you were born and could possibly set into play conditions that would prevent you from being born. It makes for great stories: no argument there. PK

STARBOUND TELESCOPES

Cosmic Crumbs Reveal Umbrella Galaxy's Eating Habits

July 1, 2014 – <http://www.space.com/26412-umbrella-galaxy-cosmic-cannibal.html>



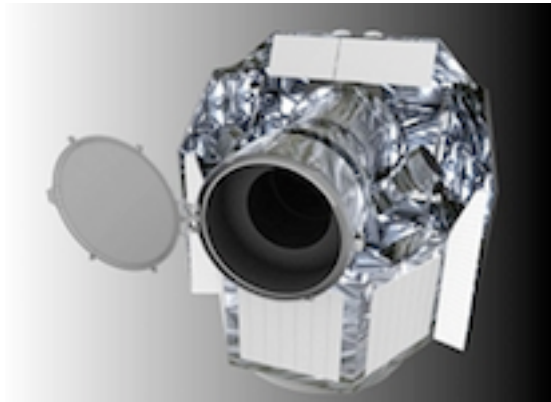
The Umbrella Galaxy was named after the wispy feature seen on the left that looks like a cosmic parasol. This “umbrella” is actually debris from a small galaxy that has been shredded apart by gravity. This image combines data from the 0.5-m BlackBird Remote Observatory Telescope and Suprime-Cam on the 8-m Subaru Telescope in Hawaii.

- When scientists discovered this umbrella in the 1950s, they interpreted it as a dwarf galaxy companion to the bigger galaxy.
- Recent research has suggested this parasol might be made up of crumbs from a leftover meal.
- Our own Milky Way has fattened up by acquiring stars from other, smaller galaxies, e.g. streams of star crumbs from the nearby Sagittarius dwarf galaxy, which is being engulfed by the Milky Way.
- A 2010 study looked at eight spiral galaxies, including the Umbrella Galaxy, and found that six of them had **signs of mergers: shells, clouds and arcs of tidal debris**.
- Australian researchers found that the Umbrella Galaxy's distinctive arc is made up of the crumbs from a single dinner, not a series of meals. They measured the movements of the stars in the very distant, very faint, stellar stream in the Umbrella, allowing them to reconstruct the history of the system. ##

CHEOPS exoplanet mission meets key milestones en route to 2017 launch

<http://sci.esa.int/cheops/54321-cheops-exoplanet-mission-meets-key-milestones-en-route-to-2017-launch/>

July 11 2014 – Cheops, ESA's first small Science Programme mission is ready for construction, going from selection to implementation in less than 18 months.



- **CH**aracterising **EX**oplanet **S**atellite (**CHEOPS**) should launch in December 2017 and target **nearby bright stars already known to have exoplanets**, to provide new insight into their characteristics.
- Ground-based Doppler searches find planets by detecting wobbles in the central star. CHEOPS will provide complementary data by monitoring parent stars for transits by the dip in starlight caused by a planet's silhouette as it crosses the line of sight.
- This information will indicate the radius of the planet.
- With the mass known from ground-based Doppler searches, these data will provide an estimate of the planet's density, distinguishing rocky planets from gas giants
- **CHEOPS will be sensitive to planets ranging from a few times the size of the Earth up to the size of Neptune.**
- CHEOPS was selected in 2012 for the small mission programme. capped at €50 million
- The Swiss Space Office (SSO) and the University of Bern, Switzerland lead the consortium of 11 ESA member states contributing to the mission
- The craft will be built by Airbus Defence and Space, Spain.
- All platform components and systems must be 'off-the-shelf' and space-qualified.
- The key scientific instrument must meet specific requirements of available technologies,.
- CHEOPS will be able to point nearly anywhere in the sky, searching for transits on bright stars known to host planets.
- CHEOPS will be **the most efficient instrument to detect shallow transits, significantly increasing the sample of exoplanets for which we know both mass and radius,**
- It will also **provide the best targets for subsequent spectroscopic studies by the next generation of ground- and space-based instruments.** ##

Sections of Protective Parasol that will keep JWST cool



ELSEWHERE IN OUR GALAXY

Most Distant Stars in the Milky Way Galaxy yet found

July 10, 214 – <http://www.space.com/26483-milky-way-most-distant-stars.html>

The boundaries of our home galaxy may have to be redrawn.

- Astronomers have discovered the two farthest-flung stars yet known to belong to the Milky Way. **ULAS J0744+25** and **ULAS J001+01**, are about 775,000 and 900,000 light-years from Earth, respectively, both c. 5 times more distant than its largest satellite galaxy, the Large Magellanic Cloud.
- They were found in a probe of the halo's outer reaches, hunting for cool red giants.
- The light from ULAS J0015+01 left the star about the time our ancestors were just starting to make fires .
- The Milky Way extends far beyond its familiar disk, just 100,000 light-years or so wide and includes a surrounding sparse "halo" of stars — perhaps stragglers after the Milky Way's many mergers with dwarf galaxies over the eons.
- This halo extends to at least 500,000 light-years out, but its exact dimensions are unknown.
- Cool red giants are much rarer than the red dwarfs that make up about 70 % of the Milky Way's stars.
- These red giants are about 10,000 times brighter, making them much easier to see from a distance.
- The two stars' extreme distance was confirmed by a variety of different estimation techniques. ULAS J0744+25 and ULAS J0015+01 are more than 50 percent farther from the sun than any other Milky Way star yet discovered, only a third the distance of the famed Andromeda galaxy.
- The new study could help astronomers test their models of the Milky Way's formation and evolution. These stars might be the brightest members of some leftover remnants of the Milky Way's formation.
- If we find significant numbers of stars in the outer halo, then "the models will need to be revised." ##

The Star that Exploded at the Dawn of Time

Aug 21, 2014 - <http://news.sciencemag.org/space/2014/08/star-exploded-dawn-time>

To probe the dawn of time, astronomers peer far away; but now they've made a notable discovery close to home. An ancient star a mere thousand light-years from Earth bears chemical elements that may have been forged by the death of a star that was both extremely massive and one of the first to arise after the big bang.

- If confirmed, the finding means that some of the universe's first stars were so massive they died in exceptionally violent explosions that altered the growth of early galaxies.
- Theorists have long suspected that the universe's very first stars were massive, because early gas clouds favored the formation of heavy stars.
- The big bang produced only hydrogen, helium, and a little lithium, and gas clouds containing only these elements can't cool.

- Cooling requires heavier elements that didn't exist back then. When clouds cool, they split into smaller parts and collapse, forming smaller stars.
- Because the primordial gas clouds stayed warm, more gravity was needed to overwhelm the gas pressure and make them collapse, so they spawned massive stars. Some of these brilliant stars, those born 140 to 300 times as massive as the sun, exploded in a way unseen in the Milky Way today.
- Astronomers at the National Astronomical Observatory of Japan have discovered a star bearing signs of just such an explosion, with a high abundance of elements with even atomic numbers compared with odd ones. .
- The team searched for 18 chemical elements in SDSS J0018-0939, a dim orange star in the constellation Cetus that emits less light than the Sun.
- The star belongs to the Milky Way's stellar halo, the ancient population that surrounds the galaxy's bright disk.
- Like other halo stars, it has little iron, because it arose before most of the stellar explosions that spewed the element into space.
- The star likely formed from a gas cloud enriched by a "pair-instability explosion," 10 to 100 times more violent than an ordinary supernova.
- Such a blast marks the death of a star so luminous that photons hold up its weight; but the star is so hot that the photons can convert themselves into pairs of electrons and antielectrons, which exert little outward pressure, causing the star to collapse, which heats the gas, promoting more nuclear reactions, which heat the gas further, inducing yet more nuclear reactions, until the whole thing blows up.
- During the explosion, helium nuclei bombard one another, creating elements as heavy as nickel.
- Because helium is atomic number 2, elements with even atomic numbers vastly outnumber odd-numbered ones, which is exactly the pattern that the Japanese team finds in the star in Cetus.\
- This discovery is very important. Pair-instability explosions were so powerful they altered the growth of galaxies shortly after the big bang. ##

Quasars – 20-Year Mystery of the Universe's Brightest Objects Solved

Sept 10, 2014 – <http://www.space.com/27102-bright-quasar-mystery-solved.html>
<http://www.space.com/17262-quasar-definition.html>



A quasar is depicted releasing massive amounts of energy as stars are shredded near the supermassive black hole of a galaxy

Quasars, the brightest objects in the universe, display a mysterious diversity in their appearance that has puzzled astronomers for more than two decades. Now this mystery can be solved by looking at two simple features of quasars

1. How quickly matter is getting fed into the quasars
2. The direction from which the quasars are seen.

Quasars are supermassive black holes up to billions of times the mass of the sun that live at the hearts of distant, massive galaxies. They release extraordinarily large amounts of light as they rip apart stars and gobble matter

Past studies have found that their physical properties follow definite, regular trends

- A quasar's size is linked with its mass
- Quasars can vary greatly in appearance in visible and ultraviolet light

Statistical analyses of data from more than 20,000 quasars captured by the Sloan Digital Sky Survey revealed that the appearance of quasars could mostly be explained by two basic factors.

1. The first factor is the so-called Eddington ratio — the luminosity of a quasar compared with its mass. This ratio predicts how quickly matter is falling into a quasar, and was long suspected to play a major role in why quasars often varied in appearance.
2. The other factor is the direction from which astronomers look at a quasar, which influences how much they can see of the clouds of gas closest to the black hole. This fast-moving gas produces a broad range of wavelengths of light, greatly affecting a quasar's appearance, and these findings suggest that these clouds are arranged in a flattened disk, explaining why the direction from which they are seen can matter so much.

These findings will help improve future measurements of black hole masses, which in turn will help scientists better understand. ##

How Do You Age a Star? Check Its 'Heartbeat' (Video)

July 3, 2014 – <http://www.space.com/26427-young-variable-stars-age-heartbeat.html>
<http://www.space.com/26428-stars-pulses-used-to-determine-age-animation.html>

- Watching the "heartbeat" of young stars could help precisely determine their ages and how they are born and develop.
- Stars form in massive clouds of gas, contracting and growing hotter until they fuse hydrogen in their cores.
- Because they form inside such clouds, it is hard to observe them until they get to a certain size and age, and blow the gas away from themselves.
- Now we have found a way to do this by observing variable stars that change their luminosity over time, either regularly or irregularly.
- The youngest stars, not yet fusing hydrogen, tend to pulse more slowly than those that just started hydrogen fusion.
- Why? We suspect that as the star gets smaller, its "heartbeat" speeds up.

Aging stars more accurately

The study team looked 34 well-characterized young stars that are considered "intermediate" in size, about 1.5 to 4 times the mass of the Sun. All have surface temperatures that average 6,725 to 7,725 °C (12,140 to 13,940 °F). Their periods of variability range between 15 minutes to five hours.

Stars that are variable have something within that makes their energy pulse outward and then bound in again. Now a correlation between the stars' age and variability has been found. ##

SEARCH FOR EXO-PLANETS & LIFE

Odd Exoplanet hints at many "Earth-like" Worlds* Amateur astronomers made the breakthrough discovery

July 3, 2014 – <http://www.space.com/26436-rocky-exoplanet-single-star-binary-system.html>
 {Editor: *We object to the loose use of the term "Earth-like planet" for anything other than a "hydrotectonic" world with continents and oceans}

Astronomers have for the first time detected a rocky world in an Earth-like orbit around just one star in a two-star system. This suggests that such worlds may be common, and the strategy used to discover the planet could help reveal more such exoplanets.

- Earth orbits a single star, but most sun-like stars are binaries, such as Alpha Centauri. There are also many three-star systems, even some with as many as seven stars.
- Worlds that orbit around twin suns, as does Luke Skywalker's fictional home world "Tatooine" in "Star Wars," are **circumbinary** planets. The first such planet ever discovered is Kepler-16b, a gas giant found orbiting the star Kepler-16, 200-some light-years distant.



- When the two stars are far enough apart, some planets can orbit each singly, circling one star but not the other.
- Planets further out might orbit both stars
- “Circumprimary” planets orbit the brighter or more massive of the pair,
- “Circumsecondary” planets the less bright.
- We have discovered circumprimary and circumsecondary planets before; Alpha Centauri Bb is a rocky planet orbiting Alpha Centauri B, the dimmer of the Alpha Centauri AB binary.
- Scientists have now detected a rocky planet circling the smaller, dimmer member of a binary system, at the same distance from its star as Earth is from the Sun.
- OGLE-2013-BLG-0341LBb has about twice the mass of Earth and lies about 3,000 light-years away.
- Both stars are red dwarfs (like Proxima Centauri), much colder, dimmer, and less massive than the Sun and about as far from each other as Saturn is from the Sun.)
- The host star has about 11–14% of the Sun's mass, while its brighter companion about 12–17%.
- OGLE-2013-BLG-0341LBb is closer to its star than Earth is to the sun, but as it is much colder since its host star shines with less than one percent of our sun's brilliance. This exoplanet does not lie within its star's habitable zone, warm enough for a world to have liquid water on its surface.
- This planet has a surface temperature about -213°C (-350°F), — a little colder than Jupiter's Europa.

Why this discovery is interesting

- **Roughly half the stars in the galaxy are in binary systems, and until now, we had no idea if Earth-like planets in Earth-like orbits could form in these systems.**
- Stars with planets are the rule, not the exception, as conservative thinkers had believed.
- Earth is still very special, but there may be far more Earth-like worlds than we had once dared believe.

How we found this planet

Scientists detected OGLE-2013-BLG-0341LBb by noticing a one-day dimming of light in data collected by the OGLE telescope in 2013. Strong gravitational fields can distort light in noticeable ways, a phenomenon known as gravitational microlensing. The exoplanet briefly dimmed light from a distant star 20,000 light-years away in the constellation Sagittarius. Without microlensing, this small planet might never have been detected.

Yes, amateur astronomers can make breakthroughs!

Amateur astronomers of Palmerston North, New Zealand made the first few critical measurements of the brightening in the light signal that revealed the exoplanet was in a binary system.

We salute them! ##

Newfound Frozen World Orbits in Binary Star System

www.spacedaily.com/reports/Newfound_Frozen_World_Orbits_in_Binary_Star_System_999.html

July 11, 2014 A newly discovered planet in a binary star system located 3,000 light-years from Earth is expanding astronomers' notions of where Earth-like—and even potentially habitable—planets can form, and how to find them.

- At twice the mass of Earth, the planet orbits one of the stars in the binary system at almost exactly the same distance from which Earth orbits the sun.
- Because the planet's host star is much dimmer than the sun, the planet is much colder than Jupiter's Europa.

The study by four international research teams provides **the first evidence that terrestrial planets can form in orbits similar to Earth's, even in a binary star system where the stars are not very far apart.** Although this planet itself is too cold to be habitable, the same planet orbiting a sun-like star in such a binary system would be in the so-called "habitable zone" – the region where conditions might be right for life.

This find greatly expands the potential locations to look for habitable planets as half of all stars in the galaxy are in binary systems. Until this find, we had no idea if Earth-like planets in Earth-like orbits could even form in these systems.

- The technique used to find such planets is called "**gravitational microlensing**". Very rarely, the gravity of a star focuses the light from a more distant star and magnifies it like a lens. Even more rarely, the signature of a planet appears within that magnified light signal. Computer modeling of these events is complicated enough when only one star and its planet are acting as the lens, much less two.
- Searching for planets within binary systems is tricky as light from the second star complicates interpretation of the data.
- In gravitational micro-lensing, we just observe how its gravity affects light from a more distant, unrelated, star.
- A second effect was an overall distortion of the light signal. Even without seeing the initial signature of the planet, it could still be detected from the distortion alone. But the effect is not visible to the eye, the signal is unmistakable in the computer modeling.
- With gravitational microlensing, it's actually possible to infer the existence of a planet, and to know its mass and distance from a star—without directly detecting the dimming of the host star due to the passing of the planet in front of it.

How it was found

The planet, OGLE-2013-BLG-0341Lb, first appeared as a "dip" in the line tracing the brightness data taken by the OGLE (Optical Gravitational Lensing Experiment) telescope on April 11, 2013. The planet briefly disrupted one of the images formed by the star it orbits as the system crossed in front of a much more distant star 20,000 light-years away in the constellation Sagittarius.

Not an "Earthlike" planet

The planet is twice the mass of Earth, and orbits its star from an Earth-like distance, around 90 million miles. But its star is 400 times dimmer than our sun, so the planet is very cold—around 60 Kelvin (–352 °F or –213 °C), a little colder than Europa. The second star in the star system is only as far from the first star as Saturn is from our sun. But this binary companion, too, is very dim.

- **Binary star systems composed of dim stars like these are the most common type of star system in our galaxy. So this discovery suggests that there may be many more terrestrial planets out there – some possibly warmer, and possibly harboring life.**

Three other planets have been discovered in binary systems that have similar separations, but using a different technique. This is the first one close to Earth-like size that follows an Earth-like orbit, and its discovery within a binary system by gravitational microlensing was by chance.

