

www.nasa.gov/press-release/nasa-confirms-evidence-that-liquid-water-flows-on-today-s-mars

Flash! Sept. 28, 2015: www.space.com/30674-flowing-water-on-mars-discovery-pictures.html

www.space.com/30673-water-flows-on-mars-discovery.html - "boosting odds for life!"

These dark, narrow, 100 meter~yards long streaks called "recurring slope lineae" flowing downhill on Mars are inferred to have been formed by **contemporary flowing water**

www.space.com/30683-mars-liquid-water-astronaut-exploration.html

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TTSIQ Sponsor Organizations



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



NEW, this issue: Most of the “editor’s summaries” of news articles in recent issues of To The Stars have been in the form of bullet points of the contents. However, time spent rendering the bulletized versions of articles has become an enormous burden, and we cannot continue.

From now on, we will give the URL web address of the article, its title and date, and a key image if there is one. We leave it up to the reader to explore further.

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



ANALOG FACILITY TRAINING

Crew of Underwater NASA Mission Available for Interviews

24 July, 2015 –

www.nasa.gov/press-release/crew-of-underwater-nasa-mission-available-for-interviews



NEEMO 18 crew member ESA (European Space Agency) astronaut Thomas Pesquet wraps up rehearsals and training in his dive helmet off the coast of Key Largo, Florida.

Arctic Crater Preps New Astronaut for Space

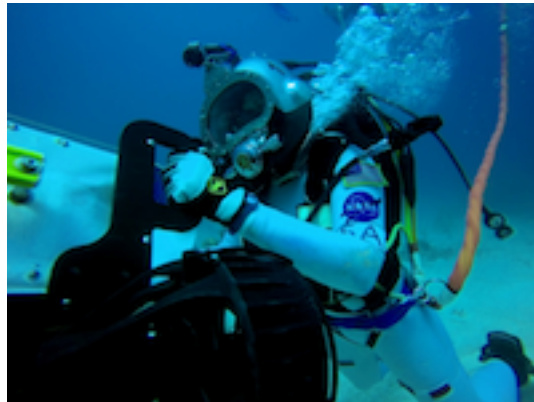
27 July, 2015 – www.space.com/30049-arctic-crater-preps-new-astronaut.html

A 28-km (17-mi) wide crater recently discovered in 2010 high up in the Canadian Arctic, in a harsh spot that could be like the Moon or Mars, is a good place to look at shatter cones, formations in rock that are formed under really high pressure after a celestial visitor smashes into the ground at high speed and cause the ground to buckle and sometimes melt.

Over thousands of years, craters on Earth get eroded by wind and rain. But on the Moon, the only erosion comes from micrometeorites and the occasional big slam. Martian craters also get eroded, but the atmosphere is thinner and the dust different; this could change the erosion time. ##

Astronauts Test Virtual-Reality Headset for Space On Ocean Floor

2 August, 2015 - www.space.com/30125-neemo-astronauts-virtual-reality-space-tech.html



NASA astronaut Serena Aunon moves tools and equipment underwater during NASA's NEEMO 20 mission, which began July 29.

It's a tech geek's dream fulfilled in the underwater lab hosting four "aquonauts" for 14 days where they get to practice space exploration with a cutting-edge Microsoft virtual-reality headset, Microsoft's HoloLens, whose augmented-reality technology overlays a virtual display on the real world, will someday go to space itself to assist astronauts. ##

Indiegogo Campaign Seeks Funds to Rebuild Mars Desert Research Station Greenhouse in Utah

3 August, 2015 - www.space.com/30143-mars-society-greenhouse-crowdfunding-campaign.html



The TTSIQ editor, having spent two 2-week tours at MDRS, the first in 2005, the second in 2006 (as mission commander) is very familiar with this facility.

Note: TTSIQ editor, Peter Kokh, served on two 14-day crews at this facility: Crew #34 in 2005, and crew #45 (crew commander) in 2006. He has many ideas of how this facility could have been better designed, or redesigned, and better serve its purposes

COMMERCIAL SPACE CARRIERS

July 28th Space X Rocket Failure

www.space.com/29796-spacex-rocket-explosion-commercial-crew.html

www.space.com/29788-spacex-rocket-landing-dragon-crs7-mission-photos.html

www.space.com/29789-spacex-rocket-failure-cargo-launch.html

www.nasa.gov/press-release/nasa-administrator-statement-on-the-loss-of-spacex-crs-7

www.space.com/29801-spacex-rocket-explosion-astronauts-survive.html
www.space.com/29802-spacex-rocket-explosion-customer-impacts.html
www.space.com/29994-spacex-rocket-explosion-cause-faulty-strut.html
www.space.com/29905-spacex-rocket-explosion-impacts-elon-musk.html
www.space.com/30013-spacex-complacent-rocket-explosion-musk.html



SpaceX Will Debut Upgraded Falcon 9 Rocket on Return to Flight Mission

3 September, 2015 – www.space.com/30431-spacex-falcon-9-rocket-upgrades-next-launch.html

The return to flight of SpaceX's Falcon 9 rocket, still a "couple of months" away, will also be the first launch of an upgraded version of the vehicle with increased performance. = upgrade to the current Falcon 9 v1.1, sometimes called v1.2, that features engines with increased thrust, providing an increase in performance of about 30 percent.

Space-X Reveals Interior of Dragon Capsule Crew Module

11 September, 2015 – www.space.com/30518-spacex-crew-dragon-spacecraft-interior-video.html
www.space.com/30515-spacex-unveils-the-interior-of-crew-dragon-video.html



Jeff Bezos' Blue Origin Will Launch Rockets & Spaceships from Florida

15 September, 2015 – www.space.com/30543-jeff-bezos-blue-origin-florida-rocket-launches.html
www.space.com/30542-blue-origin-invests-200-million-in-florida-launch-complex-video.html

How Jeff Bezos and Other Billionaires Are Transforming Space Travel

16 September, 2015 – www.space.com/30557-jeff-bezos-billionaires-private-spaceflight.html

Bezos announced September 15th, that Blue Origin, the private spaceflight company that he established in 2000, will manufacture and launch a **fleet of reusable vehicles** from Florida's Cape Canaveral Air Force Station, with the first flights scheduled to begin by the end of the decade. ##

Past **TTSIQ** issues are online at: www.moonsociety.org/international/ttsiq/ and at: www.nss.org/tothestarsOO

ROCKET TECHNOLOGY

Startup Makes Progress in Beamed Propulsion for Reusable Launch Vehicles

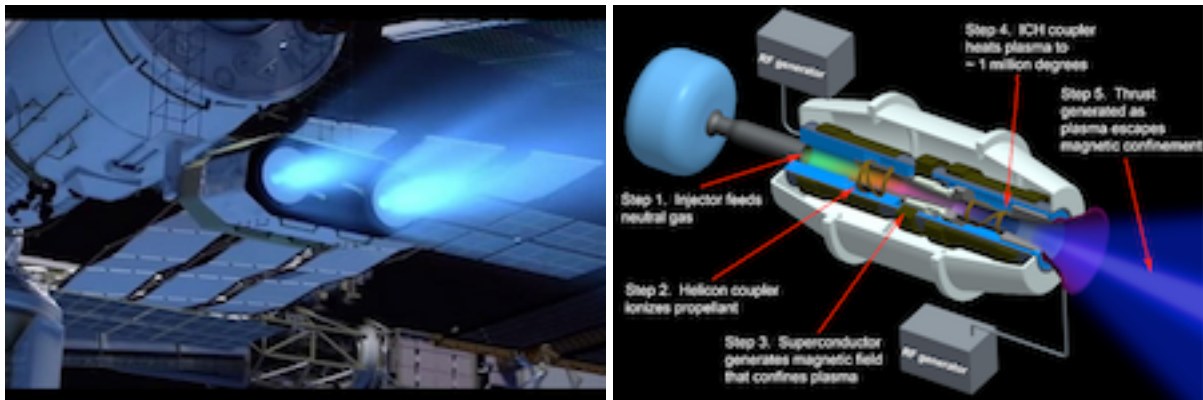
3 August, 2015 - www.space.com/30134-beamed-propulsion-reusable-launch-vehicles-startup.html
 16 September, 2015 - SAN, Calif. — A small Colorado company, Escape Dynamics, has successfully tested a new type of propulsion technology believes could eventually enable low-cost, single-stage-to-orbit launch vehicles.



It has carried out a small-scale test in the laboratory of its beamed microwave thruster, heating helium propellant and generating a small amount of thrust.

Plasma Rocket Technology Receives NASA Funding Boost

24 August, 2015 - www.space.com/30221-plasma-rocket-technology-nasa-funding.html



Right: concept of a single-state-to-orbit spacecraft, powered with beamed microwaves

A potential advancement in the United States' electric propulsion capability for the future of spaceflight is being underscored by a new NASA contract to support work on the VASIMR project - the **V**ARIABLE **S**PECIFIC IMPULSE **M**AGNETOPLASMA **R**OCKET.

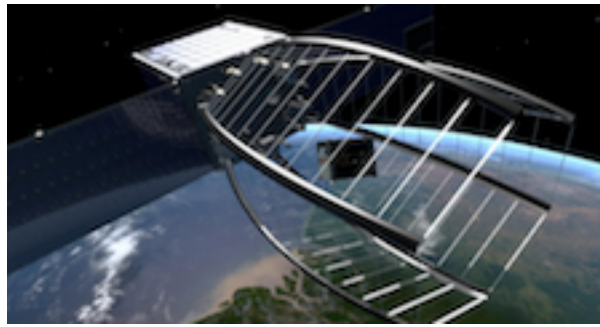
Ad Astra Rocket Company is to conduct a long duration, high-power test of an upgraded version of the VX-200 VASIMR prototype, the VX-200SS ("SS" for steady state), for a minimum of 100 hours continuously at a power level of 100 Kilowatts. These experiments aim to demonstrate the engine's new proprietary core design and thermal control subsystem and to better estimate component lifetime, ##

ORBITAL SPACE DEBRIS PROBLEM

How 'A Pac-Man' Satellite Will Gobble Up Space Debris | Video

www.space.com/30079-how-a-pac-man-satellite-will-gobble-up-space-debris-video.html

www.space.com/30007-space-junk-cleanup-pac-man-approach.html



Do watch [the Xideo](#)

This small cubesat-type satellite, measures just 4 in by 4 in (10 cm by 10 cm).