"Normally, once we see that we have a binary, we stop observing. In the future we'll change our strategy," say the investigators. ##

How to Search for E.T. by Scanning Alien Skies

Sept. 4, 2014 – <http://www.space.com/26729-alien-life-hunt-exoplanet-atmospheres.html>

- In the future, astronomers could detect hints of alien life by scanning the atmospheres of distant worlds with advanced space telescopes
- In the past two decades, astronomers have confirmed the existence of more than 1,700 worlds outside our solar system, many of which lie in the habitable zones of stars, warm enough for worlds to harbor liquid water of their surfaces.
- Since there is life pretty much everywhere water exists on Earth, we expect one day to detect life as we know it on such planets,.
- Statistically, every star in our Milky Way galaxy should have at least one planet
- Small rocky planets are extremely common [at least among 2nd generation systems formed from dusty gas clouds, not just from the primeval gas only clouds – Editor]

- Our own galaxy has 100 billion stars, and our universe has upwards of 100 billion galaxies, making the chance for life elsewhere seem inevitable based on sheer probability.

Searching for “biosignature gasses”

- One strategy to hunt for signs of life elsewhere involves looking for ways that organisms might alter a world's appearance. Key chemicals might change the spectrum of light from the atmospheres of those planets — **chemicals or combinations of chemicals that life could produce, but that processes other than life could not or would be unlikely to create.**
- So far, we have studied more than three dozen exoplanet atmospheres, yielding enough data for researchers to glimpse both the future prospects and limitations of the atmosphere-based method of searching for alien life.
- One challenge is that exoplanet atmospheres continue to surprise researchers. Scientists have detected hazes and clouds on planets once thought too hot for such features to form.
- In 2018 and after, the James Webb Space Telescope (JWST) will study the atmospheres of dozens of super-Earths, exoplanets slightly larger than Earth.
- However, JWST will rely upon planetary “transits” to do such work, only scanning the atmospheres of planets that pass in front of their stars from the observatory's perspective and are thus backlit by starlight. Ideally, researchers would like to scan exoplanet atmospheres by directly taking photos of the planets without having to wait for transits.
- The problem with such direct imaging of exoplanets is that any nearby Earthlike exoplanets would be about as faint as the faintest galaxies ever observed by the Hubble Space Telescope. These exoplanets are next to parent stars up to 10 billion times brighter than the planets themselves.
- “The challenge of direct imaging of an Earth analog is similar to the search for a firefly in the glare of a searchlight when the firefly and searchlight are 2,500 miles distant.”

Two different strategies for “direct imaging:”

- One involves so-called **internal coronagraphs**, or systems within telescopes that can block out the light of stars to reveal the presence of any orbiting exoplanets. This requires mirrors that can focus starlight without scattering it; these reflectors must be smoothed to levels of less than a nanometer, or a billionth of a meter. (In comparison, the average human hair is about 100,000 nanometers wide.) Laboratory experiments have already demonstrated such a level of control.
- Another strategy to directly image Earth twins involves a giant sunflowerlike **starshade** external to the telescope, a system designed to hide the light of stars to reveal the presence of any orbiting planets.
- Most designs involve a starshade dozens of feet/meters wide flying tens of thousands of miles/kilometers in front of a telescope, carefully positioned to blot out the light of just one star at a time. Current lab experiments have created scaled-down versions of such devices that need to cast shadows about 10 times darker before they can find use in starshades.
- In the future, researchers could build very large space telescopes with apertures more than 33 feet (10 meters) wide capable of finding more than 100 potentially habitable exoplanets. The telescopes could then analyze those planets' atmospheres for biosignature gases.

“It will still be a while before we have the capability to study small exoplanet atmospheres for biosignature gases.” ##

First evidence for water ice clouds found outside solar system

www.spacedaily.com/reports/First_evidence_for_water_ice_clouds_found_outside_solar_system_999.html

<http://www.space.com/27100-water-ice-clouds-beyond-solar-system.html>

<http://www.asianscientist.com/2014/09/in-the-lab/signs-water-solar-system/>

Sept 10, 2014 – A team led by Carnegie's Jacqueline Faherty has discovered the first evidence of water ice clouds on an object outside our Solar System. Water ice clouds exist on our own gas giant planets—Jupiter, Saturn, Uranus, and Neptune—but have not been seen on planets orbiting other suns until now.

- Brown dwarfs, too small to sustain the hydrogen fusion process that fuels stars aren't quite very small stars, but they aren't quite giant planets either. Their temperatures can range from nearly as hot as a star to as cool as a planet, and their masses also range between star-like and giant planet-like.
- They offer clues to star-formation processes as they overlap with the temperatures of planets

- They are much easier to study since they are commonly found in isolation.



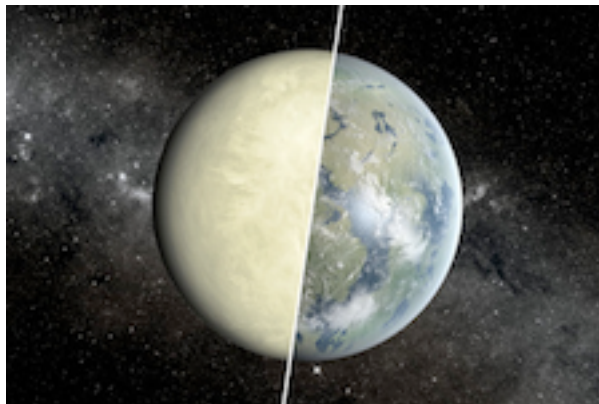
The FourStar near infrared camera at the Las Campanas Observatory in Chile was used to detect the coldest brown dwarf, named WISE J085510.83-071442.5, or W0855 ever characterized. The findings are the result of 151 images taken over three nights and combined.

- Brown dwarfs, too small to sustain the hydrogen fusion process that fuels stars aren't quite very small stars, but they aren't quite giant planets either. Their temperatures can range from nearly as hot as a star to as cool as a planet, and their masses also range between star-like and giant planet-like.
- They offer clues to star-formation processes as they overlap with the temperatures of planets
- They are much easier to study since they are commonly found in isolation.
- W0855 is the fourth-closest system to our own Sun
- A comparison of the team's near-infrared images of W0855 with models for predicting the atmospheric content of brown dwarfs showed evidence of frozen clouds of sulfide and water.
- Ice clouds are predicted to be very important in the atmospheres of planets beyond our Solar System, but they've never been observed outside of it before now, ##

'Venus Zone' Could Aid Search for Earth-Like Alien Worlds

Sept. 11, 2014 - <http://www.space.com/27106-exoplanet-venus-zone-habitable-planet.html>

Exoplanet hunters have just made it easier to identify alien Venuses, in the hopes that doing so will lead to the discovery of more alien Earths. A team of researchers has delineated the "**Venus Zone**," **the range of distances from a host star where planets are likely to resemble Earth's similarly sized sister world, which has been rendered unlivably hot due to a runaway greenhouse effect.**



Despite being about the same size, Earth (represented by the right half of this image) and Venus (the left half), have vastly different temperatures and other surface conditions.

- The new study should help us get a better handle on how many of the rocky planets spotted by the Kepler space telescope are truly Earth-like,
- Earth and Venus likely had similar starts in terms of their atmospheric evolution, but something changed at one point, and the obvious difference between the two is proximity to the Sun.

- The definition of the Venus Zone is based on solar flux — the amount of stellar energy that orbiting planets receive. The outer edge of the zone is the point at which a runaway greenhouse effect would take hold, with a planet's temperature soaring thanks to heat-trapping gases in its atmosphere. The inner boundary, meanwhile, is the distance at which stellar radiation would completely strip away a planet's air (as is the case of Mercury, whose gravity is the same as Mars'.
- The dimensions of these astronomical zones vary from star to star, as some stars are hotter than others.
- In our own solar [system](#), the Venus Zone's outer boundary lies just inside the orbit of Earth.
- NASA's James Webb Space Telescope, scheduled to launch in 2018 — will be able to analyze some exoplanets' atmospheres, helping scientists refine the Venus Zone concept, researchers said.
- This is ultimately about putting our solar system in context ##

Name an Alien Planet: Voters Wanted to Christen Strange New Worlds

July 09, 2014 - <http://www.space.com/26478-alien-planet-names-iau-vote.html>

Do you want to help name an alien planet? Starting next year, space fans around the world will get the chance to vote on their favorite names for worlds beyond our solar system.

In an unprecedented change from procedure, the **International Astronomical Union (IAU) in charge of naming heavenly bodies will open its [exoplanet](#) naming process to the world in 2015 in the form of a public vote.**

The new naming project is called “**NameExoWorlds**,” .

305 worlds discovered before Dec. 31, 2008 are a starting point for the exoplanet name vote.

These exoplanets belong to 260 exoplanet systems with 1–5 members, beside the host star. These systems and their host star together are here referred to as ExoWorlds. The list is published on the [NameExoWorlds.org website](#)."

- In September, registration will open to astronomy clubs and nonprofits that wish to name the alien worlds,
- In October; Members of the clubs and other groups will vote for the top 20 to 30 exoplanetary systems they want to name
- In December, the groups will submit their proposals for names.
- in March 2015 ,The IAU will oversee the proposals and then open the competition to the public, when it will ask space fans to rank the proposed names for the alien planets and stars.

After votes are cast, the IAU will oversee and validate winning names in July 2015. IAU officials plan to announce the results in August 2015.

Ground rules for organizations that plan to submit names for the competition before the public vote:

- Names should be 16 characters or less, preferably one word, non-offensive, pronounceable and not too similar to names already assigned to other celestial bodies
- Not allowed: names of pet animals, commercial names, or names of living people. Additionally, groups cannot propose names of individuals, events or places mainly known for political, military or religious activities.
- Names cannot be protected by trademark or protected by intellectual property law.
- Winning names won't replace the scientific designation (the scientific name of the star followed by a letter, for example: Kepler-22b). However, the IAU will recognize the name as a legitimate, publicly used name.

Scientists have discovered more than 1,700 exoplanets. The first in 1992.

The IAU is partnering with **Zooniverse**, an organization focused on citizen science, to make the NameExoWorlds contest a reality. To learn more about exoplanet naming and the IAU, visit:

http://www.iau.org/public/themes/naming_exoplanets/ ##

Is Voyager 1 Really in Interstellar Space? New Test Could Prove It for Good

July 23, 2014 - <http://www.space.com/26628-voyager-1-interstellar-space-controversy.html>

- Is it inside or outside the heliosphere — the bubble of solar particles and magnetic fields that the sun puffs around itself
- Voyager 1 will cross the current sheet — a huge surface within the heliosphere — at some point within the next one to two years
- a reversal in the magnetic field surrounding the probe, proving that it is still within the heliosphere
- If this change doesn't occur in the next two years or so, then Voyager is almost certainly already in interstellar space. ##

Hubble Finds Three Surprisingly Dry Exoplanets

<http://www.nasa.gov/press/2014/july/hubble-finds-three-surprisingly-dry-exoplanets/>

July 24, 2014 RELEASE 14-197

- Looking for water vapor in the atmospheres of three planets orbiting stars similar to the sun -- coming up nearly dry, and found to have only one-tenth to one one-thousandth the amount of water predicted by standard planet-formation theories.
- The water measurement in one of the planets, HD 209458b, is the highest-precision measurement of any chemical compound in a planet outside our solar system, and we can now say with much greater certainty than ever before that we've found water in an exoplanet
- This finding presents a major challenge to exoplanet theory. We expected all these planets to have lots of water in them. We have to revisit planet formation and migration models of giant planets, especially "hot Jupiters," and investigate how they're formed."
- Instruments on future space telescopes may need to be designed with a higher sensitivity if target planets are drier than predicted.
- Detecting water is almost impossible for transiting planets from the ground because Earth's atmosphere has a lot of water in it, which contaminates the observation.
- Theory predicts that the proportions of the different elements in the planet are enhanced relative to those in its star, especially oxygen, which is supposed to be the most enhanced. Once the giant planet forms, its atmospheric oxygen is expected to be largely encompassed within water molecules. The very low levels of water vapor found by this research raise a number of questions about the chemical ingredients that lead to planet formation. ##

On Cloudy Alien Planets, a Chance for Life

July 24, 2014 - <http://www.space.com/26636-cloudy-alien-planets-life.html>

- Clouds could keep a planet cooler, and may indicate water
- The cloudier an alien planet is, the closer it can get to its star and still remain potentially life-friendly, researchers say.
- In fact, clouds might help Earth-like planets remain hospitable to life even when orbiting a sun-like star as closely as the hellish Venus circles the sun in our solar system, the scientists added.
[Editor: that heavily clouded Venus traps heat in would seem to resoundingly refute this statement. ##]
- This finding suggests that many alien worlds previously thought to be too hot for life as we know it may actually be habitable

Alien Planet's Size Measured Like Never Before

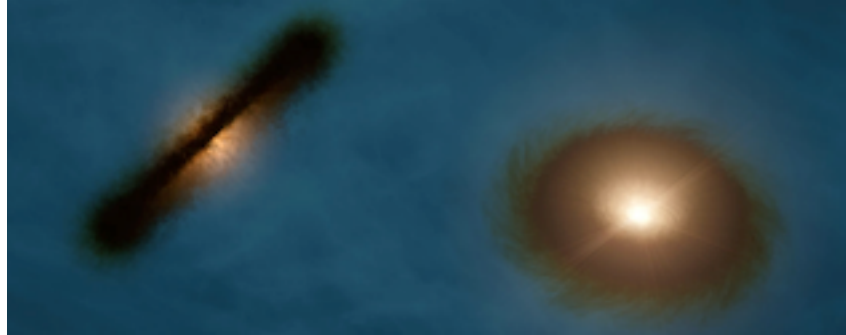
July 25, 2014 - www.space.com/26639-alien-planet-size-best-measurement-kepler93b.html

- Combining measurements of Kepler and Spitzer space telescopes, we've captured the most precise measurement to date of an alien planet's size, which is critical for understanding these far-off worlds. "Like being able to measure the height of a six-foot-tall person to within three-quarters of an inch" — if that person were standing on Jupiter.
- Kepler studied the stellar dimming caused by seismic waves within the star, making it one of the lowest-mass targets of astroseismic study. These measurements allowed for a more precise computation of the star's radius, which in turn led to a more refined solution for the planet's width

Weird Orbits of Alien Planets May Be Due to Twin Stars

July 30, 2014 - <http://www.space.com/26686-weird-alien-planets-orbits-twin-stars.html>

- Some of the oddly skewed orbits of many alien worlds may be due circling a pair of stars



- A striking pair of wildly misaligned planet-forming gas discs around both the young stars in the binary system HK Tauri. The two stars may have different equatorial planes
- The greater the distance from its sun, the greater the gravity tug of the other star will have on its orbit

Much of Earth's Water Is Older Than the Sun - Implications

Sept. 25, 2014 - <http://www.space.com/27256-earth-water-older-than-sun.html>

Not only are planetary systems all but universal, but ones as "wet" as ours must be common too.

Much of the water on Earth and elsewhere in the solar system likely predates the Sun's birth

- Water is commonly incorporated into newly forming planets throughout our galaxy and beyond
- Interstellar water-ice remarkably survived the incredibly violent process of stellar birth to then be incorporated into planetary bodies,
- If our sun's formation was typical, interstellar ices, including water, likely survive and are a common ingredient during the formation of all extrasolar systems
- Confirmed extrasolar planetary systems to date had access to abundant, life-fostering water during their formation.
- With nearly 2,000 exoplanets so far in one very small area of the sky, and many billions yet to be detected .
- Some once wondered if the Sun was the only star with planets. But on average, every Milky Way star is thought to host at least one planet.

Water, water everywhere

- Our solar system abounds with water. Oceans of it slosh about not only on Earth's surface but also beneath the icy shells of Jupiter's moon Europa and the Saturn satellite Enceladus.
- Water ice is found on the Moon, on comets, at the Martian poles and even inside shadowed craters on Mercury, the planet closest to the sun.
- If water in the early solar system was primarily inherited as ice from interstellar space, then it is likely that similar ices, along with the prebiotic organic matter that they contain, are abundant in most or all protoplanetary disks around all forming stars.

Heavy and 'normal' water

- Not all water is "standard" H₂O. Some water molecules contain deuterium, a heavy isotope of hydrogen that contains one proton and one neutron in its nucleus. The most common hydrogen isotope, known as protium, for example, has one proton but no neutrons.)
- With different masses, deuterium and protium behave differently during chemical reactions. Some environments are thus more conducive to the formation of "heavy" water — including super-cold places like interstellar space.