Barring an unforeseen event, SwissCube's demise has been programmed for 2018.

The size of SwissCube makes it tough to grasp, but it also has darker and lighter parts that reflect sunlight differently. CleanSpace One could be launched as early as 2018 in collaboration with the company S3, headquartered in Payerne. The engineering team is reporting a major step forward in designing an approach and capture system – a so-called "Pac-Man" solution. ##

SPACE STATIONS

China's super "eye" to speed up space rendezvous

www.spacedaily.com/reports/Chinas_super_eye_to_speed_up_space_rendezvous_999.html

25 June, 2015 – Chinese space experts have developed the world's most sensitive "eye" that enables the autonomous rendezvous and docking of two spacecraft – flying eight times faster than bullets – more efficiently and safely.

The "eye" is China's newly developed third-generation rendezvous and docking CCD optical imaging sensor. It will be used on China's 2nd orbiting space lab, Tiangong-2, the Chang'e-5 lunar probe and the permanent manned space station, according to China Academy of Space Technology (CAST).

More than Space Salad: Zero-G Botany is Rewriting Textbooks

www.space.com/30199-more-than-space-salad-zero-g-botany-is-rewriting-textbooks.html

8 August, 2015 – Gravity is a constant for all organisms on Earth. It acts on every aspect of our physiology, behavior and development – no matter what you are, you evolved in an [environment](#) where gravity roots us firmly to the ground. But what happens if you're removed from that familiar environment and placed into a situation outside your evolutionary experience? ##

NASA Notifies Congress About Space Station Contract Modification with Russia

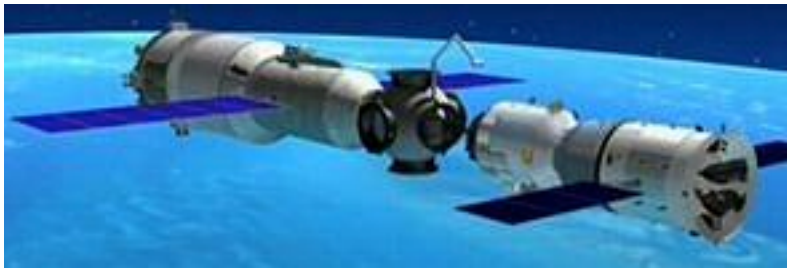
www.nasa.gov/press-release/nasa-notifies-congress-about-space-station-contract-modification-with-russia/ TEXT: www.nasa.gov/sites/default/files/atoms/files/soyuz_seat_modification_letter.pdf

Due to their continued reductions in the president's funding requests for the agency's Commercial Crew Program over the past several years, NASA was forced to extend its existing contract with the Russian Federal Space Agency (Roscosmos) to transport American astronauts to the International Space Station. This contract modification is valued at about \$490 million. ##

China's super "eye" to speed up space rendezvous

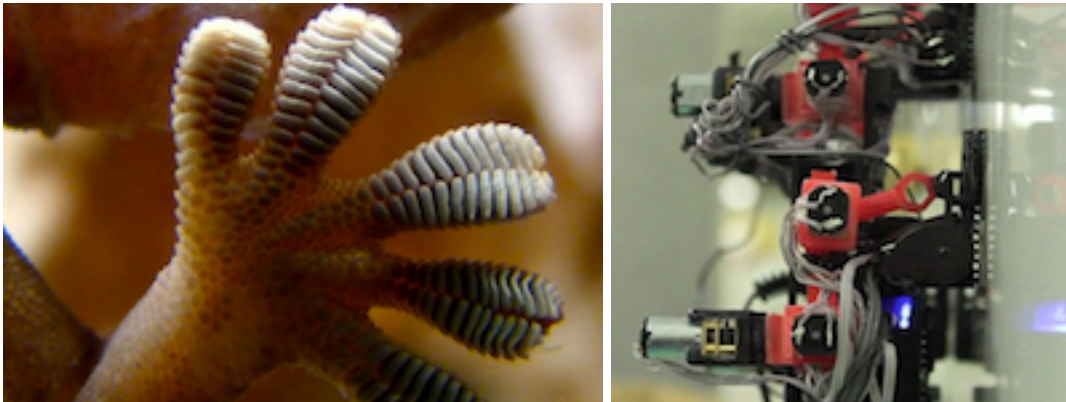
28 June, 2015 – www.spacedaily.com/reports/Chinas_super_eye_to_speed_up_space_rendezvous_999.html

Chinese space experts have developed the world's most sensitive "eye" to enable the autonomous rendezvous and docking of two spacecraft – flying eight times faster than bullets – more efficiently and safely. The "eye" is China's newly developed third-generation rendezvous and docking CCD optical imaging sensor. It will be used on China's second orbiting space lab, Tiangong-2, the Chang'e-5 lunar probe and the permanent manned space station. ##



Gecko Feet Inspire Climbing Space Robots

13 August, 2015 - www.space.com/30258-nasa-gecko-space-robot-sticky-feet.html
www.space.com/30255-gecko-feet-teach-nasa-how-to-stick-to-space-objects-video.html
www.wired.co.uk/news/archive/2015-08/14/nasa-gecko-robots



Grippers the key to robots that can climb anything in zero-G and aboard Space Station.

NASA Extracting Tanks from Retired Shuttle Endeavour for Use on Space Station

17 August, 2015 - www.space.com/30271-nasa-removes-space-shuttle-endeavour-tanks.html



The tanks were in the lower deck of Endeavor
 NASA's retired space shuttle Endeavour will supply four tanks to the International Space Station for use as water storage systems for the space station to help free more crew time for science operations on-board the orbiting outpost by reducing the astronauts' involvement in refilling their water reserves. ##

Inflatable Habitats: From the Space Station to the Moon and Mars?

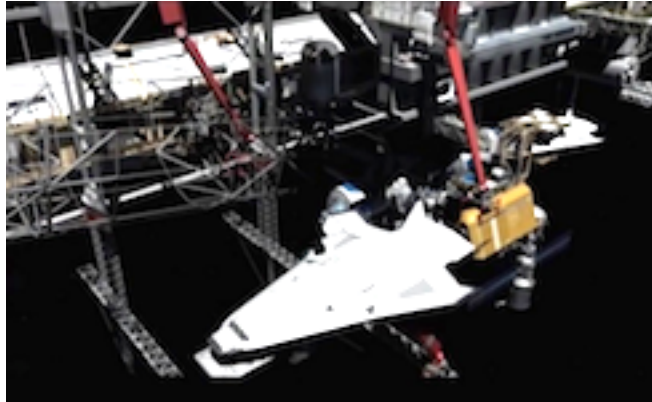
18 August, 2015 - www.space.com/30277-bigelow-aerospace-private-space-station.html



This image shows how Bigelow Aerospace's Bigelow Expandable Activity Module (BEAM) will look after its arrival at the International Space Station in 2015.

US Military Foresees Robot-Run 'Transportation Hub' in Space

14 September, 2015 - www.space.com/30529-darpa-robotic-space-transportation-hub.html



Artist's concept of a robot-run space transportation hub at geosynchronous orbit, about 22,370 miles (36,000 kilometers) from Earth.

The future of spaceflight involves building, refueling and repairing spacecraft in a depot far from Earth, all without the aid of human hands, according to the Defence Advanced Research projects Agency (DARPA) which is developing a **highly capable robotic arm** that could make such a space "transportation hub" possible in the relatively near future. It makes much more sense to build a transformative transportation hub at GEO than at low-Earth orbit (LEO), which lies at an altitude between 186 miles and 373 miles (300 to 600 km). ##

Improve the Space Station Tour - Do take it!

<http://blogs.esa.int/rocketscience/2015/08/27/improve-the-space-station-tour/>



ESA published a full street-view tour of the International Space Station to explore with video explanations from astronauts and links to websites:

ASTRONAUTS

NASA Assigns 4 Astronauts to Commercial Boeing, SpaceX Test Flights

9 July, 2015 - www.space.com/29892-nasa-astronauts-spacex-boeing-test-flights.html

NASA Selects Astronauts for First U.S. Commercial Spaceflights

www.nasa.gov/press-release/nasa-selects-astronauts-for-first-us-commercial-spaceflights-0

9 July, 2015 - Robert Behnken, Eric Boe, Douglas Hurley and Sunita Williams (born in India)

TECHNOLOGIES & ROBOTICS

NASA Awards Aerospace Propulsion, Communications Research Contracts

www.nasa.gov/press-release/nasa-awards-aerospace-propulsion-communications-research-contracts

28 July, 2015 - NASA has awarded contracts to 13 companies to provide advanced propulsion and communications system technologies as part of ongoing long-term aerospace research activities at the agency's Glenn Research Center in Cleveland.

- GE Aviation, Cincinnati
- United Technologies Corporation, East Hartford, Connecticut
- Rolls-Royce North American Technologies, Inc., Indianapolis
- Williams International, Walled Lake, Michigan
- Aerojet Rocketdyne of DE, Inc., Canoga Park, California
- Orbital Technologies Corporation, Madison, Wisconsin
- The Boeing Company, St. Louis
- Northrop Grumma & n Systems Corporation, Redondo Beach, California
- Alliant Techsystems Operations LLC, Elkton, Maryland
- Sierra Lobo, Inc., Fremont, Ohio
- General Dynamics C4 Systems, Scottsdale, Arizona
- John Hopkins University Applied Physics Laboratory, Laurel, Maryland
- MTI Systems, Inc., Greenbelt, Maryland

Each of the 13 indefinite-delivery, indefinite-quantity contracts provide for fixed price, cost share and cost reimbursement competitive tasks with a cumulative maximum value of \$190 million over the next five years. Each contract will have a minimum value of \$30,000.##

NASA Awards Grants for Technologies That Could Transform Space Exploration

www.nasa.gov/press-release/nasa-awards-grants-for-technologies-that-could-transform-space-exploration

15 August, 2015 The selected NASA Early Career Faculty proposals are:

- Robust Planning for Dynamic Tensegrity Structures -- Kostas Bekris, Rutgers U. New Brunswick, New Jersey
- Synthetic Biology for Recycling Human Waste into Food, Nutraceuticals, and Materials: Closing the Loop for Long-Term Space Travel -- Mark Blenner of Clemson U., Clemson, South Carolina
- Lightweight and Flexible Metal Halide Perovskite Thin Films for High Temperature Solar Cells -- Joshua Choi of the University of Virginia in Charlottesville
- Dynamics and Control of Tensegrity Space Manipulators -- James Forbes, U. Michigan, Ann Arbor
- Advanced Physical Models and Numerical Algorithms to Enable High-Fidelity Aerothermodynamic Simulations of Planetary Entry Vehicles on Emerging Distributed Heterogeneous Computing Architectures -- Matthias Ihme of Stanford U., Stanford, California
- Reduced Order Modeling for Non-equilibrium Radiation Hydrodynamics of Base Flow and Wakes: Enabling Manned Missions to Mars -- Marco Panesi, U.f Illinois, Urbana-Champaign
- Engineering Cyanobacteria for the Production of Lightweight Materials -- Fuzhong Zhang of Washington U., St. Louis

- High Temperature InGaN-based Solar Cells -- Yuji Zhao, Arizona State U, Tempe.