- The researchers constructed models that simulated reactions within a protoplanetary disk, in an effort to determine if processes during the early days of the solar system could have generated the concentrations of heavy water observed today in Earth's oceans, cometary material and meteorite samples.
- The team reset deuterium levels to zero at the beginning of the simulations, then watched to see if enough deuterium-enriched ice could be produced within 1 million years — a standard lifetime for planet-forming disks.
- The upshot is that all planetary systems in our galaxy are likely to be as water-rich as our own. ##

Mystery of 'Hot Jupiter' Planets' Crazy Orbits May Be Solved

September 11, 2014 – <http://www.space.com/27122-hot-jupiters-crazy-orbits-mystery.html>



Giant alien planets known as "hot Jupiters" can induce wobbles in their parent stars that may lead to the wild, close orbits

- Hot Jupiters are gas giant planets, much like Saturn or Jupiter, that orbit extraordinarily close to their stars, at about one-tenth of the distance from Mercury to the sun. About 1 percent of sunlike stars host these roaster planets.
- Prior studies found that hot Jupiters could not have originated where they are currently found, since interference from the gravity and radiation of their stars would have destroyed any gas giants attempting to form that close.
- Instead, scientists have suggested that hot Jupiters were initially born farther away from their stars and later migrated inward, due perhaps to gravitational tugs from companion stars to their host stars located a few hundred astronomical units away. AU: average distance between the Earth and the Sun)
- The mystery of the origins of hot Jupiters deepened when astronomers recently discovered the scorching orbits of these worlds are often bizarrely skewed, tilted when compared with the equators of their stars.
- Because of the size and proximity of these giant exoplanets to their parent stars, they exert large gravitational tugs on their hosts that researchers can readily spot.
- As these giant worlds drew close to their stars, they may have forced the stars to wobble chaotically. #

How to Search for E.T. by Scanning Alien Skies

<http://www.space.com/26729-alien-life-hunt-exoplanet-atmospheres.html> – August 4, 2014

<http://www.space.com/26995-alien-life-hunt-stinky-chemicals.html> – September 2, 2014

- Advanced space telescopes may be able to analyze exo-planet atmospheres
- Detection of water vapor could indicate an "Earth-like" planet

Spiral Galaxy Glows in Breathtaking Telescope Photos, Video

<http://www.space.com/26764-amazing-triangulum-spiral-galaxy-photos-video.html>



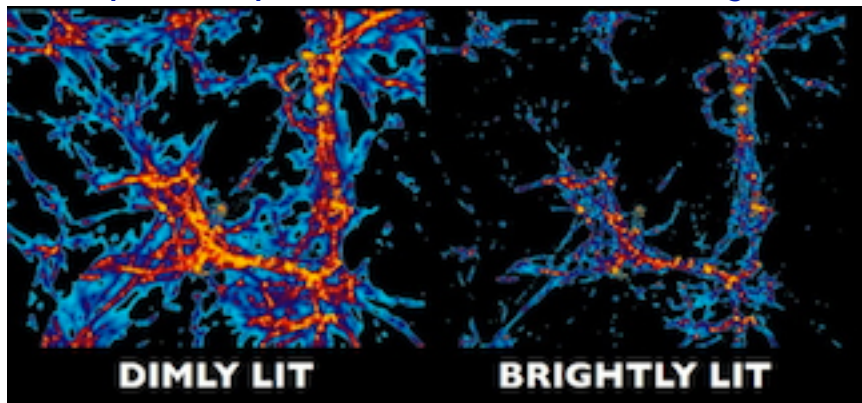
August 8, 2014 – Red clouds of gas are speckled among the stars of a relatively nearby galaxy that shines in this new image, one of the most detailed wide-angle views ever taken of the cosmic object.

September 2, 2014 – Alien organisms may betray their presence by pumping stinky chemicals into their home planets' skies.

Editor: in looking for **methane** on Mars and **tholins** on Titan, we are already doing something similar,

What?! The Universe Appears to Be Missing Some Light

August 8 2014 – <http://www.space.com/26795-universe-missing-ultraviolet-light.html>



- New data from the Hubble Space Telescope and computer simulations have revealed that the universe has much less ultraviolet light than previously thought.

'Man vs. the Universe' Explores Humanity's Cosmic Journey

August 13, 2014 – <http://www.space.com/26812-man-vs-universe-tv-show.html>

<http://www.space.com/26808-moon-lander-prototype-launches-in-man-vs-the-universe-video-clip.html>

- A new three-part series will shed light on humanity's ever-expanding place in the universe.

Hairspray Chemical Could Aid Search for Intelligent Alien Life

August 13, 2014 – <http://www.space.com/26789-alien-life-search-hairspray-chemicals.html>

- Scientists have often focused on molecules such as oxygen, which theoretically disappears quickly from atmospheres unless life is present to provide a constant supply of the gas.
- Searches for atmospheric biomarkers could also look for industrial pollutants as potential signs of intelligent aliens.

How Viewing Earth as an Exoplanet Can Help Search for Alien Life

Sept 29, 2014 – <http://www.space.com/27288-alien-life-hunt-earth-as-exoplanet.html>

An extraterrestrial spacecraft lurking near Earth would be able to see city lights and pollution in our atmosphere. What if it searched for signs of life on Earth from inside its own distant solar system.

- How Earth would look like from afar, and what hints there would be in Earth's spectrum that it was a life-bearing planet are questions with great pertinence to those searching for other Earths outside of our solar system.
- From afar, any Earth-like world would appear as a tiny points of light, making it hard to imagine ever finding out much about it.
- The best we can do with telescope technology at the moment is to examine some atmospheric components of worlds that are larger than Jupiter. But telescopes are getting more and more powerful.
- We're trying to think about how to use observations of the Earth itself to understand the kinds of things we'll be able to do in the future with possibly the next generation of telescopes.
- One experiment is trying to analyze the shadow of the Earth during lunar eclipse. See "High resolution transmission spectrum of the Earth's atmosphere: Seeing eEarth as an exoplanet using a lunar eclipse" available at <http://arxiv.org/pdf/1405.4780v1.pdf> .

Shadow glance

- Observations took place during a total lunar eclipse on Dec. 10, 2011. In this study, the researchers made observations with the High Resolution Spectrograph mounted on a 2.16-meter telescope at Xinglong Station, China, and focused the telescope near the Moon's Tycho Crater because that is where the Moon has high reflectivity.
- Earth's spectrum is revealed in the Moon's reflection. Certain elements preferentially emit certain wavelengths of light, and absorb others. By using a spectrograph to examine another planet, for example, you can see what atoms or molecules are present in its atmosphere or surface. ##

Search for Alien Life Should Target Water, Oxygen and Chlorophyll

Sept 30 2014 – <http://www.space.com/27294-alien-life-biosignatures-chlorophyll.html>

The next generation of space telescopes hunting for signs of extraterrestrial life should focus on water, then oxygen and then alien versions of the plant chemical chlorophyll, a new study suggests.

In the past 20 years or so, astronomers have confirmed the existence of nearly 2,000 worlds outside Earth's solar system. Many of these exoplanets lie in the habitable zones of stars, areas potentially warm enough for the worlds to harbor liquid water on their surfaces. Astrobiologists hope that life may someday be spotted on such alien planets, since there is life pretty much everywhere water exists on Earth. One strategy to discover signs of such alien life involves **looking for ways that organisms might change a world's appearance.**

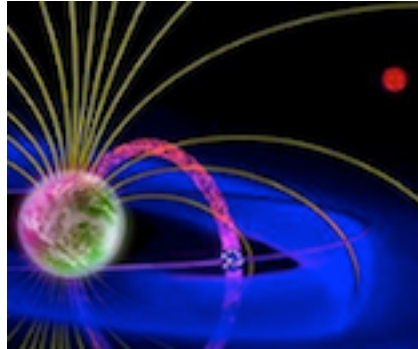
Biosignatures

- Alien-hunting telescopes could look for spectra that reveal chemicals associated with life. In other words, these searches would focus on biosignatures — chemicals or combinations of chemicals that life could produce, but that processes other than life could not or would be unlikely to create.
- Water would be the easiest to detect.
- In comparison, oxygen is more difficult to detect than previously thought, requiring scientific instruments approximately twice as sensitive as those needed to detect water and significantly better at discriminating between similar colors of light
- Oxygen, however, has only been a large part of Earth's atmosphere for a few hundred million years. It probably points to life, but not finding oxygen certainly does not mean that the planet is sterile.
- Identifying chlorophyll typically requires scientific instruments about six times more sensitive than those needed for oxygen.
- Chlorophyll becomes as detectable as oxygen only when an exoplanet has a lot of vegetation and/or little in the way of clouds cover.
- Chlorophyll slightly reddens the light from Earth. If extraterrestrial life does convert sunlight to energy as plants do, scientists expect that the alien process might use a different pigment than chlorophyll. But alien photosynthesis could also slightly redden planets, just as chlorophyll does.
- The researchers suggest a strategy for discovering Earthlike alien life that first looks for water, then oxygen on the more favorable planets and finally chlorophyll on only the most exceptionally promising worlds.

- The goal of a future space telescope will be primarily to detect water and oxygen on a planet around a nearby star. The construction and launch of such a telescope will probably cost at least \$10 billion and won't happen for at least 20 years ##

Follow the Radio Waves to Exomoons

Aug 13, 2014 – www.spacedaily.com/reports/Follow_the_radio_waves_to_exomoons_999.html



- Scientists have discovered more than 1,800 planets outside our solar system, or exoplanets; but so far, no one has been able to confirm an exomoon. Now, physicists from The University of Texas at Arlington believe following a trail of radio wave emissions may lead them to that discovery.
- Schematic, above, of a plasma torus around an exoplanet, which is created by the ions injected from an exomoon's ionosphere into the planet's magnetosphere
- Recent findings describe radio wave emissions from the interaction between Jupiter's magnetic field and its moon Io. They suggest using detailed calculations about the Jupiter/Io dynamic to look for radio emissions that could indicate moons orbiting an exoplanet.

A Rare Opportunity to search for Planets around Proxima Centauri

<http://www.spacecalendar.com/september-29-october-5-2014-vol-33-no-39-hawaii-island-usa/>

Sept. 29, 2014. The Hubble Space Telescope (HST) has the opportunity this month, and in Feb 2016, to take advantage of a rare stellar alignment of red dwarf Proxima Centauri when it passes in front of another star. It will attempt to search for small terrestrial-like planets by looking for microlensing effects.

- A planet has already been found around Alpha Centauri B, and presumably, there must be planets around its larger sibling star, Alpha Centauri A.
- Proxima Centauri (also known as Alpha Centauri C) is the nearest Star to the Sun and our Solar System – 4.243 LY, 0.123 LY (44 Light days or 7 light weeks) closer than Alpha Centauri AB
- Proxima Centauri revolves around the Alpha Centauri AB binary at some distance – 0.237 ± 0.011 ly ($15,000 \pm 700$ AU (1 AU is the average distance of Earth from the Sun)). Proxima Centauri's orbital period around Alpha Centauri A – B may be greater than 500,000 years, so it will be "Proxima" {Latin for "nearest"} far into our future. [http://en.wikipedia.org/wiki/Proxima_Centauri]
- At 61 degrees south, the Alpha Centauri system lies deep in the southern skies and is never visible in the northern United States or Canada.
- The HST has been in Low Earth Orbit for over 24 years with its 2.4-meter mirror, and four main instruments observing in near ultraviolet, visible and near infrared spectra,
- Editor: Way back in Moon Miners' Manifesto #43, March 1991, we had quite unofficially christened Alpha Centauri A and B **Ixion** and **Nepthele** respectively, after the King and Queen of the Centaurs in ancient mythology. Follow-up articles appeared in MMM #44, April 1991. These articles have been republished in the MMM Starbound Theme issue, a free download from either:
 - http://www.moonsociety.org/publications/mmm_themes/mmmt_Starbound.pdf
 - http://www.nss.org/settlement/moon/library/mmm_Starbound.pdf ##

What Made This Nova So Super? | Video

<http://www.space.com/26853-what-made-this-nova-so-super-video.html>

SN 2014J in the Messier 82 galaxy, one of the nearest Type 1a supernovas in modern times, was watched by telescopes around the world. Chandra X-Ray observations suggest it's unlikely the burst was caused by matter transfer from a companion

Watching Planets Collide, In Real Time

Sept. 3, 2014 - www.asianscientist.com/in-the-lab/watching-planets-collide-real-time-2014/

Editor: The following text has been minimally abbreviated as the article has little textural "fat" and reasoning is already tight.

An international team of scientists from Thailand, Japan and the United States have observed the aftermath of a planetary collision around a distant star for the first time, using the Spitzer Space Telescope's infrared camera.

Planetary systems, like our own, begin their lives as a cloud of dust and gas orbiting a star, which then clump into larger aggregates through adhesive and gravitational forces. In the final stage of planetary formation, these aggregates undergo massive collisions before forming a stable collection of planets orbiting a star. These collisions constantly release debris into the surroundings of the star, and the resulting "debris disks" can absorb the star's energy output and re-radiate it as infrared radiation, which astronomers on Earth can then detect and analyse.

A debris disk has appeared around NGC2547 ID8, a 35-million-year-old star some 2,000 light years from Earth. Along with optical observations of the star itself, the team measured the infrared radiation from the debris disk using the Spitzer space telescope.

After three months of collecting data, from May to mid-August 2012, the position of the star in the sky was too close to the Sun and observations were paused. When ID8 came back into view January 2013, the debris disk was c. 50% brighter, and rapidly decreasing over successive months.

Computer models indicated that the increased brightness was the result of a large amount of fine dust added to the debris disk. Furthermore, the brightness showed a consistent monthly rise and fall as it faded. This could be explained if the additional dust was concentrated into an elongated arc along its orbit around the star, such that the proportion of light facing the Earth from the dust cloud varied as the dust revolved around the star

There was only one plausible explanation: There must have been a violent collision between planet-sized bodies around ID8 during the pause in observations, and the aftermath.

Around ID8, the remains spattered from the collision had been ground by successive collisions into a dust cloud, which was then quickly blown away from the vicinity of the star by radiation pressure. The constant escape of dust explains why the additional brightness quickly faded away, and makes it very unlikely that the source could have been anything other than a recent collision.

This is the first time that large variations in a debris disk have been observed over time scales as short as months, providing new dimensions to study the aftermath of a large impact in a planetary system of a star. In particular, observing a massive collision in the planetary system of distant stars places the formation of our own Solar System in a broader context, as meteorics and dynamical modelling indicate that a similar large impact involving the Earth formed the Moon more than 4.5 billion years ago.

This would have occurred when the Sun was 30-100 million years old, right in this age range.

The study of planetary formation also goes beyond the Solar System, to address an important question about how often we should expect to find terrestrial planets around stars that resemble the Sun. Only about one percent of solar-like stars in the age range of terrestrial planet formation show debris disks similar to that around ID8.

Traditional theories predict that debris disks should persist for hundreds of millions of years after the collisions that cause them; if they are right, then giant collisions and thus terrestrial planet formation must also be very rare. However, NASA's Kepler mission suggesting that at least a fifth of all solar-like stars have terrestrial planets orbiting them.

If impact-produced debris disks decay on much shorter timescales, as observed around ID8, then their short lifespans explain why they are so rarely observed. As such, this study indirectly provides yet more evidence that Earth-like planets are common around stars like the Sun. ##

In the Spotlight: Leonard David

One of the most prolific reporters on the space scene for the past 50 years:



www.space.com – <http://www.spacenews.com/users/leonard-david>

<http://www.spacefest.info/V/speakers/David.html>

<http://www.foxnews.com/archive/leonard-david/index.html> space reports for FOX NEWS

Leonard David is responsible for many of the [space.com](http://www.space.com) articles cited in issues of TTSIQ

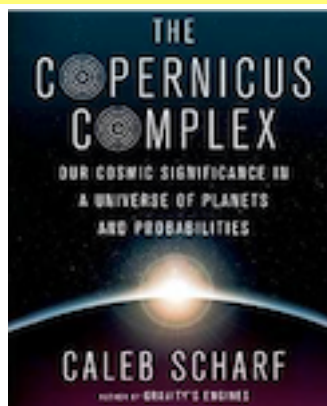
Leonard has been reporting on the space industry for more than five decades. He is a former director of research for the **National Commission on Space** and is **co-author of Buzz Aldrin's new book "Mission to Mars – My Vision for Space Exploration"** published by National Geographic.

Leonard David is a lifelong space journalist. These days he free-lances for space.com, Space Coalition and Space News, but was past editor of Final Frontier, as well as NSS' Ad Astra and Space World magazines. He also contributes to the American Institute of Aeronautics and Astronautics (AIAA) Aerospace America magazine. His wife Barbara writes for Odyssey magazine, astronomy for children.

His informative articles help keep those of us interested in astronomy and space discoveries and new missions well informed, and even more importantly, enthused.

“Leonard, if we didn’t have you, we’d have to invent you!” – TTSIQ Editor, Peter Kokh

LINKS to Featured Book Reviews



The Copernicus Complex: Our Cosmic Significance in a Universe of Planets and Probabilities

Book by Caleb Scharf – Review by Jeff Foust

In recent years, scientists have debated whether life is commonplace in the universe or if it, at least in its intelligent forms, is rare. Jeff Foust reviews a book by an astrobiologist that seeks to find middle ground between those extremes. <http://www.thespacereview.com/article/2606/1>

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ARTICLES & ESSAYS & MORE

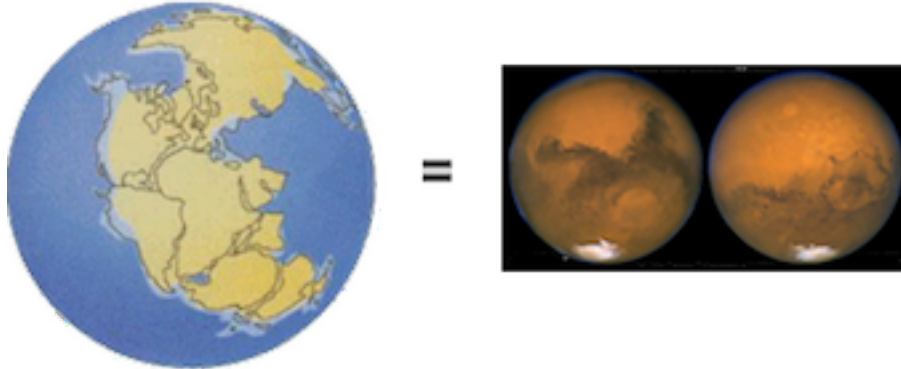
Which World would You rather pioneer? the Moon? or Mars?