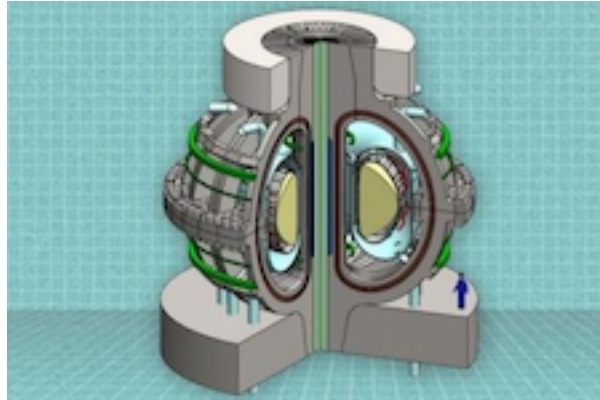
These proposals have the potential to yield significant rewards for space exploration by:

- Allowing solar cells to function at reasonable levels of efficiency in high-temp. environments;
- improving the process of identifying most effective thermal protection systems for entering various atmospheres;
- providing means to produce food, medical supplies and building materials on site at distant destinations using synthetic, biology-based approaches; and
- enabling more capable and affordable space missions through development of tensegrity technologies that permit large, reconfigurable structures such as antennas, solar arrays and observatories, as well as lightweight landers. ##

Could This Innovation Signal A Breakthrough In Fusion Energy

<http://finance.yahoo.com/news/could-innovation-signal-breakthrough-fusion-205100351.html>

13 August, 2015 – Massachusetts Institute of Technology (MIT) researchers are using advances in magnet technology [advances in magnet technology](#) to propose a new design for a practical compact tokamak fusion reactor. It's one that might be realized in as little as a decade, they say. They suggest the era of practical fusion power, which could offer a nearly inexhaustible energy resource, may be coming near.



<http://newsoffice.mit.edu/2015/small-modular-efficient-fusion-plant-0810>

A cutaway view of the proposed ARC reactor. Thanks to powerful new magnet technology, the much smaller, less-expensive ARC reactor would deliver the same power output as a much larger reactor.

Small fusion reactors could open the entire solar system to manned space travel. ##

European Astronaut Uses 'the Force' to Control Rover from Space

14 September, 2015 – www.space.com/30539-astronaut-drives-robot-with-the-force.html



www.space.com/30488-space-borne-astronaut-runs-robot-on-earth-video.html

www.cnet.com/news/astronaut-drives-rover-on-earth-from-space/

ESA astronaut Andreas Mogensen helped demonstrate the first "force feedback" using a rover controlled from space. With the help of a system that let him feel forces pressing against the rover's arm, he remotely inserted a small, round peg into a "task board" that offered just a fraction of a millimeter of clearance. He managed two complete drive, approach, park and peg-in-hole insertions, demonstrating precision force-feedback from orbit for the very first time in the history of spaceflight. ##

CUBESATS

NASA Wants to Use Hoverboard Tech to Control Tiny Satellites

2 September, 2015 - www.space.com/30446-nasa-hoverboard-technology-cubesats.html

It's a vision of the future that may even have eluded Marty McFly: hoverboard tech in space. NASA wants to make this vision a reality, and soon by teaming up with California-based company Arx Pax, which has developed a real-life hoverboard using a technology called Magnetic Field Architecture (MFA).



MISSION TO PLANET EARTH

NASA Satellite Camera Provides "EPIC" View of Earth

20 July, 2015 - www.nasa.gov/press-release/nasa-satellite-camera-provides-epic-view-of-earth
www.space-travel.com/reports/From_a_million_miles_away_NASA_camera_shows_moon_crossing_face_of_Earth_999.html

20 July, 2015 - A NASA camera on the Deep Space Climate Observatory (DSCOVR) satellite has returned its first view of the entire sunlit side of Earth from one million miles away.

The color images of Earth from NASA's Earth Polychromatic Imaging Camera (EPIC) are generated by combining three separate images to create a photographic-quality image. The camera takes a series of 10 images using different narrowband filters -- from ultraviolet to near infrared -- to produce a variety of science products. The red, green and blue channel images are used in these Earth images.



Ancient Huts May Reveal Clues to Earth's Magnetic Pole Reversals

28 July, 2015 - www.space.com/30070-ancient-huts-earth-magnetic-reversal.html



Grain bins much like these modern ones in southern Africa, were ritually burned down during Africa's Iron Age. The scorched ground beneath them conserved rare clues about the Earth's magnetic field.

If Greenland's Ice Melts, Sea Levels Rise 23 Feet | Video

14 Sept. 2015 = www.space.com/30466-if-greenland-s-ice-melts-sea-levels-rise-23-feet-video.html



[From now on, we will give the URL web address of the article, its title and date, and a key image if there is one. We leave it up to the reader to explore further. . - Peter Kokh kokhmmm@aol.com]

NEAR SPACE & SPACE TOURISM

Deadly SpaceShipTwo Crash Caused by Co-Pilot Error: NTSB



28 July, 2015 - www.space.com/30073-virgin-galactic-spaceshiptwo-crash-pilot-error.html

www.space.com/30077-spaceshiptwo-crash-sir-richard-branson-responds-to-ntsb-report-video.html
www.space.com/30076-spaceshiptwo-catastrophic-failure-moment-video.html

29 July, 2015 - www.space.com/30085-spaceshiptwo-crash-pilot-parachute-photo.html

Past **TTSIQ** issues are online at: www.moonsociety.org/international/ttsiq/ and at: www.nss.org/tothestarsOO

XCOR to Raise Ticket Prices for Suborbital Space Plane Flights

31 July, 2015 – <http://www.space.com/30102-xcor-spacecraft-higher-ticket-prices.html>



The price of tickets for flights on its Lynx vehicle will increase from \$100,000 to \$150,000 U.S.

Private Space Stations Could Be a Reality by 2025

25 August, 2015 – www.space.com/30359-private-space-stations-reality-2025.html

“If entrepreneurs and NASA can properly manage the tricky transition from the government-run international space station to privately built and operated facilities ...”



Boeing CST-100 spacecraft approaching a private inflatable space station (by Bigelow Aerospace).

World View Offers Cost-Sharing Balloon Flights to Stratosphere

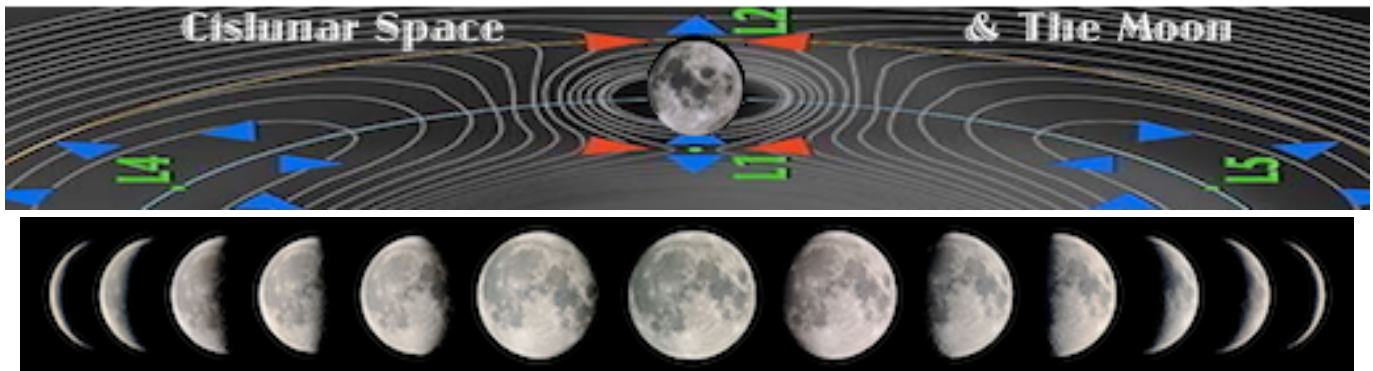
8 September, 2015 – www.space.com/30477-world-view-balloon-flights-cost-sharing.html
www.space.com/23288-space-tourism-balloon-rides-world-view-pictures.html



This capsule will eventually carry passengers

Arizona-based **World View Enterprises** announced that it is introducing a cost-sharing system that will let **researchers and educators** loft payloads to near space, about 130,000 feet (39,600 meters) above Earth, via a balloon for as little as \$20,000. The new system applies to payloads that range in mass from less than 0.45 kg (1 lb) to more than a few hundred kilograms/pounds,

(Typical "full flight" contracts, by contrast, cost hundreds of thousands of dollars.)



[From now on, we will give the URL web address of the article, its title and date, and a key image if there is one. We leave it up to the reader to explore further– Peter Kokh kokhmmm@aol.com]

THE MOON

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

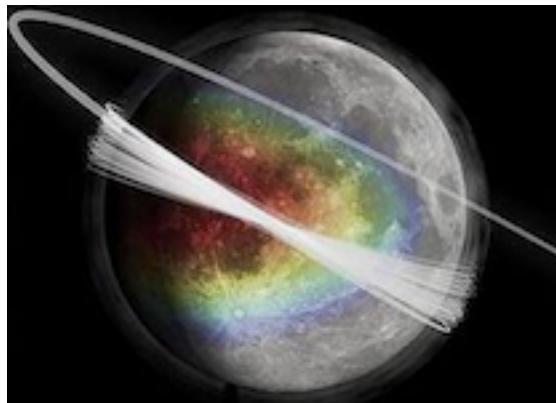
Read why: www.moonsociety.org/info/capital-M-for-Moon.html

LUNAR SCIENCE

Moon engulfed in permanent, lopsided dust cloud

www.space-travel.com/reports/Moon_engulfed_in_permanent_lopsided_dust_cloud_999.html

22 June, 2015 – The Moon is engulfed in a permanent but lopsided dust cloud that increases in density when annual events like the Geminids spew shooting stars. The cloud is made up primarily of tiny dust grains kicked up from the moon's surface by the impact of high-speed, interplanetary dust particles



An artist's conception of the thin dust cloud surrounding the Moon and the LADEE mission orbit. The colors represent the amount of material ejected from the lunar surface, with red representing the highest density of dust and blue representing the lowest density.

Do Moon's 'Time Capsules' Hold Secrets to Early Earth?

8 July, 2015 – www.space.com/29888-do-moons-time-capsules-hold-secrets-to-early-earth.html

The surface of the Earth preserves little or no information about its distant past. Constant tectonic activity has recycled Earth's crust and shifted landmasses. Rainfall, wind, ice and snow have weathered away surface features over billions of years. Most of the craters formed by the impacts of asteroids and comets have been erased from the geologic record, with just over 100 known craters remaining on the continents.

But we can go to the Moon to learn more about the past of our own planet. The Moon is covered with thousands of craters of all sizes, many of them produced shortly after the Moon was born. Without winds, rivers or plate tectonics to erode and erase these marks of ancient impacts, it is like a window into the early history of our solar system. ##

Past **TTSIQ** issues are online at: www.moonsociety.org/international/ttsiq/ and at: www.nss.org/tothestarsOO

Fire Fountains of the Ancient Moon Explained

24 August, 2015 - www.space.com/30352-fire-fountains-ancient-moon-explained.html



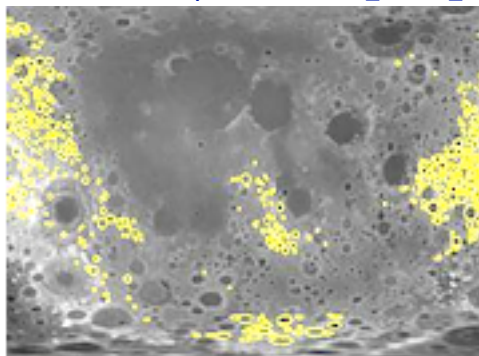
Above: the Moon coalescing from debris created when a “Mars-size” object slammed into the early Earth. Carbon found in lunar samples suggests that the moon's surface composition was very similar to Earth's.

The ancient lunar surface once erupted with geysers of lava — and now, scientists think they know what caused those fiery fountains. For a long time, its surface was much different from the staid, unmoving landscape present today. Rather, the Moon's surface was hot and active, and magma often bubbled up from below and broke the surface in fiery fountains. Until recently, researchers were unsure of the driving force behind those explosions.

But now, scientists may have found a possible culprit for the molten explosions: carbon monoxide. The carbon is the one that is producing the large spectacle. With a little bit of water, with a little bit of sulfur — but the main driver is carbon. All these volatile elements ... are in concentrations that are very similar to the lava that formed the ocean floor of the Earth. ##

Moon's crust is as fractured as can be

11 September, 2015 - www.space-travel.com/reports/Moons_crust_as_fractured_as_can_be_999.html



Researchers analyzed the gravity signatures of more than 1,200 craters (yellow) on the Moon's farside.

Some 4 billion years ago, during the “Late Heavy Bombardment,” the Moon took a severe beating, as an army of asteroids pelted its surface, carving out craters and opening deep fissures in its crust. Such sustained impacts increased the Moon's porosity, opening up a sub-surface network of seams.

Regions on the far side of the Moon, called the lunar highlands, may have been so heavily bombarded — particularly by small asteroids — that the impacts completely shattered the upper crust, leaving these regions essentially as fractured and porous as they could be. Further impacts to these highly porous regions may have then had the opposite effect, sealing up cracks and decreasing porosity.

The upper layer of the crust — the megaregolith. This layer is dominated by relatively small craters, measuring 30 kilometers or less in diameter. In contrast, it appears that deeper layers of crust, that are affected by larger craters, are not quite as battered, and are less fractured and porous.

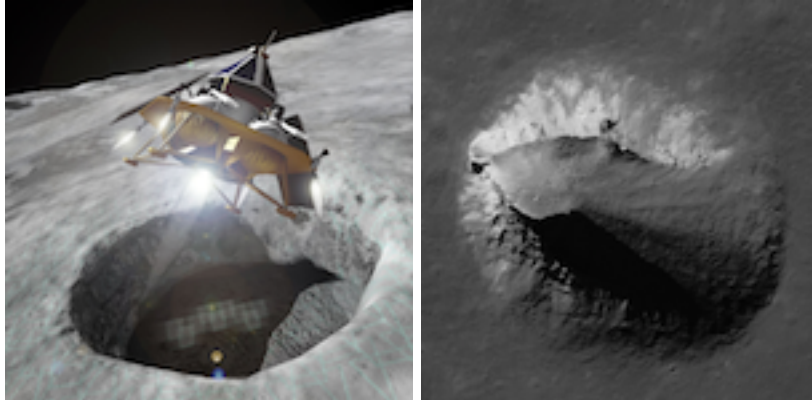
The evolution of the Moon's porosity can give scientists clues to some of the earliest life-supporting processes taking place in the solar system. ##

NASA's LRO discovers Earth's pull is 'massaging' the Moon

www.space-travel.com/reports/NASAs_LRO_discovers_Earths_pull_is_massaging_our_moon_999.html

16 September, 2015 – The gravitational forces the Moon and Sun exert are responsible for Earth's rising and falling tides. Earth's gravity also exerts forces on the Moon in the form of solid body tides that distort its shape. The Moon is slowly receding away from Earth and forces build as the moon's tidal distortion diminishes with distance and its rotation period slows with time. These tidal forces combined with the shrinking of the moon from cooling of its interior have influenced the pattern of orientations in the network of young fault scarps. ##

MOON MISSIONS



Left: Astrobotic has sold Mexico payload space on its proposed lunar lander, seen here descending to a “skylight” feature on the Moon’s surface. Credit: Astrobotic/Mark Maxwell

Right: The Lacus Mortis feature targeted by Astrobotic may have a route for its rover to follow into a cave below. Credit NASA.

How Robots Could Build a Radio Telescope on Far Side of the Moon

29 July, 2015 – www.space.com/30084-moon-far-side-rovers-radio-telescope.html



Radio telescope array being emplaced by human-controlled rover on the far side of the Moon.

Tiny Cubesat Will Hunt for Water Ice on the Moon

5 August, 2015 – www.space.com/30161-moon-water-cubesat-lunar-icecube.html



Lunar

IceCube

will probably end up launching with a number of other deep-space cubesats on the first flight of NASA's Space Launch System (SLS) megarocket, currently scheduled for 2018.

There is **room for 11 6U cubesats** on the maiden SLS mission, whose primary purpose is sending NASA's Orion capsule on an uncrewed test flight around the Moon.

Three cubesats — **Lunar Flashlight**, **BioSentinel** and **NEA (Near-Earth Asteroid) Scout** — are on the manifest, and Lunar IceCube is widely expected to share the rocket ride when all is said and done.##

Russia to Land Space Vessel on Moon's Polar Region in 2019

www.space-travel.com/reports/Russia_to_Land_Space_Vessel_on_Moons_Polar_Region_in_2019_999.html

25 June, 2015 – Russia's lunar research is currently undergoing "Earth trials" before landing on the moon in 2019. Russia plans to land a research vessel, called Luna-25 (Moon-25) on the Moon's south polar region instead of the equator, where all other landings have been centered.

The plan is to explore internal structure of the Moon and the impact of the cosmic rays and electromagnetic radiation on the lunar surface, and to search for natural resources (water ice) in the area. ##

Russia to Launch Large-Scale Space Projects with China

www.spacedaily.com/reports/Russia_to_Launch_Large_Scale_Space_Projects_With_China_999.html

5 July, 2015 – "China is willing to develop cooperation in engine building [and] urges to consider the idea of setting up joint production. We are more interested in commercialization. "

"We (Russia) intend to sell engines," ##

China Tests New (Moon) Rocket

18 August, 2015 – http://www.spacedaily.com/reports/China_Tests_New_Rocket_999.html

China aims to become the first country to land on the far side of the moon and build a base camp for astronauts within the next few years. The mission will also involve making probes from the far side of the moon, test data relay and communication capabilities from that part of the moon and demonstrate the capabilities of lunar night power generation. ##

China aims to land Chang'e-4 probe on far side of the Moon

www.space-travel.com/reports/China_aims_to_land_Change_4_probe_on_far_side_of_moon_999.html

10 September, 2015 – China is planning to be the first country to land a lunar probe on the far side of the Moon. The mission will be carried out by Chang'e-4, a backup probe for Chang'e-3, and is slated to be launched before 2020.

The far side of the Moon has a clean electromagnetic environment, providing an ideal field for low frequency radio study. Placing a frequency spectrograph on the far side, will fill a void.

Chang'e-4 is very similar to Chang'e-3 in structure but can handle more payload. ##

China to rehearse new carrier rocket for lunar mission

www.space-travel.com/reports/China_to_rehearse_new_carrier_rocket_for_lunar_mission_999.html



22 September, 2015 – A Long March-5 carrier rocket on Sunday was shipped from North China's Tianjin port for a rehearsal of a scheduled Chang'e-5 lunar mission around 2017. ##

ENTERPRIZE ON THE MOON

First Ad on the Moon: Lunar Billboard for Pocari Sweat to Fly in 2016

21 August 1015 - www.space.com/30333-moon-billboard-pocari-sweat-sports-drink.html

Japan-based Otsuka Pharmaceutical Co. aims to land a special "time capsule" can of the Pocari Sweat sports drink on the Moon next year. It will be delivered to the lunar surface by Astrobotic Technology's Griffin lander, aboard a Space-X Falcon 9 rocket in late 2016 -if all goes according to plan.