By Peter Kokh (There is no wrong answer)

Amount of Land Space

There are many significant differences between the Moon and Mars, besides their size (see the graphic on page 1 this issue. But let's start with the size of Mars:

- Earth's surface is 71% ocean. Subtract that and **Mars is comparable to all Earth's continents put together.**



- **The Moon**, obviously smaller, has a surface of 37,930,000 km² (14.6 million square miles)

Land area comparisons – in order of similarity – closest at top:

1. Africa + Australia = 37,936,000 sq km (only 6,000 sq km larger than the Moon)
2. United States + Canada + China + Brazil = 37,837,000 sq km (93,000 sq km smaller than the Moon)



Unfortunately, we all too often see the comparison with Africa alone = 30,244,049 sq km (way too small) – that comparison is substantially inaccurate and should never be repeated.

North and South America together would be a little less than 5% too big (drop Greenland).

Both worlds are quite ample in size and room enough for a spreading civilization

Conditions that are the same:

1. Both worlds are awash in Cosmic Rays

Both the Moon and Mars lack one key thing that makes life on Earth's surface possible: the Van Allen Belts, part of the strong magnetic field generated by currents of molten iron in Earth's core. Not having such a field, the surfaces of both Moon and Mars are washed by cosmic rays and other forms of radiation. That Mars has a thin atmosphere and a relatively bright sky changes nothing.

Settlers on both worlds must "dig themselves in," covering their living spaces with about 5 m (16 ft) of loose rock powder soil, or make use of lava tubes, networks of which are common on both worlds. That does not mean that they have to live like moles! **There are ways to bring "down inside" both sunlight & views:** (www.moonsociety.org/images/changing/underground_sun_view.gif)

2. The need to create and maintain minibiospheres

For the very same reason, there can be no plant life on the surface. Agriculture as well as plants to refresh the air and water, and just for beauty's sake, must be "down under" within the common spaces such as pedestrian tubes, streets, and parks – a system that connects all the settlement homes and workplaces in what we have dubbed the "Middoors." Black water treatment and air purification methods will be common challenges. More, they will be living "downwind and downstream of themselves." Careless pollution would quickly doom them all!

Yes, Mars has relatively bright skies, though not nearly as bright as Earth's, Earth getting twice the sunlight per square meter as does Mars. Yes, Mars has gentle breezes, sunrises and sunsets, and dust storms, etc. But that doesn't change the basic commonality of two-layered indoor/middoor architecture shared by Lunans and Martians. However, given Mars' thin atmosphere of Nitrogen and Carbon Dioxide – both needed for biospheres large or minimal, that gives Martian settlements the "green edge." Settlement biospheres on the Moon will be minimal in volume, though most of the savings could come in height, e.g. allowing bushes and dwarf trees.

3. Both worlds have water ice reserves concentrated in specific areas

That will work to concentrate settlements in areas with relatively easy access to water supplies:

- a. On the Moon, craters as far as 30° from the poles are likely to have some ice. Highland/Mare border zones will offer the all-around best choices
- b. On Mars, there seem to be buried glaciers in areas even at the equator, under the flanks of debris slides of the great shield volcanoes and below the rim of the vast impact basin, Hellas Planitia

4. Both worlds offer extensive lava tube networks

When it comes to settling lavatubes, found on both worlds, technologies needed to explore and utilize these vast networks will again be largely similar, both situations in contrast to Earth where we live out on the relatively unprotected surface. Tricks and system protecting habits learned on one world can be shared with settlers on other worlds.

5. Neither world offers concentrated metal ores

This will make production of preferred metal alloys difficult, and at least initially, settlers may have to work with "second rate" alloys or iron/steel, aluminum, titanium, and magnesium – the four "engineering metals." Their "settlement systems" and metal alloy production systems will be largely similar, if not identical. That means that Lunans and Martians will have a mutual interest in sharing improved technologies and ideas and that this will be a foundation of cooperation and trade. It is regrettable that here on Earth, Moon fans and Mars fans do not see this and choose to battle each other for funds and government priorities when they should be working together.

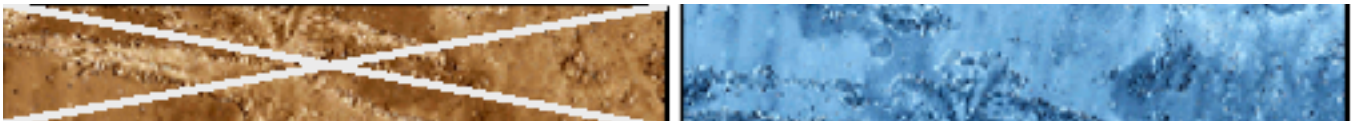
Climate and Temperature Range and Mean

The Moon's surface temperatures, **not counting the perpetually shaded north and south polar craters** lies between 250°F (120 °C) and -200°F (-130°C). This swing occurs over the lunar month (or sunth) which is 29.53 days long, half in darkness, half in sunlight.

As extreme as these temperatures seem to be, a comfortable medium in the room temperature range can be maintained inside living spaces shielded with a 5 meter or 16 foot overburden of moon-dust.

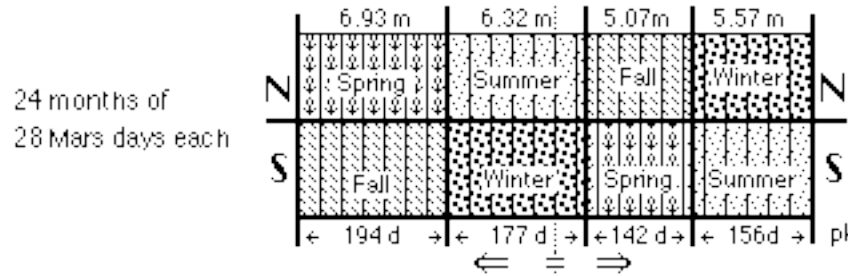
This short cycle lends itself to **geothermal heating systems that would use surplus water to absorb excess dayspan heat for use when needed for nightspan heating, and vice versa**

On Mars, the mean temperature is substantially lower, rarely reaching comfortable "room temperatures," and with the winter summer thermal cycle being over two Earth years long, **geothermal heating will not be an option.** Heating will be needed throughout the very long Martian year, with thermometers rarely reaching "room temperature." Without coal, oil, or gas reserves, and with **solar power unavailable during months-long dust storms, Mars' heating fuel options would seem to be reduced to nuclear power only.**



Mars **looks like Arizona**, but **feels like Antarctica**, which, snow and ice apart, “enjoys” a temperature range very similar to Mars. If you wouldn’t want to settle Antarctica (not even in its ice-free Dry Valleys), perhaps you should stay home, or settle for the Moon. **The Moon wins this one.**

Mars Seasons



Mars’ orbit around the Sun is much more eccentric than Earth’s, so the season pattern in the Northern hemisphere differs quite a bit from that in the Southern hemisphere. Mars’ Seasons are about twice as long as ours.

If you prefer a 7 month spring and 6.5 month summer and a shorter 5 month fall and 5.5 month winter, you will do best to settle in the Northern Hemisphere, and leave those who would enjoy a longer Fall and Winter and shorter Spring and Summer to settle in the Southern Hemisphere.

In both hemispheres, change of seasons will seem to take forever. Not much we can do about it.

The “Day” on the Moon vs. on Mars

On the Moon the solar day and night cycle is some 29.53 of our days long, with 14 plus days of sunshine, and an equal length of night. Settlers are free to set their clocks to standard hours and 24 hour days. During the “Dayspan” they will occupy themselves with energy-intensive chores: mining, manufacturing, and storing up energy in various ways for use during the following “nightspan” when Lunans will shift gears to tackle energy-light, labor-intensive chores such as inventory, packaging, repairs, etc. They might like such a “bi-sunthly” change of pace.

A bimonthly calendar that repeats through the year, with 3 weekends out of every 8 having a 3rd day off may be quite popular. <http://www.moonsociety.org/images/changing/lunarcaldend.gif>

On Mars, schedules will be at a more familiar pace: a Mars day is only 39 mn. longer than ours. But whoa! Wait a minute! **If you are a night person**, and like to “sleep in” every morning you can, that extra 37 minutes will be just up your alley. But I strongly suspect, that **if you are a morning person** like myself, and can’t wait to get the day started and tend to wake up the same time every day, you may be doomed to a lifetime of perpetual jet-lag. It will be hard to for you to stay up 37 minutes later every night, forever. A crew at the Mars Arctic Station lived on Mars Time for a few months and had no problems. I suspect that none of them were day persons. On the other hand, after Curiosity landed on Mars, the crew at JPL set their clocks back every night and after a month demanded to go back on Earth time.

Thirty-nine minutes may not seem like much, but day after day? Be careful of what you ask for.

The Moon and “Black Sky Blues” vs. Mars’ Salmon Colored Skies

We are used to our bright skies. Even periods of prolonged cloudiness bother those of us who don’t “make their own sunshine.” **On the Moon**, the skies are “forever black.” But there is significant compensation! Those living on the Earth-facing side will enjoy the constant treat of a very colorful Earth, much larger than the Moon is to us down here, and some 80 times as bright. When it is dark on the nearside, Earth will be at its brightest, lit up by the Sun coming from behind the Moon. And when the Sun is shining down on us, we’ll enjoy the fascinating sight of Earth’s city lights between the clouds.

For those living or working on the farside, from which Earth is never visible, there will be the compensation of seeing the stars and the Milky Way with such intensity and brightness that magnitude 8 stars may be visible. In several articles in MMM we have suggested ways to treat the “Black Sky Blues,” with vehicle and roadway design etc.

On Mars, yes we will have “relatively” bright skies, but with the Sun so much further away and smaller in the sky, “daylight” will not be as bright as it is on Earth. And given that we do not have really accurate photos of Martian skies, much less of sunrises and sunsets, settlers on will miss the “bright blue skies of Earth” almost as much as lunar pioneers will. And then there are the seasonal dust storms that might cut visibility down to a light fog level, storms that can last for several months, and be a nui-

sance. Mars does have dust devils, but other than that, will not have the life-threatening storms we are used to here on Earth.

Martians will appreciate man-made objects in complementary colors, such as blues and greens, reds, purples, etc. **Lunans and Martians alike will surround themselves with green vegetation and colored flowers!**

Location, location, location and time

Do you want to be within range of easy resupply? Easy rescue? Easy return home? From Earth to the Moon, it is a couple of days at most, in time less than a day. **The Moon is always “within quick reach” of Earth and the “window” is always open** – if arriving at a certain local time of the Moon’s 29.53 day-night cycle is not an issue.

More, the time delay in a conversation between someone on Earth and someone on the Moon is no longer than a television relay from one side of Earth to the other by a pair of relays in geocentric orbit. We are used to that. In effect, **the Moon is Earth’s “suborb.”** In comparison, Mars is in the boon-docks.

Mars on the other hand, is in “the sticks.” **Not only does it take months to get from Earth to Mars and from Mars to Earth, (future Vasimir or nuclear rockets could one day cut that journey in half), but you still can’t go from one to the other any time you like.** While Earth and the Moon are orbitally locked, Earth and Mars revolve around the Sun in very different lengths of time, and unless you don’t care how much fuel it takes, the two will line up for an “economical” trip only once every 25+ months. Miss a connection and that will delay you another two years plus.

Obviously, at this stage of the game, a trip to Mars is not a weekend jaunt. While you can take a month off and do the Moon, “doing Mars” could take a few years. Lunans can look for visits from relatives. Those leaving Earth to settle Mars can pretty much kiss friends and relatives goodbye. For some few, that might be an incentive!

You can sign up as a Moon settler and then after a few weeks or months decide it’s not for you and take a ride back home to Mother Earth. But you would do best to be very, very sure that settling Mars is what you want to do, and that leaving family and friends, possibly forever, is something you can handle.

The Moon will get 99.9% of the tourist traffic. Going to Mars for a visit will take a chunk out of your life, much of it spent in transit. (However, you might be able to complete a few college courses both coming and going with very little by way of “distraction.” Traffic to Mars will be strongly one-way. Yet it cannot be challenged that Mars has, along with vast areas best described as boring, some of the most scenic features in the Solar System. Yet given the time involved, **the tourist market for Mars will be largely the wealthy and the retired.**

Not to forget, that if on the Moon, you develop an illness that only a specialist can handle, that is not a problem. In a similar situation on Mars, it might take over two years for such a specialist to arrive, at astronomical cost. And conducting a complicated and risky procedure by radio/internet with time delays up to 40 minutes does not seem to be a promising workaround. We’ll need to have “all” the specialists on location on Mars.

Students can go to the Moon on field trips between semesters. To go to Mars for a field trip or special course will take years out of their lives.

Yet we can expect both worlds to be settled in time. But don’t be surprised if the “prize” settlers on Mars will be hardy pioneers who have already spent time on the Moon. Lunans will find Mars “a walk in the park.”

Location, Trade, and Economics

The Moon orbits Earth at a distance convenient for ever growing steady trade. Now the Moon might need a lot of things made on Earth that cannot yet be made on the Moon. These “upports” will climb up Earth’s gravity well to the Moon. But there will be little besides souvenirs that the Moon can ship down the gravity well to Earth at a profit. No, **the Moon’s major market will be GeoSynchronous Earth orbit.** While “GEO” is only one tenth the distance from Earth as the Moon, it takes 20–some times as much energy (think rocket fuel) to get things “uphill” from Earth’s nearby surface to GEO as it does to get functional equivalents “down the gravity hill” from the Moon to GEO. That gives the Moon a secure market. GEO is already responsible for over \$300 billion US dollars of economic activity, enough, if it were a country, to get a seat in the G-20.

Now GEO is limited by treaty to only 180 “stations” 2° apart. If its economy is going to continue to grow, it may be necessary to build large platforms, one at each station, each platform able to host hundreds or more satellites, providing station-keeping, power, robotic repair, etc. The cheapest way to build such platforms is with materials brought down from the Moon at far less fuel cost than launching them up from Earth. Distance is not a factor: ‘uphill’ vs. “downhill” is the decider.

But obviously, Earth can make complex advanced items that will be difficult to manufacture on the Moon. We’ve coined a composite word to describe the two-way trade. Read the “M.U.S./c.l.e.” Strategy for Lunar Industrial Diversification:

http://www.moonsociety.org/publications/mmm_papers/muscle_paper.htm

You will have noticed that our “muscle” was spelled as a two part acronym, “M.U.S. – c.l.e.”. For our strategy calls for the M.U.S (Massive, Unitary, Simple) parts to be made by the settlements and the c.l.e. (Complex, Lightweight, and Electronic) components to be made on Earth for support and assembly on the Moon or in space. Here then is the logical formula for giving industrial muscle to the early settlement still too small to diversify into a maze of subcontracting establishments. It is a path that has been trod before. It plays on the strengths of the lunar situation and relies on the early basic industries: lunacrete, iron-steel, ceramic, and glass-glass composites (glax). [we have since added basalt, basalt fiber, and basalt composites.]

The point is that the Moon is a “suborb” of Earth, easily and regularly reached, with definite shipping advantages. And thus the Moon will be relatively quickly settled and industrialized. Unfortunately, Mars enjoys no such advantage.

Mars’ biggest market is likely to be the Moon, since, when time is not of the essence, Mars could ship items to the Moon at lower fuel cost than they could be supplied from Earth. On the other hand, no one has come up with a product that Mars could market to Earth except travel and exploration experiences. Mars has to survive on its own, with some helpful trade with the Moon.

<http://www.moonsociety.org/mars/TradeRoutes.gif>

If Mars’ two mini-moons turn out to be carbonaceous chondrites, as has long been the leading theory of their origin, **liquid methane and liquid oxygen** produced on Phobos and/or Deimos could become a crucial export to the Moon, where carbon and nitrogen are relatively scarce. But this origin scenario has a rival theory that makes the PhD pair “offspring of Mars,” having coalesced from Mars debris cast into orbit by a major impactor.

Anything produced principally from hydrogen, carbon, and nitrogen, could be shipped more economically from Mars to the Moon than from Earth to the Moon – if time is not a factor – simply because Mars’ gravity well is shallower than that of Earth. Earnings from Mars-Moon trade will let Mars buy needed goods not made on the Moon, from Earth.

The upshot? **Without the Moon, Mars does not have a chance!** All the same, both worlds will be settled. **Both Mars and the Moon will thrive better economically as trading partners than either will by itself. Yet, paradoxically, Mars may declare its (very dependent) “independence” first.**

Attracting Settlers to a “Hard” Frontier

But settlers will come to Mars. It would not be surprising if recruiting for Mars met with greater success in northern arctic populations of Inuit, Samoyed, and other inhabitants of cold barren desert areas, far outnumbering those from Mars-fascinated ranks of the American southwest. The screening will take place on Earth.

If Mars needs more settlers than it can attract, incentives could always be offered such as debt forgiveness, parole from prisons, etc. A once in a lifetime opportunity to start over fresh could become a powerful magnet. It has worked before.

Reaching out Beyond: Astronomy on the Moon and on Mars

One activity, pursued from time immemorial on Earth, that will transfer with pioneers to both worlds, is astronomy. Both worlds offer assets. The Moon’s Farside is the only place in the solar system and quite further out, where radio and other electronic noise from Earth is blocked.

Astronomy is pursued wherever man has settled. It is a core instinct of intelligent creatures to wonder what is out there beyond our physical reach.