The "Lunar Dream" capsule will contain titanium plates engraved with messages submitted by people around the world, as well as a serving of powdered Pocari Sweat.

The vision calls for future lunar explorers to pop open the can and enjoy a drink, after mixing the powder with water sourced from the Moon. **VIDEO ##**

HUMAN RETURN TO THE MOON

Moon Base Would Be Cheap with Help from Private Industry: Report

27 July, 2015 - www.space.com/30008-moon-colony-cost-commercial-space-report.html

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NASA–Funded Study Reduces Cost of Human Missions to Moon and Mars by Factor of Ten

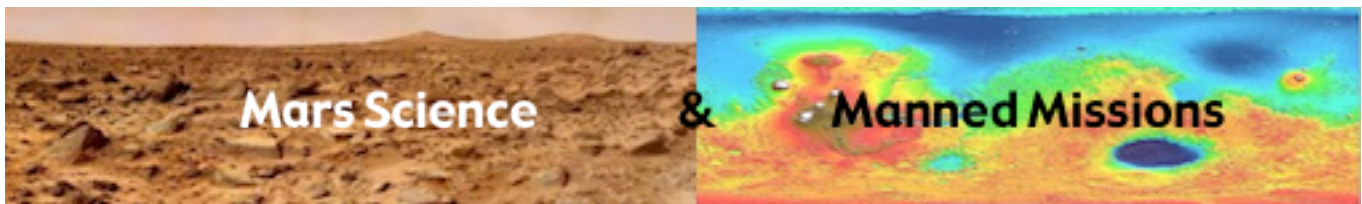
13 July, 2015 – <http://www.nss.org/docs/EvolvableLunarArchitecture.pdf>

20 July, 2015 – www.spaceref.com/news/viewpr.html?pid=46392

Russia Eyes Moon for Hi–Tech Lunar Base

www.space-travel.com/reports/Russia_Eyes_Moon_for_Hi_Tech_Lunar_Base_999.html

4 September, 2015 – Russian space agency Roscosmos is sending a robotic spacecraft to the moon to scope out potential locations for a planned lunar base. The high–tech base would feature living quarters for cosmonauts, laboratories, a launching and landing port for spacecraft, and even an astronomy observatory. The European Space Agency has also announced plans for its own Moon colony. ##



[From now on, we will give the URL web address of the article, its title and date, and a key image if there is one. We leave it up to the reader to explore further – Peter Kokh kokhmmm@aol.com]

MARS SCIENCE

Is Mars Humid Enough to Support Life?

http://feedproxy.google.com/~r/spaceheadlines/~3/81z-5U_cm88/29857-mars-humidity-alien-life.html

7 July, 2015 – The moisture in the atmosphere of Mars could be particularly conducive to life if the water condenses out to form short–term puddles in the early morning hours.

"The conditions on Mars, where the relative humidity is high and the available water vapor is approximately 100 precipitable microns, is the equivalent of the drier parts of the Atacama Desert in Chile," ##

Past **TTSIQ** issues are online at: www.moonsociety.org/international/ttsiq/ and at: www.nss.org/tothestarsOO

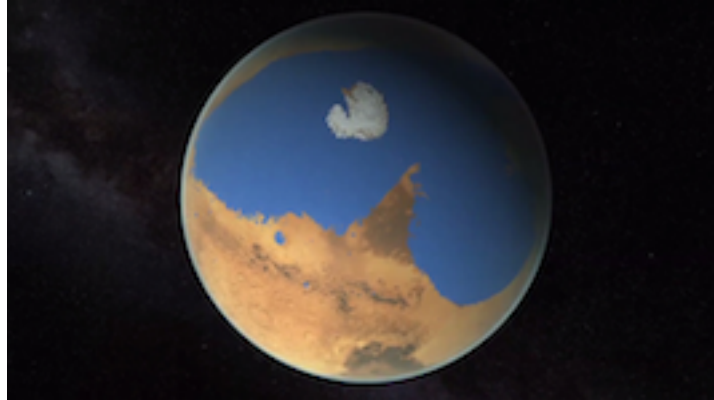
11+ Years for Opportunity on Mars

www.space.com/29868-11+-years-of-mars-roving-in-8-minutes-time-lapse-video.html

www.marsdaily.com/reports/Opportunity_Rovers_7th_Mars_Winter_to_Include_New_Study_Area_999.html

Did Ancient Mars Have Continents?

16 July, 2015 - www.space.com/29967-ancient-mars-continents-curiosity-rover.html



We now think that water once covered 20% of Mars – which means only the lowest portions of the “ocean basin” shown in blue above, may actually have held water. – Editor

With the help of a rock-zapping laser, NASA's Mars rover Curiosity has detected Red Planet rocks similar to Earth's oldest continental crust. This discovery suggests that ancient Mars may have been more similar to ancient Earth than previously thought.

Earth is currently the only known planet whose surface is divided into continents and oceans. The continents are composed of a thick, buoyant crust rich in silica, whereas the seafloor is made up of comparatively thin, dense crust rich in silica-poor basaltic rock.

In contrast, analyses of images snapped by Mars-orbiting spacecraft and studies of meteorites from the Red Planet previously suggested that the Martian crust was made up primarily of basaltic rock.

Now researchers have found that silica-rich rock much like the continental crust on Earth may be widespread at the site where Curiosity landed on Mars in August 2012. ##xs

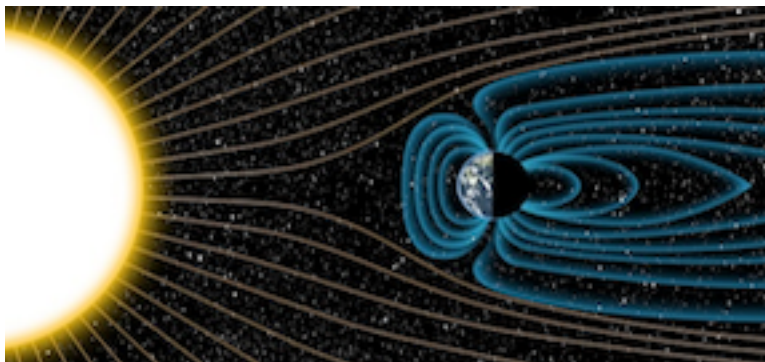
Should Scientists be looking for the Last Life forms on Mars?

30 July, 2015 - www.space.com/30099-last-life-forms-on-mars.html

Life may have lived and thrived in the oceans and lakes that once covered Mars — but some scientists want to focus the search for life on Mars on the organisms that held on when the water dried up: The last life-forms to survive on the Red Planet. ##

'Magnetic' Discovery May Reveal Why Earth Supports Life and Mars Doesn't

31 July, 2015 - www.space.com/30116-earth-magnetic-field-age.html



An illustration of how Earth's magnetic field protects the planet from solar radiation.

MARS MISSIONS

Mars Rovers and the Last Moonwalker to Invade Poland in September

www.marsdaily.com/reports/Mars_Rovers_and_the_Last_Moonwalker_to_Invade_Poland_in_September_999.html

10 August, 2015 – Poland will once again host the biggest Mars rover competition in Europe.

This year, from Sept. 5 to 6, the **second edition of the European Rover Challenge (ERC)** is expected to get even more publicity as **Harrison "Jack" Schmitt**, a member of the **Apollo 17** crew and the last man to walk on the Moon will be a special guest of the event.

ERC will also give the participants a unique opportunity to talk with **Andy Weir**, the author of the best-selling book "The Martian".

ERC will be held at the Regional Science and Technology Center in Podzamcze near Checiny, Poland. More than 300 designers in 34 teams from 12 countries will participate in the contest. ##

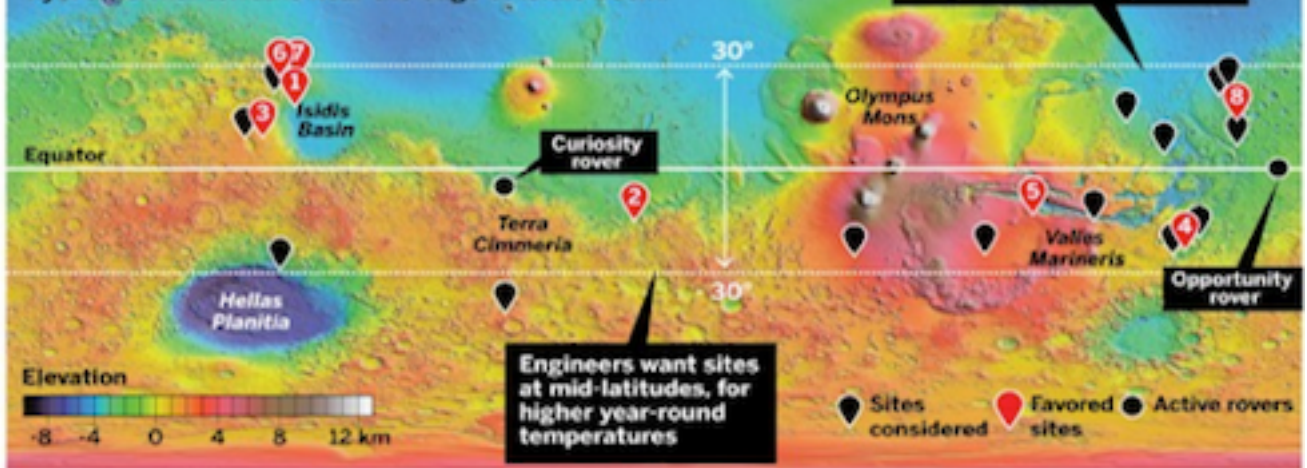
Ancient River Deltas & Hot Springs as promising targets for 2020 Rover

<http://news.sciencemag.org/space/2015/08/mars-scientists-tap-ancient-river-deltas-and-hot-springs-promising-targets-2020-rover> – 8 August, 2015 –

Favored Mars 2020 rover landing sites

Scientists have nominated the most desirable sites for NASA's next Mars rover, to be launched in 2020. Many of the favored sites lie in hydrothermal terrains near the edge of Isidis Basin.

Engineers want sites at low elevations, so the rover can generate more atmospheric drag during landing

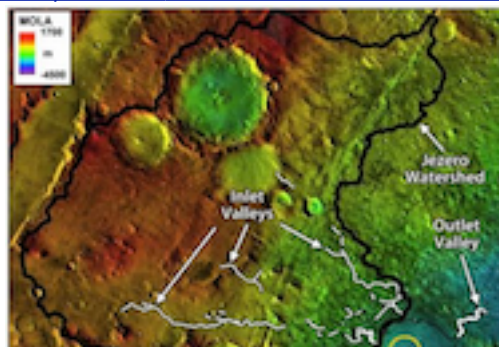


Top 8 sites (by average vote): 1. Jezero Crater | 2. Columbia Hills | 3. NE Syrtis | 4. Eberswalde | 5. SW Melas | 6. Nili Fossae Trough | 7. Nili Fossae Carbonate | 8. Mawrth

Where Will NASA's 2020 Mars Rover Land?

20 August, 2015 – www.space.com/30320-nasa-2020-mars-rover-landing-site.html

www.space.com/21900-nasa-mars-rover-2020-images.html



NASA's Mars 2020 rover may study ancient Mars by surveying the big Jezero Crater paleolake.

The 45 km (28-mi)-wide Jezero Crater emerged as the frontrunner among 30 or so potential locales during the second landing-site workshop for NASA's 2020 Mars rover mission.

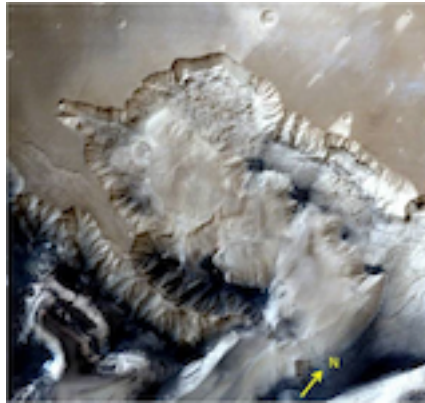
By zeroing in on Jezero Crater — the Mars 2020 mission could study and cache samples from one of the most intriguing regions of the Red Planet. But Jezero Crater the top candidate for now.

Jezero is rich in clay minerals and once harbored a basin lake and drainage network that covered a huge catchment area – a rover's paradise of mineralogy and geochemistry: Martian life may have developed in Jezero, since it is believed the lake was long lived.

www.space.com/26701-nasa-mars-2020-rover-explained-infographic.html ##

India's 1st Mars Probe Captures Stunning 3D View of Huge Chasm

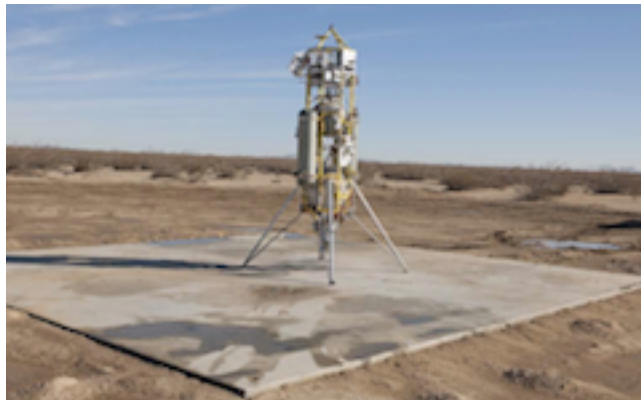
28 August, 2015 – www.space.com/30367-india-mars-probe-3d-chasm-photos.html



3D portrayal of the **Ophir Chasma** canyon on Mars was taken by India's Mars Orbiter **Mangalyaan-1**. Ophir Chasma is a portion of the massive **Valles Marineris** that stretches across much of Mars equator. The images were taken July 19 and have a resolution of about 96 m (315 ft). ##

'Xombie' Rocket Got Brains! Proves New Mars Landing System | Video

www.space.com/30385-xombie-rocket-got-brains-proves-new-mars-landing-system-video.html



28 August, 2015 – Masten Space Systems, in collaboration with NASA, successfully flew the Autonomous Descent and Ascent Powered-flight Testbed (ADAPT) on its XA-0.1B rocket. This public-private partnership will increase landing precision on planets. ##

NASA's Next Nuclear-Powered Mars Rover: Building the Beast

27 August, 2015 – www.space.com/30395-nasa-mars-2020-rover-technology.html

www.space.com/30402-precise-mars-landings-xombie-rocket.html

Largely based on NASA's Mars rover Curiosity, now exploring Mars, there are a variety of distinctions that set it apart. The 2020 mission is expected to explore a select site that's geologically diverse, is likely to have been habitable and to seek out signs of past life.



The Mars 2020 mission will leverage the design of this landing system and other aspects of Curiosity's Mars Science Laboratory architecture. ##

The rover is also slated to collect and stash Mars samples in tubes and drop them off at a pre-selected depot point. Years later, those Martian samples would be scooped up by a "ship and shoot" robotic mission to deliver them back to Earth. Artist concept below shows sky-crane maneuver during the descent of NASA's Curiosity rover to Mars' surface, which engineers dubbed "seven minutes of terror."

MAVEN Using Stars To Study' Atmosphere | Video

www.space.com/30445-maven-using-stars-to-study-mars-atmosphere-video.html

NASA's Mars Atmosphere and Volatile Evolution (MAVEN) mission is exploring the Red Planet's upper atmosphere and using the light of stars to determine its composition. The mission hopes to better understand the history of water on Mars. ##

Gigantic Ice Slab Found on Mars Just Below the Planet's Surface

10 September, 2015 - www.space.com/30502-mars-giant-ice-sheet-discovery-mro.html

A giant ice slab as big as California and Texas combined lurks just beneath the surface of Mars in the northern hemisphere. It may be the remnant of snowfall on Mars many millions of years ago.

Mars is now dry and cold, But lots of evidence suggests that rivers, lakes and seas once covered the planet. We have found life virtually wherever on Earth where there is liquid water, So life might have evolved on Mars when it was wet, and could be there even now, hidden in subterranean aquifers. ##

Space-x' 'Red Dragon' Mars Sample-Return Mission Could Launch by 2022

10 September, 2015 - www.space.com/30504-spacex-red-dragon-mars-sample-return.html



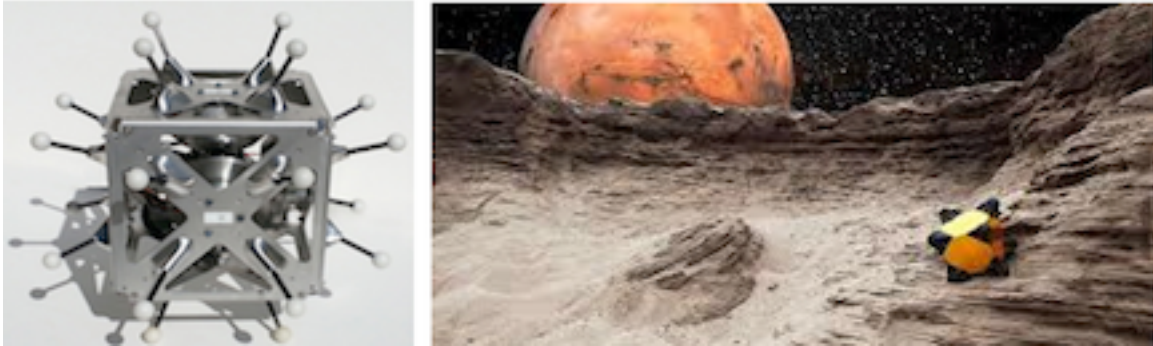
Space-X "Red Dragon" — just a concept at the moment, and not yet an approved mission — would grab samples collected by NASA's 2020 Mars rover and send them rocketing back toward Earth, where researchers could scrutinize the material for possible signs of past Red Planet life. ##

Hopping 'Hedgehog' Robot Could Explore Mars' moonlets (Video)

6 September, 2015 – www.space.com/30487-nasa-hedgehog-robot-space-exploration.html

This summer, researchers tested two "hedgehog" robot prototypes, to get an idea of the machines' potential to explore space locations inaccessible to conventional rovers.

Wheeled robots like car-size Mars rover Curiosity works well on planetary surfaces, but in the low-gravity environment of a comet or asteroid, such machines would be in danger of floating away or snagging on the rough terrain. The Hedgehog is a "spiked cube" that moves around using spinning and braking internal flywheels. Spikes keep the robot attached to the ground and protect its delicate body.



Above right: Hedgehog probe stays "grounded" on one of Mars' lightweight Moons, Phobos or Deimos

Sweeping over the south pole of Mars

11 September, 2015 – www.marsdaily.com/reports/Sweeping_over_the_south_pole_of_Mars_999.html



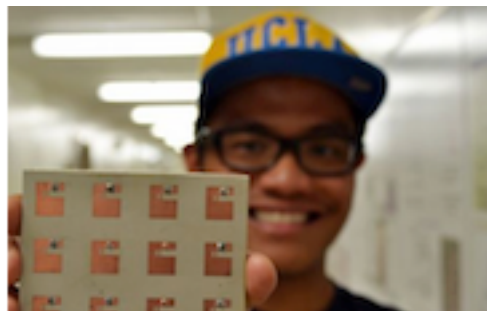
Left: This sweeping view by ESA's Mars Express extends from the planet's south polar ice cap and across its cratered highlands to the Hellas Basin (top left) and beyond.

Right: Large-scale rossbedding in the sandstone of this ridge on a lower slope of Mars' Mount Sharp is typical of windblown sand dunes that have petrified. ##

New Antenna Could Give Mars Rovers a Direct Line to Earth

11 September, 2015 – www.space.com/30519-new-antenna-connects-mars-rovers-to-earth.html

The new antenna will dramatically increase the available communication time between Mars rovers and Earth, The new design could be a major boost for NASA's Mars 2020 rover, to begin its journey in 2020.



the 4x4 prototype antenna

speaks directly to Earth.