On Mars, the best spots will be on the crater rims of the giant shield volcanoes” Mons Olympus, Arsia Mons, Pavonis Mons, and Ascreus Mons.

Gateway to the Asteroid Belt?

Mars is closer to the Asteroid Belt, Right? Well yes, but that is not an asset. The closer two bodies are in their orbits, the less frequent is the opportunity to coast from one to the other and the longer that journey will take. Paradox? Yes. True, Yes. Because it orbits the sun much faster than Mars, the opportunities to coast from the Moon to any main belt asteroid will come more often than opportunities to get there from Mars.

Indeed, if propulsion power and fuel are less important than speed and frequency, Mercury is the best place in the solar system to launch to anywhere! But in practice, **the Moon will be the jumping off place to the asteroids for some time.**

Terraforming

This is not a word I like. Consider that our human experience to date is in “**de-terraforming Earth!**”

Mars may well have been “more Earthlike” in its distant path. It most likely had a thicker atmosphere, and running water – lakes, rivers, even seas, and some think, an ocean. A more fitting goal, is the “**Rejuvenation**” of Mars, restoration of its once thicker atmosphere, allowing a somewhat warmer climate, and perhaps vegetation.

Our goal should not be the unrealistic one of making Mars a smaller Earth.

Our goal should be to meet Mars halfway.

1. Increase Mars temperature to the point that atmospheric carbon dioxide does not freeze out over the polar water ice caps, thickening the remaining atmosphere significantly in Northern Winter = Southern Summer and Southern Winter = Northern Summer. If we can boost temperatures year around to the higher spring/fall levels, that will be a good start
2. Find ways to keep increasing the air pressure. Top prize? Year around, aviation transport of people and cargo.
3. Starting here on Earth we can try to breed plants in Mars type atmosphere at Earth air pressures (“**redhousing**”) and evolve them to be hardier and hardier at reduced pressures until we get them to the point where they will take root and prosper on Mars itself, first at very low altitudes such as in the Hellas Basin, then elsewhere.
(Redhousing: see MMM Classics #10 pp. 25–27
www.moonsociety.org/publications/classics/mmmc10_Jan006.pdf)
4. Increase the “Mars Air” air pressure to the point where Martian settlers need only an oxygen breathing mask to go outdoors, instead of a spacesuit, at least under “open-air” but shielded walkway canopies.

On the Moon, such a parallel program does not seem feasible. Any attempt to give the Moon an atmosphere would turn it into a permanent dust bowl. Add water, and we get mudville.

Red, (Muddy), Green, Blue Mars:

<http://www.moonsociety.org/images/changing/muddymars.gif>

So if your personal goal is to live on a planet becoming Earthlike bit by bit on a path that may take centuries or millennia, and you don’t mind mud, Mars is where you should head.

If your goal is to accept a world as it is and learn to live rich fulfilling lives there all the same, the Moon is just your ticket.

There is no “right” choice **between** Moon and Mars. **But there is a right choice in common: Settle both Moon and Mars.** They will complement one another, and **we will have become more fully human in the process.** Moon vs. Mars “wars” are counterproductive and could lead to the failure of both frontiers. **Mars and the Moon need each other as industrial and trade partners.** But that’s not the end!
PK

We encourage readers to support a Research and Development policy that favors all three:

Moon, Mars, Asteroids –http://www.moonsociety.org/images/changing/space_triway.gif

Read: “The Triway to Space” by Peter Kokh and Al Anzaldúa Published in Space Review.

May 7, 2012 – <http://www.thespacereview.com/article/2078/1>

Are Solar Power Satellites Sitting Ducks for Orbital Debris?

By Al Anzaldua, David Dunlop, and Brad Blair

Background

Even conservative estimates of the energy needed in coming years to meet surging world demand are staggering. Energy use, currently over 120,000 billion kWh annually, is forecast to double by 2030–2040 and to quadruple by 2090 – 2100.¹ To meet this growing demand, many space enthusiasts are promoting the idea of space solar power for terrestrial use. Unfortunately, a fierce and growing spoiler lies in wait: orbital debris.

Individuals and governments around the globe are becoming aware of the danger that orbital debris presents both to our modern life and to future plans for the utilization of space. According to NASA, there are over 21,000 Earth-orbiting objects larger than a softball (10 cm) and 500,000 shrapnel fragments between 1 and 10 cm. The number of shrapnel smaller than 1 cm exceeds 100 million.²

Because of their high relative velocity on impact, typically 10 km per second or 22,000 miles per hour in Low Earth Orbit, orbiting shrapnel as small as 5 mm can disable a spacecraft.³ The debris is an ever-growing hazard to the International Space Station, future space flights, and the approximately 1,100 operational satellites.⁴ Indeed, Jer-Chyi Liou, Chief Scientist for NASA's Orbital Debris Program Office, using estimates drawn from six space agencies, recently declared that even without a new catastrophic collision or explosion in orbit, and with 90% compliance with the 25-year deorbiting-after-use guideline, debris will continue to grow over the next 200 years.⁵ Moreover, it seems reasonable to expect that the increase in debris, by knocking out stationkeeping capabilities of impacted satellites, will worsen Liou's current estimate⁶ that there will likely be a major catastrophic collision every 5–9 years.

Although most of the debris is in LEO, with the greatest concentration found near 750 – 1000 km altitude, there is a considerable amount in Medium Earth Orbit (MEO) and Geostationary Orbit (GEO).⁷ Within two LEO altitude bands, the density needed to initiate the "Kessler Syndrome," i.e., a cascading chain-reaction of collisions leading to uncontrollable growth of debris, may have already been reached.⁸ High debris density LEO bands should therefore be some of the first targets for remediation and parallel mitigation efforts.

Precious Targets in the Sky

The Risk to Present Assets

Orbital debris, by threatening our satellites and related spacecraft, is also threatening to shred the very fabric of modern life. Satellites are intimately involved with our everyday activities. Anyone using Google maps, checking the weather forecast, watching TV, listening to the radio, flying on a plane, using an ATM while traveling, accessing certain Internet sites, taking a cruise, or calling on a cell phone – makes use of satellite technology.

The Risk to Future Developments

Worse yet, future space technologies and missions are threatened. For example, Solar Power Satellites (SPS) for terrestrial use, an energy technology with enormous potential to improve lives, is also at stake. In 2009, retired astrophysicist Donald Kessler, who started NASA's work on orbital debris more than 30 years ago, stated, "large structures such as those considered ... for building solar power stations in Earth orbit could set up a situation where a single satellite failure could lead to cascading failures of many satellites."⁹ Solar power satellites are not the only future spacecraft that will be threatened. Bigelow Aerospace plans to have its BA 330 habitats serve as tourism hotels in orbit starting in 2016.¹⁰ Add to this, the untold satellites and other spacecraft scheduled to go into Earth orbits well into the future.

Risk Reduction Strategies

But would a hyper-modular system, such as proposed by John C. Mankins also be vulnerable? Mankins admits that micrometeoroids and orbital debris might impact the SPS and cause damage, but then he argues, "Fortunately, with a hyper-modular architecture such as SPS-ALPHA¹¹ there are no 'single' points of failure. Impacts will cause damage, but it will be mostly inconsequential and will only occasionally require repairs."¹²

This statement bears skeptical examination. Much shrapnel debris exists below current detection limits, so quantification of risk remains problematic. Further studies of risk and greater detection capacity are needed to reduce uncertainty and to encourage potential investors that the risks to capital invested in solar power satellites (SPS) are acceptable.

Admittedly, the hyper-modularity of the SPS-ALPHA system would mitigate damage from orbital debris. But Mankins proposes multiple SPS-ALPHAs to solve our energy concerns, each measuring approximately 3 km x 5 km.¹³ These structures would be very large targets, “sitting ducks,” in the case of a Kessler-type runaway debris growth at the 35,700 km, and the damage would likely go beyond “inconsequential.” Even if the satellite remained structurally intact, maintenance costs would sharply rise. Keep in mind also that to build such a large SPS in the first place, many SPS module-carrying spacecraft would have first to pass through shrapnel-cluttered LEO bands before carrying modules to GEO for construction by telerobotically operated spacecraft.¹⁴

Perhaps SPS-ALPHAs require, not only hyper-modularity, but hyper-permeability, such that the modular elements can each separately move to avoid debris. Ideally, the modules would describe an array of SPS-ALPHA elements flying in precise formation and with the ability to self-adjust to avoid danger, reminiscent of a school of fish avoiding the lunge of a predator.

Large Debris Collisions Make Spacecraft-Killing Shrapnel

Large debris, i.e. larger than 10 cm in diameter and 1 kg in mass, can range in size all the way up to 9-ton rocket bodies and 5-ton satellites. These multi-ton bodies make up the mass of approximately 6300 tons of orbital debris, with approximately 2200 tons in Low Earth Orbit (LEO) alone, and collisions among them are the source of millions of shrapnel fragments.¹⁵ For example, China in 2007 intentionally destroyed its Fengyun-1C weather satellite, and in 2009 a non-functioning Russian Cosmos 2251 satellite collided with an U.S. Iridium 33 satellite. One-third of all orbital shrapnel can be traced to just these two collisions.¹⁶ Worse yet, orbital shrapnel smaller than 10 cm/1 kg is currently untrackable, and because of the high collisional velocity of around 22,000 mph, even shrapnel as small as 5 mm can take out a spacecraft.¹⁷

POTENTIAL REMEDIES

The Large-Objects-First Strategy

A consensus is building among persons studying the orbital debris problem the greatest danger will come from inevitable catastrophic collisions between large debris objects, which will produce immediate and subsequent financial loss due to untrackable shrapnel. And because the subsequent financial loss will dwarf the immediate loss, Jerome Pearson and his colleagues Joe Carroll and Eugene Levin in a recent article argued strenuously for dealing with such large objects as soon as possible.¹⁸

But which large debris objects should be the priority? Launching countries are naturally sensitive about the nature of their satellites. Therefore, to induce international cooperation to remove, recycle, or rehabilitate large debris objects, it is best to start with the much less sensitive, but still dangerous, upper stages (i.e. basically aluminum tanks). They make up about half of the debris mass in low earth orbit. Capturing aluminum tanks would also be a lot less complicated than grabbing satellites with solar arrays, antennas, and nuclear reactors. Because most of the large debris is of Russian origin, a bilateral treaty with Russia would be a good place to start. (See below.)

Large Debris Remediation in GEO

Cellularization

The DoD's Defense Advanced Research Projects Agency (DARPA), under a demonstration project called Phoenix, is teaming up with the private sector to harvest and “repurpose” still functional components of nonworking satellites in GEO to create new space systems at greatly reduced cost. Beginning in 2016, the project proposes to attach nano-satellites to parts of retired U.S. government and commercial satellites, making the debris a resource. In a process called, “cellularization,” nanospacecraft separately carrying out functions such as power, communications, attitude control would be launched into orbit as secondary payloads. A service-tender spacecraft would then be telerobotically directed to attach such miniature devices to large antennas or other large parts of dead satellites to produce working satellites at a fraction of the cost of new ones launched from Earth.¹

Refueling

Another way that defunct satellites in GEO can be rehabilitated, if not already too damaged by orbital debris, is through refueling. The Canadian company MacDonald, Detwiler, and Associates (MDA) 2010 Space Infrastructure Services (SIS) project envisioned both refueling and otherwise servicing satellites in orbit telerobotically. Although MDA and Intelsat in 2012 cancelled their collaborative agreement in which MDA was to develop a satellite capable of servicing Intelsat's 50 operating satellites, MDA remains interested in the concept and is waiting for a possible DARPA contract.²⁰

In this connection, it is important to note that in May 2013, NASA carried out a series of telerobotically operated "propellant transfer experiments" on an exposed platform of the International Space Station (ISS).²¹ Although the ISS is in LEO, the refueling technology being developed is intended for use in GEO.

Remediation of Large Debris in LEO

"EDDE," The ElectroDynamic Debris Eliminator Vehicle

Various ideas and technologies are being developed potentially to remove, recycle, or reuse (through rehabilitation or repurposing) large debris objects in LEO as well. For example, three companies, Star Technology and Research, Inc., Tether Applications, Inc., and Electrodynamic Technologies, LLC have been developing a technology called ElectroDynamic Debris Eliminator (EDDE), wherein a long conductor is energized using solar energy to thrust against the Earth's magnetic field. Operating without propellant, EDDE can repeatedly change its altitude by hundreds of kilometers per day and its orbital plane by degrees per day.²²

Assuming effective EDDE or other non-propellant debris remediation technologies²³ are developed, which LEO orbits are ripe for remediation? About half of the mass of orbital debris in LEO is at inclinations of 71° – 74°, 81° – 83° and sun-synch orbit. According to Jerome Pearson, President of Star Technology and Research, Inc., and Joe Carroll, President of Tether Applications, Inc., disposing of upper rocket stages in these inclinations, which would remove 79% of the collision-generated debris potential, is a crucial first step to stopping the growth of shrapnel.²⁴

The ISS as The Demo Site for Debris Remediation Technologies

There are good reasons for testing and developing EDDE and other debris remediation technologies from the ISS. In the first place, the ISS generates ten tons of waste annually and money and effort is already being spent to remove it.²⁵ The ISS also has features that can facilitate early demonstrations of debris removal technologies: its own electrical power supply, a redundant international supply chain, human extravehicular capabilities, robotic grappling and docking, a Ka Band microwave transmission antenna, and a potential for servicing and refueling other spacecraft. Joe Carroll maintains that EDDE vehicles could bring another 100 tons of orbital debris to the ISS for either de-orbiting or salvage.²⁶ Testing and developing EDDE and other technologies, such as energy-beaming and solar-electric propulsion (SEP), at the ISS could inform the space development community on techniques and technologies for capturing and handling orbital debris for subsequent de-orbiting, metal recycling, or repurposing.

Once we have learned to deal with this smaller amount of debris in connection with the ISS, we will be better prepared to deal with the estimated 2200 tons of dangerous large debris objects in LEO and elsewhere. The ISS has occasionally to dodge space debris, and this involves moving its million-pound mass with rocket engines using chemical propellants. Perhaps the ISS-connected debris remediation demonstrations, done with free flyers operating within power beaming-distances,²⁷ could evolve into technologies specifically to protect the ISS and thus obviate the need to burn precious chemical propellant.

Considerations for a Debris-Remediation Economic Model

A) Transportation and Removal Costs

Assuming that Space X does indeed manage to get the payload price to LEO down to \$2200/kg²⁸ using the Falcon Heavy and eventually half that cost with routine first-stage reuse, debris remediation at LEO and higher using only rockets would remain prohibitively expensive. Fortunately, using EDDE and other non-propellant using vehicles to carry out the actual removal of at least a thousand tons of large debris from LEO will make a noticeable difference at a more reasonable cost. In this regard,

Jerome Pearson, et al., in considering an orbital debris removal campaign removing only upper stages from LEO, estimate that in seven years of operation “1000 tons of upper stages and 79% of the collision-generated debris potential can be removed at an average cost of less than \$500 per kg and an average annual cost of about \$70 million.”²⁹

B) Salvaged Raw Materials & Their Market Value

To the above considerations, we must add the salvage value of 2000 mt of refined metal. Aluminum scrap on Earth is currently around \$1730 per mt.³⁰ So at a minimum large debris in LEO represents at least \$3,460,000 in raw materials. Finished products would have many multiples of that value in orbit. However, as shown below, getting to finished products would involve heavy production costs.

C) Production Cost for Value-Added End Products

The Market Model

Salvaged metal can only be worth something to a company ready and able to process it into new tools, devices, or spacecraft – for a profit. To get that profit, the potential buying company will have to figure in capitalization costs necessary to transform the metal into final products. Then, the buyer must either sell the new tools, devices, or spacecraft or use them to provide a service for which there is demand. All these actions within the cislunar market will determine the actual value of the salvaged metal to the first buyer. Also keep in mind that it is unlikely that all those tons of salvaged metal will be bought for space construction in the foreseeable future; a good number of the smaller upper stages and “zombie” satellites will likely be deorbited.

Beyond these preliminary market figures and considerations, on-orbit recycling of materials for construction and manufacturing would counteract the throwaway culture that has made space operations largely beyond the reach of the commercial economy, with the exception of commercial communications and GPS satellites.

The Risk-Reduction & Quantification Model

On the other hand, lowering or removing the odds of large debris collisions, by whatever means, which threaten a satellite industry grossing over \$200 billion annually, is a valuable service that must be quantified. The community of satellite users must remove large debris objects safely and thus lower the risk of catastrophic collisions, or face customer anger and loss, coupled with much higher costs for satellite replacement. Retiring this risk of collision will avoid subsequent much larger losses. Market-based insurance and salvage quantification-models could be used to provide economic incentives to remove, reuse, or recycle space debris, and thus save this industry.

Space Debris and Orbital Mechanics

Serious thought should be given to where orbiting scrapyards would best be located and what sorts of vehicles should emplace them. Most orbital debris resides within 1500 km of the Earth’s surface, although there is a significant band of debris around GEO. The orbits of scrapyards below 600 km would degrade, depending on the particular altitude, within a few years or months because of atmospheric drag and de-orbit.

At around an altitude 650 km, however, orbital debris is relatively sparse and scrapyards there would need only infrequent boosting to maintain altitude. EDDE vehicles could therefore carry large debris objects to cross-truss scrapyards at that altitude. Also, carrying defunct upper stages to 650 km for collection would make the raw aluminum more accessible for subsequent construction in LEO³¹ and would be quicker than carrying them to deorbiting altitudes.