Flash! Sept. 28, 2015 Water Confirmed on present day Mars! (See page 1)

www.nasa.gov/press-release/nasa-confirms-evidence-that-liquid-water-flows-on-today-s-mars:
29 September, 2015 - www.space.com/30683-mars-liquid-water-astronaut-exploration.html

MARS AVIATION

Could This Become the First Mars Airplane?

7 July, 2015 - www.marsdaily.com/reports/Could_This_Become_the_First_Mars_Airplane_999.html
www.marsdaily.com/reports/Prandtl-m_prototype_could_pave_way_for_first_plane_on_Mars_999.html



The proposed Prandtl-m is based on the Prandtl-d seen coming in for a landing during a flight test in June. The aerodynamics offer a solution that could lead to the first aircraft on Mars.
Full size image: www.nasa.gov/sites/default/files/thumbnails/image/ed15-0193-336.jpg ##

Little Flying Buddy For Off-World Rovers Built by NASA | Video

www.space.com/30115-little-flying-buddy-for-off-world-rovers-built-by-nasa-video.html



Drones in Space! NASA's Wild Idea to Explore Mars

5 August 2015 - www.space.com/30155-nasa-drones-on-mars-video.html



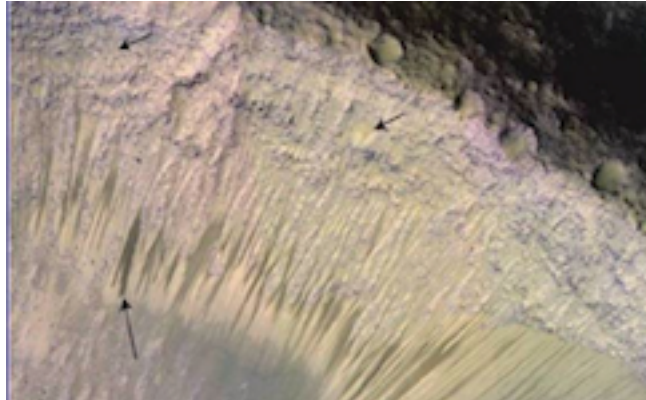
Autonomous quadcopters wherever there is atmosphere (Mars, Titan, etc.)

Space Planes Could Be Powered By Ground-Based Microwaves | Animation

www.space.com/30162-space-planes-could-be-powered-by-ground-based-microwaves-animation.html

Mars' Mysterious Dark Streaks Spur Exploration Debate

23 September, 2015 – www.space.com/30618-mars-water-streaks-rsl-mystery.html



NASA Mars Reconnaissance Orbiter's HiRISE image of recurring slope lineae

The dark, fingerlike features that creep down steep Martian slopes in warm weather continue to puzzle scientists. These "recurring slope lineae" (RSL) have been spotted at low and middle latitudes on the Red Planet, fade during cooler months but come back again annually at nearly the same locations over multiple Martian years.

Evidence is mounting that RSL are the mark of some kind of volatile substance, and a leading theory posits that they are caused by the flow of salt-laden liquid water. If so, could RSL be the best markers of available water to help sustain future crewed Mars expeditions (and settlements)? RSL sites may also offer insights into Mars subsurface, as well as help identify places where microbial life could occur on the Red Planet. ##

India's 1st Mars Mission Celebrates One Year at Red Planet

24 September, 2015 – www.space.com/30633-india-mars-orbiter-mission-anniversary.html

Mangalyaan-1 carries a color camera and four scientific instruments, which it has been using to study the Martian surface and atmosphere over the past 12 months.

Photo Gallery taken by Mangalayaan-1 www.space.com/23203-india-mars-orbiter-mission-photos.html

Streaks On Mars Reveal Salty Water | Orbiter Imagery + Animation NASA Confirms Evidence That Liquid Water Flows on Today's Mars

www.space.com/30676-streaks-on-mars-reveal-salty-water-orbiter-imagery-+-animation.html

www.nasa.gov/press-release/nasa-confirms-evidence-that-liquid-water-flows-on-today-s-mars

www.space.com/30681-mars-water-discovery-life-chances.html

Opportunity Continues Search for Clay Minerals On Mars

www.marsdaily.com/reports/Opportunity_Continues_Search_for_Clay_Minerals_On_Mars_999.html

22 September, 2015 – Opportunity is within 'Marathon Valley' on the west rim of Endeavour Crater conducting a walk-about in search of clay minerals. ##

HUMANS TO MARS

NASA-Funded Study Reduces Cost of Human Missions to Moon and Mars by Factor of Ten

13 July, 2015 - <http://www.nss.org/docs/EvolvbleLunarArchitecture.pdf>
 20 July, 2015 - www.spaceref.com/news/viewpr.html?pid=46392

How we'll live on Mars – Interview with author Stephan Petranek

31 August, 2015 - www.space.com/30403-mars-colonization-interview-stephen-petranek.html

The book paints a picture of humanity's first journey to the Red Planet, which he sets in 2027, and describes the key technologies needed to reach, survive and thrive on the planet and exactly how that process would play out.

Excerpt: <http://www.space.com/30318-how-we-will-live-on-mars-book-excerpt.html>

Making Mars Exploration 'Smart and Cool': NASA and 'The Martian'

4 September, 2015 - www.space.com/30469-nasa-the-martian-movie-mars-exploration.html

In the history of Hollywood envisioning the future of space exploration, few, if any movies have come as close to NASA's own goals at the time of their release as does "The Martian." ##

SpaceX Images Show How Its Dragon Spaceship Will Land on Mars

17 September, 2015 - www.space.com/30563-spacex-dragon-mars-landing-images.html
www.space.com/26060-f.html



SpaceX announced recently that it could use a **robotic version of its Dragon capsule** in a mission to **bring samples of Martian soil and rock** back to Earth. The "Red Dragon" project, which is only in the concept stage, would pick up samples **collected by NASA's 2020 Mars rover**. This could help tremendously in the search for ancient life on Mars. Finding signs of ancient organisms in the Martian soil will likely be an extremely delicate task and will require that the samples be analyzed in advanced laboratories on Earth.

From early in its creation, SpaceX has made clear that one of its central goals is to set up human colonies on Mars. Test flights have already begun on the Dragon capsule, so the gorgeous scenes captured in this stunning and incredibly realistic image series could already be on the horizon. ##

A Manned Mission to Mars Is Closer to Reality Than Ever: NASA Chief

18 September, 2015 - www.space.com/30580-nasa-manned-mars-mission-reality.html

NASA's current goal of **getting astronauts to Mars in the 2030s** is eminently achievable, according to Bolden. Orion and the SLS are scheduled to fly together for the first time, on an unmanned test flight, in 2018. ##



[From now on, we will give the URL web address of the article, its title and date, and a key image if there is one. We leave it up to the reader to explore further - Peter Kokh kokhmmm@aol.com]

ASTERIODS

New Study Sheds Light on Origin of Most Common Meteorites

www.spacedaily.com/reports/New_Study_Sheds_Light_on_Origin_of_Most_Common_Meteorites_999.html - 7 August, 2015

For decades astronomers debated the source of the most common type of meteorites that fall on Earth called H ordinary chondrites. A new study by researchers at the Planetary Science Institute sheds some light on the origin of these meteorites in the main asteroid belt between Mars and Jupiter. ##

ASTERIOD RESOURCES

Asteroid Mining Company's 1st Satellite Launches from Space Station

19 July, 2015 - www.space.com/29975-asteroid-mining-planetary-resources-satellite-launch.html

The Arkyd 3 Reflight spacecraft, a small satellite built by the space-mining company Planetary Resources, launched from the International Space Station on Thursday (July 16), beginning a 90-day mission to test the avionics, control systems and software needed to make asteroid mining possible. ##

'Trillion-Dollar Asteroid' Zooms by Earth as Scientists Watch (Video)

28 July, 2015 - www.space.com/30074-trillion-dollar-asteroid-2011-uw158-earth-flyby.html

When an asteroid packed with about \$5 trillion worth of platinum zoomed past Earth this month scientists were ready, capturing the space rock on radar as it sailed safely by our planet.

The asteroid **2011 UW158** missed Earth by about 2.4 million km (1.5 million mi) — a little more than six times the distance between Earth and the Moon — during its flyby on July 19. ##

Asteroid Mining May Be a Reality by 2025

11 August, 2015 - www.space.com/30213-asteroid-mining-planetary-resources-2025.html

Planetary Resources deployed its first spacecraft from the International Space Station in July, and the Washington-based asteroid-mining company aims to launch a series of increasingly ambitious and capable probes over the next few years.

The goal is to begin transforming asteroid water into rocket fuel within a decade, and eventually to harvest valuable and useful platinum-group metals from space rocks. ##

www.space.com/15387-asteroid-mining-planetary-resources-gallery.html

Hopping 'Hedgehog' Robot Could Explore Comets & Asteroids (Video)

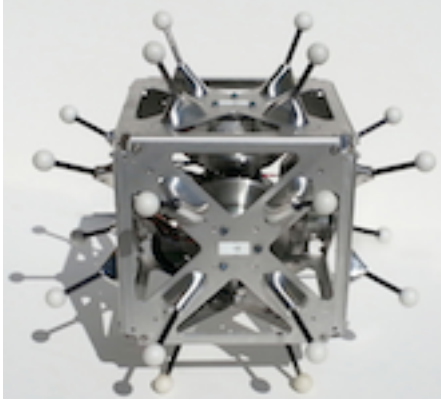
6 September, 2015 - www.space.com/30487-nasa-hedgehog-robot-space-exploration.html

This summer, researchers tested two "hedgehog" robot prototypes, to get an idea of the machines' potential to explore space locations inaccessible to conventional rovers.

Wheeled robots like the car-size Mars rover Curiosity works well on planetary surfaces. But in the low-gravity environment of a comet or an asteroid, such machines would be in danger of floating away or snagging on the rough terrain.

Past **TTSIQ** issues are online at: www.moonsociety.org/international/ttsiq/ and at: www.nss.org/tothestarsOO

That's where the Hedgehog comes in. This "spiked cube" moves around using spinning and braking internal flywheels. The spikes keep the robot attached to the ground and protect its delicate body.