Orbiting scrapyards could also be located within other sparse debris bands in Medium Earth Orbit (MEO), High Earth Orbit (HEO), or even around Earth-Moon Lagrange points. Scrapyards embedded in cross-frames in meta-stable halo orbits near Earth-Moon L1/L2 (E-M L1/ L2), with a little stationkeeping, could serve as a metal-resource sites and a nexus for cis-lunar infrastructure, facilitating the later growth of staging sites, fuel depots, spacecraft construction sites, comsats, and habitats with telerobotic capabilities.

Keep in mind that it takes a bit less chemical propellant from LEO to reach E-M L1&2, than to reach and circularize on orbit in GEO.³² On the other hand, in comparison to going to GEO, reaching E-M L4 or L5 would take a little more chemical propellant. Scrapyards in these latter locations, however,

could remain in stable-bean shaped orbits without stationkeeping for many years. When dealing with low-thrust SEP from LEO to Lagrange orbits in comparison to GEO, the propellant cost is not as favorable.³³ With SEP, however, we would be dealing with much less propellant in the first place.

Of course, every proposed salvage operation should entail reducing the risk of orbital-debris collisions, not increasing it. Moreover, the act of grappling, controlling, or moving debris should not generate more of the material. Any international system monitoring such salvage operations should operate transparently and give notice of voluntary space "clean up" activities by sovereign nations or parties registered with those countries to do business. Opportunities for third-party review, comments, filing of objections, and unilateral "holds" should all be part of the process. Finally, liability assignment under various scenarios will have to be agreed upon by all parties before orbital remediation can begin.

The Russian Stakes for Cooperation to Remove Orbital Debris

Most of the large orbital debris is Russian and over 70% of the total mass in LEO is Russian. United States – Russia relations have fallen to another nadir. The relationship is filled with the growing suspicion and mutual hostility harkening back to the Cold War. So why would Russia cooperate with the United States (and others) to deal with orbital debris?

First, those Russian debris pieces, large and small, carry with them liability under the 1972 Liability Convention. Second, the debris represents enormous value in an emerging economic model for space debris clean-up, both as already emplaced highly refined metal and buses for enabling nanosats. Third, the U.S. Department of State, in coordination with the UN Committee on the Peaceful Uses of Outer Space (COPUOS) could play crucial role in putting together an agreement between Russia and the United States, to remove the 79% of the orbital debris with the greatest shrapnel-generating potential. Fourth, this heritage of Russian space debris may provide a strategic opportunity for Russia to enhance its international position in the commercial development of space.

Sweating the Small Stuff: What About the Shrapnel?

Ground-Based Lasers

To remove small debris, "laser nudging" from ground-based lasers appears to be the most viable option. In this concept, a powerful ground-based laser would ablate the front surface off a debris target to slow and thereby deorbit it. To remove the political-military element, the system would have to be ground-based, transparent, and under international civilian control. In this regard, several observers have proposed an international civilian consortium to manage, in transparent fashion, ground-based lasers targeting debris shrapnel smaller than 10 cm for ablation to induce deorbiting.³⁴ Under such a regimen, consensus would be needed to select targets and timing for deorbiting. A bounty system could also be used to facilitate commercial participation so that the consortium members need not pay for complex and expensive development project, or for failures, but only for results.³⁵ A system paying bounties for results could also be used to facilitate the removal of large debris.

Along with property rights in space, international laws and treaties touching on the delicate issue of lasers to remove orbital debris will eventually have to be modified. The prestigious Institute of Air and Space Law of McGill University has recently proposed a meeting to carry out just such reconsiderations.³⁶

Shrapnel-Tracking Improvements Are Crucial

When it comes to using lasers to deorbit debris, beyond having to organize a large group space-involved countries and getting their consensus, there is another major problem standing in the way: Small orbital debris is currently not being tracked, and even larger debris is not tracked in real-time.³⁷

Doug Beason, Senior Vice President for Special Programs at the Universities Space Research Association, decries the lack of tracking of the most immediately dangerous shrapnel, i.e. debris larger than 5 mm but smaller than 10 cm. He suggests public/private efforts to "find, fix, track, and target" orbital debris objects, so they can be engaged and that engagement later be assessed.³⁸ Also, because the Joint Space Operations Center is part of U.S. Strategic Command, much of its tracking technology is secret. According to Beason an international station with optical, radar, and polarization debris-tracking technologies under civilian control is urgently needed, not to find and track sensitive satellites, but to find and track in real-time, orbital debris, including shrapnel.

Instead of depending on military debris detection and tracking wrapped in secret capabilities and protocols, international investment in a transparent non-military commercial tracking system is needed. We have transitioned from a military-only GPS system to commercial dependence on GPS tracking that now includes Russian GLONASS and European Galileo systems, in addition to Chinese and Indian positioning systems. We can make the same type of transition with orbital debris tracking systems.

“Free Parking” Orbits as Commercial Disincentives to Risk Reduction

Beyond remediation, steps can be taken to mitigate orbital debris as well. Joe Carroll decries the 25-year “free parking,” which results from international guidelines for satellite companies to deorbit their satellites after 25 years of non-use.³⁹ Technology already exists that can begin deorbiting a satellite the moment it stops functioning. In this regard, the company Tethers Unlimited has developed a conductive “terminator tape,” which uncoils out of a defunct satellite, causing both aerodynamic and electrodynamic drag to deorbit the spacecraft. Two of the company’s terminator tapes are currently being tested as demonstrators on cubesats.⁴⁰

On the other side of the ocean, the European Space Agency (ESA), in coordination with the University of Surrey, is about to test the de-orbiting capabilities of the pop-out 5 x 5 meter gossamer solar sail technology it developed.⁴¹ Other countries and institutions are developing debris mitigation and remediation technologies based on grab-and-plunge spacecraft, solar sails, electro-static nets, and balloons.⁴²

The risk of generating hundreds of millions of dollars of damage from orbital debris collisions is currently not properly balanced against the costs of deorbiting or moving satellites. An economic model creating disincentives for extending the risk-time of zombie satellites is needed and is another topic for consideration of new space laws and treaty provisions. At present, we have not developed the mix of carrots and sticks needed for an effective economic model.

Pay Now or Pay (Much More) Later⁴³

There is an old adage that “A stitch in time, saves nine.” In the spirit of this saying, we should note that, if no action is taken to address orbital debris until there are multi-level Kessler cascades, the tab will be much higher than now in terms direct financial costs for satellite insurance, satellite replacement, and satellite service disruption in various industries and businesses. Therefore, nearly all persons living in industrialized societies will eventually have to pay the tab one way or another, if in no other way, through increased user-fees.

If the voluntary “seed money” and bond schemes mentioned above (under “The Risk Avoidance-Insurance/ISRU Industrial Start-up Model”) are not instituted, it might fall to the international space-users community to empower the International Telecommunications Satellite Organization (ITSO) to collect a universal and mandatory tax on satellite services to finance bounties to be paid to commercial entities for orbital-debris remediation. For such a plan to work, all satellite-service providers would have to contribute (i.e. no “free riders”), so that no competitive advantage would exist from non-compliance.

Orbital Debris: Resource Ladder to the Stars

Not only is orbital debris the “low hanging fruit” with regard to a vast supply of already refined metal and emplaced structures on which to hang empowering nanosats, the technologies that will be developed to deal with debris, will also be useful for dealing with capturing and mining near-Earth asteroids (NEOs),⁴⁴ lunar mining, on-orbit assembly of spacecraft, robotic transport of materials, and other technologies. Growing out of a commitment to remove, re-cycle, or rehabilitate orbital debris could come new cislunar industries, including materials reprocessing, spacecraft manufacturing, multi-purpose platform construction, propellant depots and staging site construction, cislunar transportation development, new communication networks, and navigation infrastructure.

Summary

The issue raised by the consideration of solar power satellites as sitting ducks is merely illustrative of the risks and reward of both present and future economic activities. It also raises the issue of international legal reforms and new initiatives. Space debris could be a show stopper for the future – but only if we let it. It is well within our power to constructively address the risks and investments to facilitate an emergent, and eventually booming, cislunar space ecosystem.

The investment to manage and remediate space debris is first an “insurance” cost to maintain acceptable levels of risk in doing space-connected business. Remediating orbital debris is also the road to a vibrant cislunar economy. The emerging cislunar economy will include solar power satellites, GEO communications platforms, Earth-Moon Lagrange facilities, and a reusable transportation infrastructure in cislunar space and will be orders of magnitude greater than the current space economy. Solving the challenges of orbital debris opens the door to that greater economy.

Notes

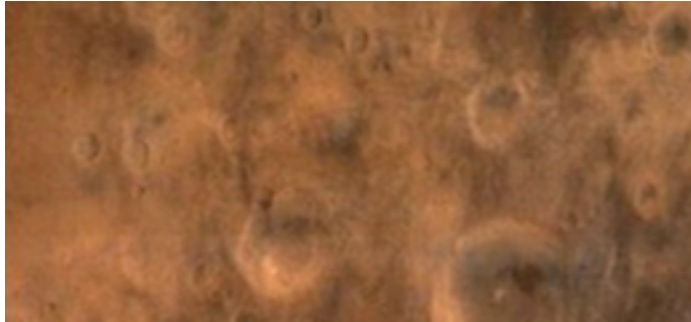
- 1 Mankins, John C.; The Case for Space Solar Power, 2014, p. 21.
- 2 NASA Orbital Debris Program Office; “Orbital Debris Frequently Asked Questions.” (<http://orbitaldebris.jsc.nasa.gov/faqs.html#7>), 12 November 2013.
- 3 Jer-Chyi Liou speaking at the 2014 NewSpace Conference Orbital Debris Panel on July 26.
- 4 Jer-Chyi Liou; Ibid., stated that working satellites represent only about 7% of the large objects in orbit around the Earth. Other have put the fraction at 7.6%.
- 5 Jer-Chyi Liou; Op. Cit.
- 6 Jer-Chyi Liou; Op. Cit.
- 7 NASA; Op. Cit.
- 8 For first reference to what became known as the “Kessler Syndrome,” see Kessler, D. J. and B. J. Cour-Palais (1978), “Collision frequency of artificial satellites: The creation of a debris belt,” J. Geophys. Res., 83(A6), 2637–2646, doi:[10.1029/JA083iA06p02637](https://doi.org/10.1029/JA083iA06p02637). For a reference to the Kessler Syndrome being approached, see Grossman, Lisa, “NASA considers Shooting Space Junk with Laser,” Wired, 15 March 2011; National Research Council, “Orbital Debris: A Technical Assessment,” The National Academies Press, 1995.
- 9 Kessler, Donald; “The Kessler Syndrome” (<http://webpages.charter.net/dkessler/files/KesSym.html>) webpages.charter.net, 8 March 2009.
- 10 See lasvegascitylife.com/sections/opinion/knappster/George-knapp-infinity----and-beyond.html, April 14, 2013.
- 11 SPS-ALPHA stands for “Solar Power Satellite via Arbitrarily Large Phased Array.”
- 12 Mankins, John C.; Op. Cit. pps. 461.
- 13 Mankins, Op.Cit.; pps. 8 and 424.
- 14 Mankins; Op. Cit. p. 9.
- 15 Joe Carroll, President of Tether Applications, Inc., speaking at the 2014 NewSpace Conference Orbital Debris Panel on July 26. Also, Jer-Chyi Liou, Op. Cit.
- 16 Multiple publications speak of this disaster, including NASA, Op. Cit.
- 17 Jer-Chyi Liou stated at the 2014 NewSpace Conference that shrapnel from 5 mm to 1 cm is the most dangerous because of its ubiquity and relative velocity. It is the collision of car-sized objects, from 1–9 MT, however, which has contributed and will continue to contribute to the vast growth of these objects.
- 18 \$200 million subsequent cost versus \$30 million immediate cost per catastrophic collision. But this conservative estimate does not take into consideration all downstream costs due to loss of communication and electronic services on the ground, which could run into the billions, especially with multiple collisions. See Pearson, Jerome; Levin, Eugene; Carroll, Joseph; “The Long-Term Cost of Debris Removal from LEO,” 64th International Astronautical Congress, Beijing, China, 2013.
- 19 Dykewicz, Paul; “DARPA Advances Plans to Salvage Antennas of Retired, In-Orbit Satellites,” www.onorbitwatch.com/program/darpa-advances-plans-salvage-antennas-retired-orbitsatellites, 24 November 2013. The cellularization process was also described by David Barnhart, Program Manager for DARPA Phoenix, during the Orbital Debris Panel on July 26 at the 2014 NewSpace Conference.
- 20 “Intelsat Picks MacDonald, Dettwiler, and Associates Ltd. For Satellite Servicing,” www.mdacorporation.com/corporate/news/pr/pr2011031501.cfm, 15 March 2011; Spark, Joel; “MDA, Intelsat Cancel On-Orbit Servicing Deal,” Space Safety Magazine, 20 January 2012; Foust, Jeff; “The Space Industry Grapples with Satellite Servicing,” The Space Review, 25 June 2012.

- 21 Adrienne Alessandro for Goddard Space Flight Center, "NASA's Robotic Refueling Mission Practices New Satellite-Servicing Tasks," Space Daily, 13 May 2013.
- 22 Pearson, Jerome; Levin, Eugene; Carroll, Joseph; "Affordable Debris Removal and Collection in LEO," 63rd International Astronautical Congress, Naples, Italy, 2012. http://www.star-tech-inc.com/papers/Affordable_Debris_Removal_IAC_2012.pdf.
- 23 Hungarian J. Szentesi has designed a non-propellant space device, using what he calls an Electro-Magnetic Propulsion System (EMPS), which also thrusts against a planet's magnetic field and theoretically could be used to move orbital debris. See J. Szentesi; "Electro-Magnetic Propulsion System (EMPS) for Spacecrafts and Satellites, 43rd Lunar and Planetary Science Conference, 2012.
- 24 Pearson, et al; both publications Op. Cit. Joe Carroll noted more specifically at the 2014 NewSpace Conference that 3/8 of the mass of orbital debris is at 81° – 83° inclination and 3/16 is in sun-synch orbit.
- 25 Joe Carroll; Op. Cit.
- 26 Joe Carroll; Op. Cit.
- 27 Although EDDE vehicles use solar energy to create an electrical flux, other spacecraft potentially involved in debris mediation may very well benefit from energy beamed from the ISS.
- 28 "Upgraded Space X Falcon 9.1.1 will launch 25% more than old Falcon 9 and bring the price down to \$4209 per kilogram to LEO," <http://nextbigfuture.com2013/03/upgraded-spacex-falcon-911-will-launch.html>.
- 29 Pearson, et al.; "Affordable Debris Removal...."; Op. Cit.
- 30 See <http://www.cinelli-iron-metal.com/market.php>.
- 31 Pearson, et al.; "Affordable Debris...."; Op. Cit., http://www.star-tech-inc.com/papers/Affordable_Debris_Removal_IAC_2012.pdf.
- 32 <http://space.stackexchange.com/questions/2046/delta-v-chart-mathematics>; <http://www.strout.net/info/science/delta-v/>; http://en.wikipedia.org/wiki/Delta-v_budget.
- 33 Ibid.
- 34 For general information about how ground-based laser could be used to deorbit space debris see work by Dr. Claude Phipps, <http://photonicassociates.com/>.
- 35 Robertson, Donald F.; "A Commercial Approach to Debris Control," Ad Astra, pps. 20 – 23.
- 36 Co-author Dunlop's personal communication with Andrea DiPaolo of McGill University Institute of Air and Space Law.
- 37 Doug Beason, speaking at the 2014 NewSpace Conference Orbital Debris Panel on July 26, noted that Space Command does not track even larger debris in real-time and can only predict location of large debris seven days in advance and with error-bars of 1.5 – 10 km.
- 38 Doug Beason; Ibid.
- 39 Joe Carroll at 2014 NewSpace Conference; Op. Cit. For general background on problems caused by free parking relevant to the LEO commons, see book by Donald Shoup, The High Cost of Free Parking, Updated Edition, 2011. Also see article by Garret Hardin, "The Tragedy of the Commons," Science, 13 December 1968, <http://www.sciencemag.org/content/162/3859/1243.full>
- 40 Robert Hoyt, CEO and Chief Scientist of Tethers Unlimited, described on July 26 this de-orbiting system during the Orbital Debris Panel at the 2014 NewSpace Conference.
- 41 Schenk, Mark; "Cleaning Up Space Debris with Sailing Satellites," University of Surrey, 31 January 2014.
- 42 See Quigley, J. T.; "Japan will Cast a 'Magnetic Net' for Space Junk, 16 January 2014; Rutkin, Aviva Hope; "Japan's Huge Magnetic Net Will Trawl for Space Junk," New Scientist, 22 January 2014. Also see Pousaz, Lionel; "The Time Has Come to Destroy Debris," <http://www.s-3.ch/en/mission-goals>; Barraud, Emmanuel; "Cleaning up Earth's Orbit: A Swiss Satellite to Tackle Space Debris," Mediacom, www.s-3.ch/en/mission-goals-and-actu.epfl.ch/news/cleaning-up-earth-s-orbit-a-swiss-satellite-to-tac/. S3 is itself partnering with 12 other companies and one major investor/sponsor (Breitling).

- 43 McNight, Darren; "Pay Me Now or Pay Me More Later: Start the Development of Active Orbital Debris Removal Now," <http://www.amostech.com/TechnicalPapers/2010/Posters/McKnight.pdf>.
- 44 Robert Hoyt; Op. Cit. at the 2014 NewSpace Conference, also described company mechanisms that could be used for de-spinning orbital debris and NEOs.

India's Mars Probe enters orbit around Mars

Comments by Dave Dunlop



Mangalyaan's 1st

Photo of Mars' Surface

With a successful entry into Mars orbit, September 24, 2014, ISRO's (Indian Space Research Organization) Mangalyaan spacecraft has admitted India into the elite club of "Mars-faring countries" of the US, Russia and the European Union." Indian media were quick to point out that India did this at about one tenth the cost of the NASA Maven spacecraft which also recently arrived in Mars orbit days earlier.

It should be mentioned that of all the missions sent to Mars about half have failed. Getting to Mars is a formidable achievement. Indians should be proud of their success on the first try and that they accomplished their goal so cost efficiently. This is one of those "drinking Champagne and smoking cigars" moments for ISRO Mission Control and Headquarters in Bangalore in celebration of the hard work that paid off.

Now, the mission's scientific work begins. We look forward to the reports of mission accomplishments. We hope that this success will spur the Indian government to give ISRO more opportunities to demonstrate its skills with additional audacious missions of exploration. As an orbital asset around Mars, this spacecraft is also a piece of communications infrastructure for Instruments landing on Mars. We hope this lays the foundation for another Mars surface mission.

Costs on this Mangalyaan mission were not dissimilar to the earlier successful Chandrayaan I Moon mission in 2007. We are looking forward to ISRO's next Moon Mission Chandrayaan II, with its orbiter, lander and rover.

We hope that the Team Indus Google Lunar X-Prize team will also make it to the Moon and contribute to an International Lunar Geophysical Year campaign that advances both lunar exploration and the understanding of development and the utilization of lunar resources. ##

ONLINE OP-ED ARTICLES FROM OTHER WRITERS WORTH READING

An International Effort could Establish Human Settlement on Mars

Welcome to the **International Mars Research Station**, a plan to bring the world's leading space-faring nations together to cooperate in the establishment of a permanent human presence on Mars.

By **Shaun Moss**, Melbourne, Australia

<http://marsbase.org/welcome>

Presenting the IMRS and Blue Dragon architecture at TEDx Noosa, 2014-04-04

This website presents a program of near-term, affordable and achievable missions to send international crews of six people to Mars and return them safely to Earth, while developing a base on Mars as an initial step towards settlement. The concept for the base is the International Mars Research

Station (IMRS), a shared facility to be developed by a partnership comprised of the world's top space agencies, for use by all nations and peoples.

This plan is supported by a modern, practical, safe and affordable architecture for human Mars missions called "Blue Dragon", which takes advantage of the latest advancements in space technology. Blue Dragon is an evolution of the [NASA Design Reference Architecture 5.0 \[7\]](#), incorporating several innovations designed to reduce costs and to maximise safety, the likelihood of success, and the overall benefit to humanity.

The main difference between Blue Dragon and the DRA is the choice to focus on a single location rather than several, thus enabling reuse of base components across multiple missions. Additional advantages are gained through the use of reusable rockets and reusable interplanetary spacecraft. Commercial off-the-shelf hardware components, such as capsules, rockets, spacesuits and habitat modules, are utilised as much as possible in order to further reduce expenses by saving on development costs. ISRU (In Situ Resource Utilisation) technology is used for manufacturing propellant, breathable air and water, thereby reducing launch mass and mission cost. Controlling program cost will reduce obstacles to sending humans to Mars, making it possible to achieve that goal sooner, and will enable more missions to be conducted and more countries to be involved, thus benefiting more people.

The architecture achieves improved safety by using capsules to ferry crews between the surfaces and orbits of Earth and Mars; pre-deploying virtually all the base hardware, including the Mars Ascent Vehicle (MAV), Surface Habitat, surface vehicles (rovers), power systems and ISRU equipment; and providing redundant backup elements of the base, such as a spare habitat, rover, solar panels, etc.

IMRS and the Blue Dragon architecture have been designed as a first step in a broader process of settlement rather than a standalone Apollo-style "flags and footprints" program focused purely on science and/or exploration. This affects the destination of the mission as well as surface activities. The reasoning is that science and exploration can proceed more easily and rapidly once a permanent human presence has been established, and since we plan to settle Mars eventually anyway, it's more efficient to take that approach from the start. Research activities during surface missions will be oriented around science and exploration, but also engineering and construction, primarily in the context of supporting human habitation and settlement of Mars.

The plan outlined here is not designed to serve the interests of any one nation, but humanity as a whole. For this reason, and also due to the cost and scale of the IMRS program, the intention is that it will be completed by an international consortium of space agencies, and perhaps also companies and universities, rather than a single entity. This is considered necessary for budgetary as well as political, ethical and philosophical reasons.

It is hoped that you will enjoy learning more about this exciting project, which has the potential to bring the world together in a peaceful and tremendously historic adventure, namely, opening up a new world for human civilisation. It's important to note that this website currently serves purely a means of presenting and sharing this idea, and at the time of writing no space agencies are attached to it as yet. If and when this changes, the site will be updated to reflect that. Part of the reason for building this website is to present the idea and hopefully to engage the interest of space-faring nations and companies.

For more information, contact Shaun Moss: <http://marsbase.org/contact>

Editor: We have known **Shaun Moss** for some years now, and have a deep respect for his insights and ideas.

The Future of Moon Exploration, Lunar Colonies and Humanity

<http://www.space.com/26584-future-of-moon-exploration.html>

By Miriam Kramer, Space.com Staff Writer – July 21, 2014 _ Summary below

Scenario: A rocket carrying more than a dozen privately built probes touches down on the Moon.

- The robots burst from the vehicle in a race to beam back high-definition video and other data while roving the surface of Earth's nearest natural satellite. The people of Earth watch a broadcast of the race as the rovers roam (or stall) in the lunar dust.
- Different motives drive the various teams
- But they have all flown the more than 354,000 km (220,000 mi) to the Moon, riding on a wave of commercial hopes that rest on the lunar surface.

- One of these Lunar X Prize teams could win the race before the end of 2015.

Eighteen teams are currently competing to win up to \$30 million to be awarded to the first private team that successfully launches an unmanned lander to the Moon and meets a set of objectives:

- Send video and other data back to Earth,
- Travel 1,640 feet (500 meters) on the Moon

Many of today's lunar entrepreneurs have different goals in mind

- Some companies might be interested in lunar tourism
- Others want to mine the moon for resources
- Others see the moon as a second home for humanity.

"The first question is why anybody is interested in the moon," said John Logsdon, professor emeritus at Elliott School of International Affairs at George Washington University. "

Probably for many potential explorers, **the most interesting thing is that it's close. It's just an offshore island, where[as] any other destination in space is weeks to months away.** Any private organization, and most nations interested in going beyond low-Earth orbit, are going to be focused on first going to the Moon."

Ideally, the Google Lunar X Prize competition will help to create an industry based around commercial motivations for visiting the Moon, representatives for the organization have said.

While the 18 teams are all contributing to the development of commercial lunar interests, their motivations for entering the competition — and explanations of what winning the prize will mean — are as diverse as the international teams themselves. (Examples of different motives follow.)

A lunar CATALYST

Though NASA is not planning to forge a way back to the Moon, it doesn't mean that agency scientists and engineers have lost interest. NASA recently launched the Lunar CATALYST program, (short for Lunar Cargo Transportation and Landing by Soft Touchdown) designed to help private companies interested in going to the Moon. The program provides unfunded NASA support for a select group of private companies that want to pave a way to the lunar surface. NASA will give Moon Express, Astrobotic and Masten Space Systems use of NASA facilities and technology.

Public-private partnerships are being examined in new ways

NASA has successfully partnered with private companies before. Two private organizations are currently flying robotic uncrewed missions to the International Space Station for the agency. NASA is also partnering with companies to create a crew ferry service to ISS that could fly as early as 2017.

The CATALYST program doesn't necessarily have the same goal as NASA's other commercial partnerships, however.

When NASA looks at the Moon, it doesn't see an anchor guarantee of any kind — nothing like an International Space Station that will be orbiting and requiring a steady supply of cargo over X-number

From the Moon to Mars

"By building up and mining the Moon, groups could be able to extract material that can be used to fuel rockets and bring people farther into space than ever before, said Robert Bigelow, founder of Bigelow Aerospace, a company aiming to develop the capability to land a base on the Moon."

"I see the Moon as a tremendous resupply asset for going to Mars, for going anyplace else," Bigelow said. "Because even though you may have depots on the way to Mars." The Bigelow Aerospace plan hinges on the idea that private companies and nations will be interested in having a base on the moon. Those groups could contract Bigelow to build a base and fly it to the lunar surface, where they can then mine, experiment and settle on the moon.]

Another company, Golden Spike, also plans to help launch people to the Moon. But first, the company plans to provide interested nations with the capability to launch their astronauts on a round trip to the lunar surface for \$1.5 billion per flight instead of starting from scratch.

The company plans to use existing, tested technology to fly astronauts to the lunar surface. The plan is to buy rockets and capsules. The company could eventually provide flights for private organizations like Bigelow who needs to get people up to the lunar surface safely. Golden Spike should be ready to fly the first missions in six to seven years. ##



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

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 presenting their entries to NASA's annual Space Settlement Design Contest. Usually, The Moon Society and SEDS participate in this conference.

<http://isdc.nss.org>

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

The Moon Society has informal relationships with the Calgary Space Workers, Calgary, Alberta, Canada and with Sociedad Espacial Mexicano, Mexico. The Society has individual members in many countries.

The Moon Society's **Moon Miners' Manifesto India Quarterly** – the predecessor to **To The Stars International Quarterly**, has been going to students and others in India and around the world since August 2008. Older issues are available as free pdf downloads at:

<http://www.moonsociety.org/india/mmm-india/> and <http://www.moonsociety.org/international/ttsq/>

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.

How to 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.

There are chapters of SEDS around the world: (USA), **India, Nigeria, United Kingdom, Philippines**, and more; SEDS–Earth is a central node for communication between these worldwide chapters.

Mississippi & Louisiana Students Get Out-of-This-World Start to School Year

http://www.spacedaily.com/reports/prnewswire-space-news.html?doc=201408291015PR_NEWS_USPR_DC00678

WASHINGTON, Aug. 29, 2014 – Students from Mississippi and Louisiana gathered at the INFINITY Science Center in Pearlington, Mississippi, for a long-distance call with NASA astronauts currently orbiting Earth aboard the International Space Station. The special back-to-school education event took place Tuesday, September 2, 2014.

The event was broadcast live on NASA Television and the agency's website. More than 300 fourth to eighth grade students had an opportunity to ask Expedition 40 Commander Steve Swanson and Flight Engineer Reid Wiseman questions about life, work and research aboard the space station.

Prior to the 20-minute Earth-to-space call, the students spent time learning about the orbiting laboratory, rockets and NASA's new deep space exploration spacecraft, Orion, which is set to make its maiden spaceflight in December.

Linking students directly to astronauts aboard the space station provided an authentic, live experience of space exploration, space study, the scientific components of space travel and the possibilities of life in space.

This in-flight education downlink is one in a series with educational organizations in the United States to improve science, technology, engineering and mathematics (STEM) teaching and learning.

It is an integral component of NASA's Teaching From Space education program, which promotes learning opportunities and builds partnerships with the education community using the unique environment of space and NASA's human spaceflight program.

NASA Wants You to Help Sort Astronaut Photos of Earth at Night

<http://www.space.com/27023-nasa-astronaut-photos-earth-at-night.html>

Sept. 5, 2014 – Scientists want your help to sort through gorgeous images of Earth at night from ISS.



Left: North and South Korea – **Right:** Spain, Portugal and Gibraltar

The Cities at Night Project – <http://www.citiesatnight.org>.

Studying these photographs could show how light pollution is affecting human health and reveal ways to [save](#) energy and improve public safety.

- The pictures need to be catalogued first. Without the help of citizens, it is almost impossible to use these images scientifically.
- Algorithms cannot distinguish between stars, cities and other objects, such as the Moon. Humans are much more efficient for complex image analysis.
- The photos are in a database called **The Gateway to Astronaut Photography of Earth**. The images range from those taken in the early 1960s during NASA's Mercury program all the way to present-day pictures taken from the International Space Station.
- As of August, there were about 1.8 million images in the database, and about 30 percent of those were taken at night.
- The citizen-science project, which is led by a group of researchers at Complutense University, is called "**Cities at Night**."
 1. "**Cities at Night**" consists of three separate parts.
 2. "**Dark Skies**," has people sort images into three categories: cities, stars or other
 3. "**Night Cities**," match places in the images with points on maps. Establishing the location of the photographs helps create light maps of cities and could provide some insight into energy usage.
- "**Lost at Night**" is the third and most complicated part of the project, asking citizens to identify cities in photos with a 500 km (310 mi) circumference.
- "We don't know which direction the astronaut pointed the camera, only where the station was at the time the image was taken," Sanchez said. "Some images are bright cities but others are small towns. It is like a puzzle with 300,000 pieces."
- Volunteers have classified almost 20,000 images so far, but scientists require multiple volunteers to classify the same image to ensure accuracy.
- The open catalog of data is free and available for anyone to use.
- The project team hopes that scientists can examine the colors of light in each photo and determine the type of energy a city is using and evaluate its energy efficiency.
- The images could also reveal areas where lighting around roads is lacking and thus help improve public safety.
- The data can also pinpoint areas where light pollution could be influencing human health and biodiversity, researchers said.

- The high resolution of some of the images comes from the European Space Agency's "NightPod," which was installed on the space station in 2012. NightPod is a motorized tripod that adjusts to match the space station's 17,500 mph (28,160 km/h) orbital speed.
- Before NightPod, the motion of the station and the motion of [Earth](#) below blurred images even if astronauts used high-speed film. ##

Student-Built Rovers Will Face Off on Mock Mars Missions

Sept. 5, 2014 - <http://www.livescience.com/47704-mars-rovers-european-competition.html>

Robots built by students from around the world faced off in a competition designed to test how well these wheeled explorers might one day get around on the surface of Mars.

- The European Rover Challenge involves creating a prototype [Mars rover](#) that must attempt to complete several tasks, such as navigation and sample return, in a simulated Martian environment.
- The competition, organized by the NGO Mars Society Polska, was held Sept. 5-7 in Poland's Swietokrzyskie Region. A 3-day "Humans in Space" conference itook place at the same time.
- The goal of the rover competition is to give students experience in developing technologies for manned missions to Mars, while increasing interest among the general public in space exploration.
- These robots will assist humans, the same way trained dogs assist rescue teams on Earth.
- 24 teams are registered for the challenge, including participants from Australia, Bangladesh, Canada, Colombia, Egypt, India, Poland, the United Kingdom and the United States.
- The teams include university undergraduates, masters and doctoral students, and recent graduates
- Ph.D. students can make up no more than half of the team.
- Each rover must attempt to complete four tasks to take place in a simulated Martian environment.
 1. The first task involves gathering samples of rock, surface soil and deeper soil, and transporting them back to the rover base.
 2. The second task is to navigate the rover to three locations given by sets of coordinates, without the use of a camera.
 3. The third task is to "repair" a broken mock reactor system.
 4. The fourth task is to obtain a spare part from storage and transporting it to a repair site..
- The budget cap for each rover was \$15,000 (11,590 euros), which the teams had to raise themselves.
- The teams were also required to provide documentation of how the rovers were built, and assign management positions within the team. ##

Float in Earth's Upper Atmosphere with Small High-Altitude Balloons

Sept 5, 2014 - <http://www.space.com/27043-high-altitude-balloons-floating-satellites.html>

<https://www.kickstarter.com/projects/1965134794/rockzip-a-million-balloons-a-billion-lives>

Have you ever wished you could have your own personal satellite? Indiana-based startup Rockzip recently launched a Kickstarter campaign to bring affordable, floating space probes to the masses. Known as high altitude balloons, or "highballoons," the company says its products will make the upper reaches of the atmosphere more accessible to researchers, entrepreneurs and budding scientists.

- Conventional high-altitude balloons are made of a thin plastic skin and filled with helium or hydrogen, the balloons are handmade and sell for around \$1,500.
- By using cheaper materials and streamlining production, Rockzip could start selling its high-altitude balloons for half that price, "around \$750.
- High-altitude balloons, some of which can reach altitudes of up to 30,500 m or 30.5 km (100,000 ft or 19 mi), have been used to observe weather patterns since the early 1900s, and NASA has been using these types of balloons to conduct scientific experiments for the past 70 years.
- One of the latest uses for high-altitude balloons is [Google's Project Loon](#), which uses them to provide affordable Internet access to remote areas of the world.

Smaller is Cheaper: The company's "full-size beta highballoon," can carry about 2.7 kg (6 lbs). Its smaller product, the "pro highballoon," can carry 0.45 kg (about 1 lb)

- The full-size beta balloon can reach altitudes of up to 65,000 feet (19,800 m) — more than twice the normal flying altitude of a commercial airplane — and can float for around 12 hours.
- The pro version travels to about 30,000 feet (9,140 m), and can stay airborne for about 5 hours.
- The company hopes to increase the amount of time its balloons can spend in the air, up to weeks.

Possible Science Applications:

- Predicting crop yields in places like sub-Saharan Africa
- Tracking deforestation of the world's rainforests
- They can snap aerial photographs at much higher altitudes than the average drone.

Using a high-altitude balloon is simple.

- First, build your payload.
- Attach a GPS tracker, camera, sensors or other equipment
- Fill the balloon with helium and can then float high up into the atmosphere.

[Rockzip's Kickstarter](#) campaign has so far raised nearly \$6,000 of its \$15,000 goal, with eight days remaining in the campaign.

NASA Announces Student-focused Experiment Program Awards Targeted at reaching graduate students and post-doctoral fellows

<http://www.digitaljournal.com/pr/2168376> – September 5, 2014

More: <http://www.digitaljournal.com/pr/2168376#ixzz3CdIZNwUt>

The International Space Station Program Science Office has announced the award recipients for the International Space Station **Post-Graduate Innovation Awards in Space Life and Physical Science Research** opportunity.

The announcement was targeted at reaching graduate students and post-doctoral fellows who were already starting a career as science researchers in the Life and Physical Sciences disciplines.

- Proposals included **innovative ideas for microgravity research** specifically in the areas of physical sciences, microbiology and space physiology.
- Recipients are eligible for awards up to \$4,000, which will allow them to submit a full space station research flight proposal.
- One of these proposals may also be eligible for full funding for a flight to the space station.
- Criteria that included the significance of the study, the approach's design and methods, level of innovation, the qualifications of the investigators and the appropriateness of the scientific environment.
- The target is a new and specific group of graduate students and fellows and get them involved in space station science: growing the next generation of space researchers.

Recipients for this set of awards are:

- Josh Colwell with the University of Central Florida for the project Behavior of Regolith in Microgravity Environments on Asteroids and Planetary Satellites. This concept investigates regolith motion in reduced-gravity environments, specifically looking at the low behavior of granular material along slopes (landslides and avalanches) under reduced-gravity conditions; and the displacement of granular matter in response to impact-induced seismic vibrations.
- Jae-Hoon Chung with the Ohio State University for the project Effect of Spaceflight on Stem Cell-derived Cardiomyocytes with Arrhythmogenic Mutation. Microgravity is known to cause various changes in the cardiovascular system such as reduced arterial pressure and heart rate. This concept proposes a study of the biological mechanism of microgravity-induced arrhythmias in a controlled in vitro model.
- Paul Steen with Cornell University for the project Inferring Contact-line Mobility by Observing Coalescence Dynamics. This concept seeks to understand contact-line (CL) mobility in drops that are undergoing coalescence on a solid surface. The results of this investigation can possibly enable longer duration missions to Mars and beyond, by potentially enabling high heat transfer rates in a low mass system that requires no external energy to remove drops.
- Thomas Avedisian with Cornell University for the project Development of an Algae Biodiesel Surrogate from Spherically Symmetric Droplet Combustion Experiments on the International Space Station. This concept studies the ignition and burning characteristics of algal biodiesel droplets and its relationship

to a surrogate derived from the major constituents of the biodiesel. The algal biodiesel is used as an alternative/renewable fuel source for combustion engines.

- Yiguang Ju with the Trustees of Princeton University for the project Study of Cool Flames with Ozone Sensitization in Microgravity. The concept presented is a novel method for using plasma-generated ozone to establish stable cool diffusion and premixed flames in a microgravity field so that cool flame dynamics, structure, and chemistry can be studied and understood in an ideal environment. This can lead to a higher energy efficiency of high performing engines.

For a dditional information about EPSCOR, visit:

http://www.nasa.gov/mission_pages/station/research/news/epscpr

Read more: <http://www.digitaljournal.com/pr/2168376#ixzz3Cdlq45ji>

NASA Announces 2014 Aeronautics Scholarship Recipients

www.nasa.gov/press/2014/september/nasa-announces-2014-aeronautics-scholarship-recipients/

Sept. 15, 2014 – NASA has selected **20 students** from across the nation to receive the agency's **Aero-nautics Scholarship for the 2014–2015 school year**.

This program, in its seventh year, is designed to assist **undergraduate and graduate students enrolled in fields of study related to aeronautics**.

Recipients were selected from hundreds of applications to the program.

The students will have the opportunity to intern with NASA researchers and work on developing technologies to

- increase efficiency in air traffic management,
- reduce aircraft noise,
- fuel consumption and emissions, and
- improve air safety.
- This year's recipients attend universities in **Alabama, California, Georgia, Illinois, Indiana, Maryland, Massachusetts, New York, North Carolina, Pennsylvania, Virginia and Washington state**.
- Undergraduate scholarship winners will receive \$15,000 a year to cover tuition costs for two years and a \$10,000 stipend during a summer internship with NASA.
- Graduate scholarship winners will receive approximately \$45,000 a year for two years and \$10,000 stipends for two summer internships.
- To maintain their scholarship awards, all recipients must continue to meet the academic standards of the universities they attend.
- For a list of the 2014 scholarship recipients, visit: <http://go.nasa.gov/1qLLvNa>

Boy Scout Space Exploration

<http://www.thespacereview.com/article/2552/1> – full text below, unabridged

What can space advocates do to help inspire the next generation of space enthusiasts and professionals? Ken Murphy describes how one National Space Society chapter updated a guide to space exploration that will be read by thousands of Boy Scouts.



Since the Dallas–Fort Worth area is home to the head office of the Boy Scouts of America, one of the projects that NSS (National Space Society) of North Texas gets to work on periodically is an update to Space Exploration merit badge pamphlet. With the 2004 edition (our last big contribution) well in need of an update, the chapter worked in 2010 to provide one, and in April of 2014 the most recent update was published, bigger and better than ever.

Past NSS of North Texas chapter president Ken Murphy has long been interested in the Space Exploration merit badge as a channel to highlight space advocacy objectives to a younger audience, and even organized a merit badge program at the Frontiers of Flight Museum for a score of scouts. When the opportunity arose in 2010 to provide another comprehensive update to the requirements, Ken quickly organized a team that included NSS Houston and NSS Austin and got to work.

The most notable content change derives from the retirement of the Space Shuttle program. We were writing for the future, and had an opportunity to highlight many new transportation options. The shuttle would have to be retired to the historical missions section, and vast swathes of text excised (from 5½ pages to 1), which created some friction with older members who had known and worked on the Shuttle program. Interestingly, because of the time frame in which we were working, the SLS doesn't make an appearance anywhere in the book. Prescient?

There were also changes to some requirements and their descriptions. The [full current list of requirements](#) can be found on the Boy Scouts website.

For requirement 2, Scouts are called upon to create an “astronaut trading card”. In the 2004 edition, a number of brief bios are given in two sections: Dreamers and Doers. For the latest edition we reworked it into Visionaries, Makers (in tribute to the Maker community), Doers, and Entrepreneurs. A couple of names were dropped, such as H.G. Wells, Gene Roddenberry, and Buzz Aldrin (his picture is on the trading card illustration in the pamphlet, so he's still represented), and some new names added, like Robert Heinlein (who published many stories in the Boy Scout magazine *Boy's Life*), Dr. Gerard K. O'Neill of L-5 fame, Sergei Korolev, Steve Squyres, John Young (to bridge the Apollo/Shuttle eras), Robert Bigelow, Peter Diamandis, and Elon Musk.

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A lot of debate went into determining the list. Some on the team wanted more shuttle-era representation in the Doers section, but no one could agree on whom to cut to make room. The first American in space? The first American in orbit? The first American on the Moon? So we cut the second man on the Moon, and added the first Space Shuttle pilot. No one could agree on a shuttle astronaut: Eileen Collins? Michael Lopez-Alegria? Ron McNair? Jeff Hoffman? No consensus could be found, so we punted on including a more current Space Shuttle astronaut.

Requirement 3 involves the building and launching of model rockets. NSS of North Texas usually passes on this requirement, leaving it to the experts at the National Association of Rocketry (NAR) to take ownership, just as we do locally with the Dallas Area Rocket Society (DARS) on rocketry-related stuff.

Requirement 4, which covers some basic physics of spaceflight, saw only modest changes, mainly a paragraph on the VASIMR engine. A short section on orbital elements and TLEs of satellites was not adopted, unfortunately.

Requirement 5, which requires a discussion of a past space mission, includes a section summarizing past robotic missions in the Solar System, which required extensive updating from the last update in the 2003 timeframe. Working in 2010–11, we recognized we'd have to be conservatively forward-looking and include missions out to the 2015 timeframe. Nevertheless, here in 2014 the info is already current. Perhaps we should have been even more forward-looking, to 2018–2020, but we did have deadlines to meet, and the uncertainty factor starts going asymptotic the farther out you get. The

Moon got almost a full additional page, while for Mars a full-page picture of one of the Mars Exploration Rovers was replaced with up-to-date text. Asteroids also got a full new page. I had attempted to “web-ify” the content a bit by including the web addresses for the homepages of each of the missions, but that was dropped.

Previously, requirement 6 called for a description of the Space Shuttle or the ISS. In the new edition, it’s the ISS or “Shuttle or any other crewed orbital vehicle, whether government-owned (U.S. or foreign) or commercial.” There was a nice comparison table of launch vehicles and in-development crew vehicles submitted that would have made a nice two-page spread and even included web links to the actual launcher guides for the rockets, but that didn’t make the cut. This was where much of the Space Shuttle material was excised, but the ISS got a couple of extra pages, and a description of “The New Era of Space Transportation” was added to reflect the changes that were and would be undergone in the industry.

Requirement 7 called for the design of a Moon or Mars base. We suggested that be expanded to include asteroids and the moons of Jupiter, but the choice ends up being Solar System-wide. Most stunning is the addition of a full page of content on “Free Space Facilities,” discussing the Earth-Moon L-1 point (a topic unknown to most, and the addition of which I am most proud), as well as habitats at Earth-Moon L-5. There’s also half a page on “Asteroid Facilities,” while both the Moon and Mars sections got an update to include discussions of commercial as well as scientific interests. There’s also an added section on “The Future of Space Exploration” that highlights many of the topical discussions, and includes several paragraphs on space development that touch on asteroid and Moon mining, solar-power satellites, infrastructure development, and propellant depots.

Requirement 8, to discuss space careers, was left alone given the high degree of uncertainty in space-related employment markets. While in the past a government-funded job was the most likely career path, either directly through employment at NASA, or indirectly through subcontractors and universities receiving NASA funding, increasing entrepreneurial efforts will require some pathfinding of new career paths, many of which can’t be foreseen. By the next update, though, things should be a bit clearer.

Overall the pamphlet has grown from 87 pages to 96, an almost 10% increase thanks to the efforts of NSS of North Texas (and others) to keep the pamphlet relevant and accurate. Many space advocacy priorities have been given a new outlet, with frank discussions of things like solar power satellites for energy, space settlement, and asteroid mining for resources. A whole new generation will be exposed to these ideas. The infrastructure is there: an organized Scouting program, local museums and universities with relevant resources, other space-related community organizations. If NSS members, or the space community at large, made an effort, how many Scouts could we help get the Space Exploration merit badge? One thousand? Ten thousand? One hundred thousand?

Some may deride the work of space activists as ineffective, and I wouldn’t particularly disagree in regards to political efforts, but this project illustrates how those critics are wrong. This updated pamphlet will be seen by countless young Scouts (and others who read it) over the next decade, and it will shape their thinking on the topic. It is a solid reference book on the topic of space exploration (and development), and an effort of which NSS of North Texas is rightly proud. ##

NASA’s New Citizen Science Website for “Mars Balance Mass Challenge”



<http://www.nasa.gov/press/2014/september/nasa-launches-new-citizen-science-website-opens-challenge-to-participate-in/>

Sept 20, 2014 RELEASE 14-259 – NASA announced the opening of registration for its **Mars Balance Mass Challenge** and the launch of its new website, **NASA Solve**, at the World Maker Faire in New York.

- NASA is committed to **engaging the public**, and **specifically the maker community** through innovative activities like the Mars Balance Mass Challenge
- And **NASA Solve** is a great way for members of the public, makers and other citizen scientists to see all NASA challenges and prizes in one location.”
- The Mars Balance Mass Challenge seeks design ideas for small science and technology payloads that could serve dual purpose as **ejectable balance masses** on spacecraft entering Mars’ atmosphere.
- The payloads will also perform **scientific or technology functions** that help us learn more about the Red Planet, and **provide the necessary weight to balance planetary landers**.
- Submissions are due by November 21.
- Winner announced in mid-January 2015 and receive an award of \$20,000.
- “This challenge is a creative way to bring innovative ideas into our planning process,
- and perhaps help NASA find another way to pack more science and technology into a mission.”
- NASA Solve will host content for all agency challenges and prizes, features information on this new challenge at: <http://www.nasa.gov/solve/marsbalancechallenge>

NASA hosted an exhibit at the World Maker Faire through Sunday, Sept. 21, where citizen scientists and makers could learn about other ways to engage with the space agency, including

- Centennial Challenges
- CubeSat program
- 3-D printer challenge,
- Asteroid Grand Challenge.

The Mars Balance Mass challenge is managed by NASA's Center of Excellence for Collaborative Innovation (CoECI). CoECI was established in coordination with White House Office of Science and Technology Policy to advance NASA open innovation efforts and extend that expertise to other federal agencies. The challenges are being released on the NASA Innovation Pavilion, one of the CoECI platforms available to NASA team members, through its contract with InnoCentive, Inc.

Money Raised for “Telescopes to Tanzania”

<http://astronomerswithoutborders.org/projects/telescopes-to-tanzania.html>

The **Center for Science Education and Observatory in East Africa** will:

- **Conduct astronomical and science training for teachers and students.**
- **Integrate astronomy into the national teaching curriculum.**
- **Develop and circulate hands-on science and astronomy teaching resources.**
- **Create a model science laboratory and observatory** with telescopes, computers, a portable planetarium, internet capacity, and connections to observatories and science centers worldwide.
- Money (\$40,000 as of 9/6/14) for this worthwhile project has been raised through **Astronomers without Borders** and on the Indiegogo website.
www.indiegogo.com/projects/telescopes-to-tanzania

“**Hint!**” An additional \$17,000 will **DOUBLE** the number of astronomy/science ambassadors who will:

- **Visit schools** throughout Tanzania
- **Train teachers** to teach hands-on, inquiry-based science
- **Teach students**
- **Train government education officers** in understanding science teaching and scientific concepts
- **Bring more NEW science curricula to schools throughout Tanzania**
- **Provide science education resources to TWICE as many schools ##**

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)

Fall 2014 issue

- 10 International Space Development Conference 2014: The Space Renaissance Begins – Clifford McMurray
- 14 Who Wants to be an Astronaut? Pretty Much Everyone – Travis K. Kircher
- 20 A Commercial Approach to Debris Control – Donald E. Robertson
- 24 Unlocking the Potential of Space Elevators: An International Academy of Astronautics Study
– Peter and Cathy Swan
- 28 Space in the Great Plains – Mark Williamson
- 36 The Ansari X- Prize – A Catalyst for Commercial Spaceflight – Mike White



www.MMM-MoonMinersManifesto.com

AUGUST 2014 – MMM #277

- 2. In Focus: Fifty Years ago, July 31st, 1964 – a Mind-Blowing Experience – Peter Kokh
- 3. Which World would you rather pioneer? Moon or Mars? – Peter Kokh
- 8. Biowaste Recycling on the Moon – David Dietzler

SEPTEMBER 2014 – MMM # 278

- 2 In Focus: Venus & Mercury: Why Limit Human Frontiers to Moon and Mars? – Peter Kokh
- 3 Venus: The Sources of Radical Transformation are already "on Location" – Peter Kokh
- 5 Mercury: Discovery of a hidden Settlement Sweet Spot; "Location, Location, Location" – Peter Kokh
- 7 Moon Base Costs: Dave Dietzler

OCTOBER 2014 – MMM #279

2

Non-time sensitive articles from past issues are available online in pdf format
in two sets of Collections

MMM Classics issues collect articles in collections by publication year with 2–3 year lag
http://www.moonsociety.org/publications/mmm_classics/

MMM Themes issues collect articles according to various "themes"
http://www.moonsociety.org/publications/mmm_themes/

Both the **MMM Classics** and **MMM Theme issues** are also available on the NSS site at:
<http://www.nss.org/settlement/moon/library/mmm.htm>

Moon Miners' Manifesto Resources

<http://www.moonsociety.org/chapters/milwaukee/mmm/>

MMM is published 10 times a year (except January and July. The December 2011 issue began its 26th year of continuous publication.

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.

Some of the points made will relate specifically to **pioneer life** in the lunar environment. But much of what will hold for the Moon, will also hold true for **Mars and for space in general**. We have one Mars theme issue each year, and occasionally **other space destinations** are discussed: the asteroids, Europa (Jupiter), Titan (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/

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 2nd 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/

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

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 to join our team.

If you think that 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 [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, and in the education of young people on whom the future of the world 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 dealing with moondust, 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):

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Reader suggestions for improvements in TTSIQ are welcome. Email kokhmmm@aol.com

This issue and others are online at: www.nss.org/tothestars/ and at www.moonsociety.org/international/ttsiq/

Membership in our Sponsor Organizations is encouraged

National Space Society

www.nss.org – <http://www.nss.org/membership/>

The Moon Society –

www.moonsociety.org – <http://www2.moonsociety.org/register.index>



The Stars International Quarterly #9

Engage! And Enjoy!