Above right: Hedgehog probe stays "grounded" on one of Mars' lightweight Moons, Phobos or Deimos

Asteroid-Mining Plan Would Bake Water Out of Bagged-Up Space Rocks

18 September, 2015 - www.space.com/30582-asteroid-mining-water-propulsion.html



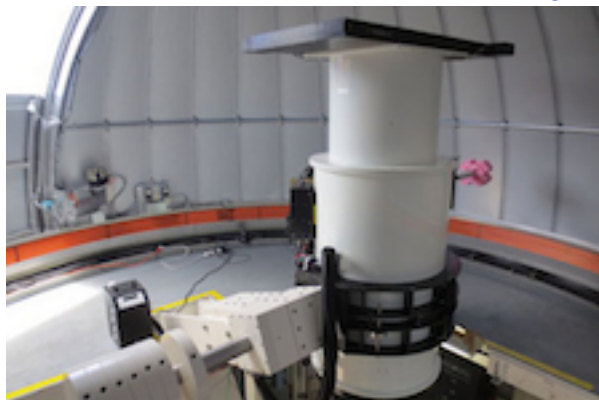
Above: www.space.com/15391-asteroid-mining-space-planetary-resources-infographic.html

A new way to harvest asteroid resources is a possible game changer for space exploration. Called "optical mining," allowing huge amounts of asteroid water to be tapped which could provide relatively cheap and accessible propellant for, lowering the cost of spaceflight significantly. ##

ASTEROID THREATS

Asteroid Impact Early-Warning System's 1st Telescope Up and Running

10 Aug, 2015 - www.space.com/30191-asteroid-impact-early-warning-system-first-telescope.html



The first Asteroid Terrestrial-impact Last Alert System telescope, or ATLAS 1, has been completed atop Maui's Haleakala volcano in Hawaii. The ATLAS telescope is one of two planned to search for potentially dangerous asteroids that might pose a threat to Earth. ##

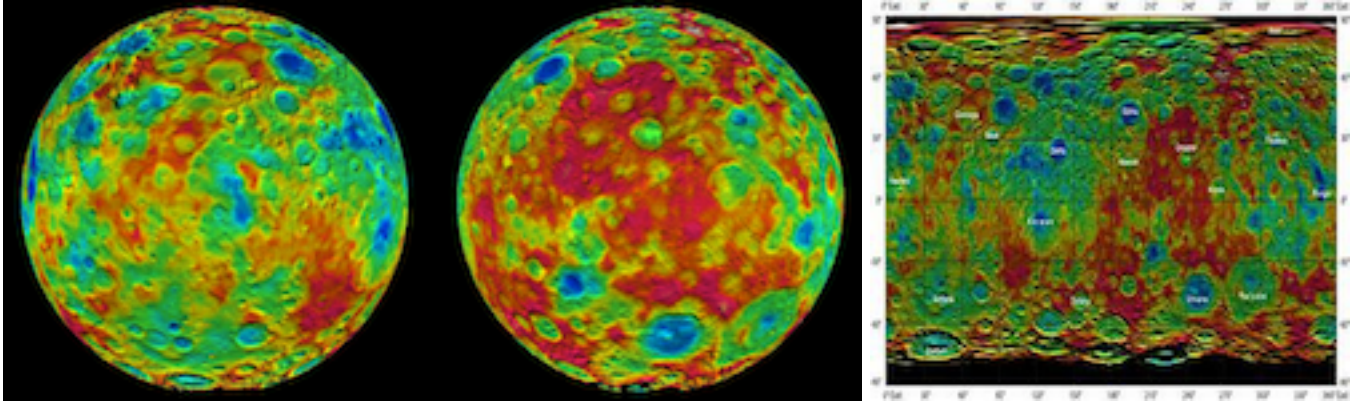
CERES

Dwarf Planet Ceres' Mountains and Craters Get Names in NASA Maps

29 July, 2015 - www.space.com/30080-dwarf-planet-ceres-nasa-maps.html

www.space.com/30075-dwarf-planet-ceres-global-highs-and-lows-animated-video.html

www.spacedaily.com/reports/New_Names_and_Insights_at_Ceres_999.html



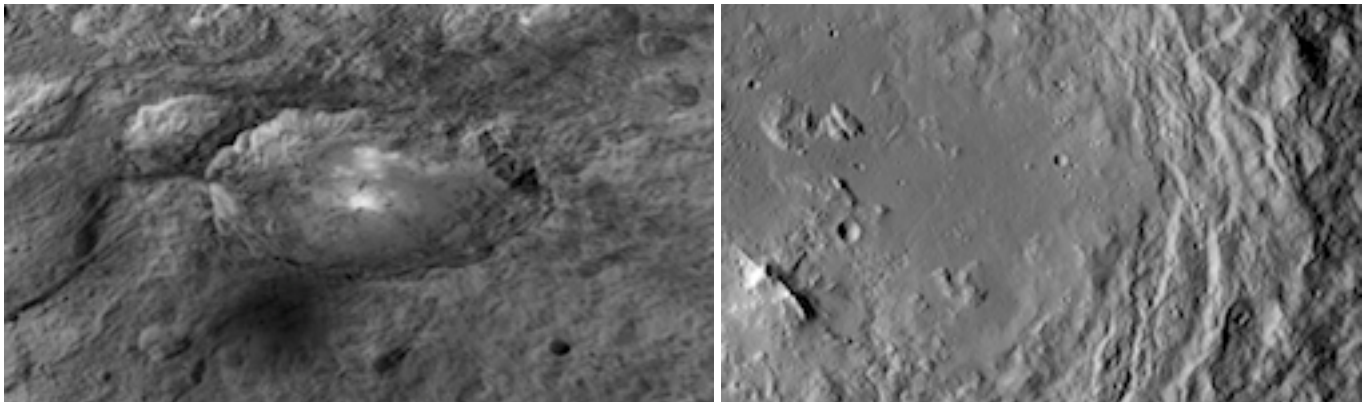
[color-coded-maps-ceres-dwarf-planet.jpg](#) - For full size image visit article

Colorful new maps of the dwarf planet Ceres reveal its dramatic mountains and deep craters, now with official new names. ##

Fly Over Ceres' Mysterious Mountain and Bright Spots in Incredible Video

6 August, 2015 - www.space.com/30181-ceres-bright-spots-mountain-video.html

www.space.com/30364-ceres-lonely-mountain-photos-dawn.html



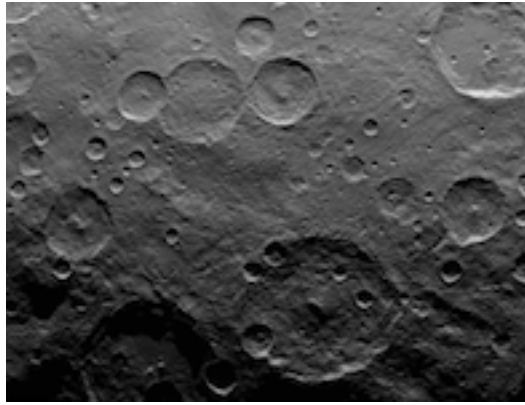
The Mystery of Dwarf Planet Ceres' Missing Craters

7 August, 2015 - www.space.com/30189-dwarf-planet-ceres-missing-craters-mystery.html

Scientists with the Dawn mission have found that Ceres, located between the orbits of Jupiter and Mars, has only 1/10th the craters that they expected. Dawn is currently descending into an orbit much closer to Ceres' surface, where it will take higher-resolution images that will reveal smaller craters.

Dawn is currently descending into an orbit much closer to Ceres' surface, where it will take higher-resolution images that will reveal smaller craters.

Past **TTSIQ** issues are online at: www.moonsociety.org/international/ttsiq/ and at: www.nss.org/tothestarsOO



Three dimensional studies of Ceres' surface may also reveal evidence of very old or very large craters that are not immediately recognizable in two-dimensional images. But even those additional craters won't fill in the missing 90 percent. ##

Strange Bright Spots On Dwarf Planet Ceres' Pyramid Mountain | Video

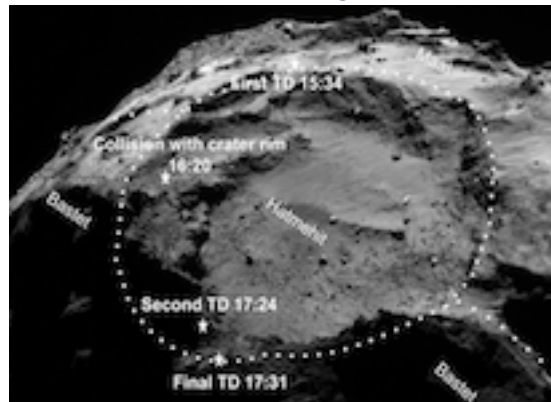
www.space.com/30179-strange-bright-spots-on-dwarf-planet-ceres-pyramid-mountain-video.html

Tour Wierd Ceres: Bright Spots and a Pyramid Shaped Mountain - GREAT VIDEO
http://www.nasa.gov/mission_pages/dawn/main/index.html - GREAT VIDEO

COMETS

Surprising Comet 67P Discoveries by Rosetta's Philae Lander Unveiled

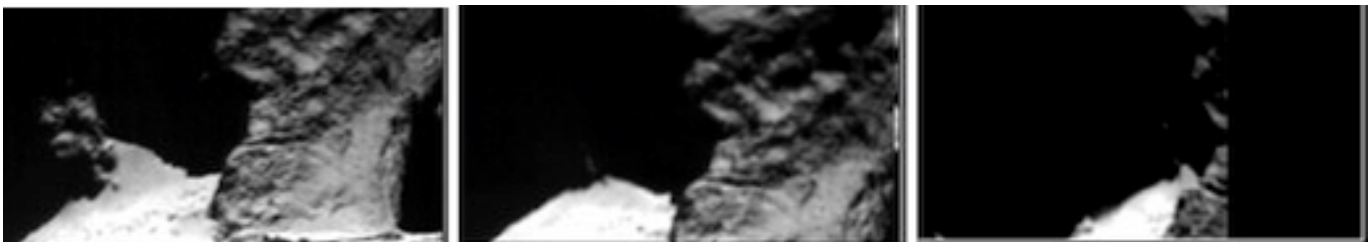
30 July, 2015 - www.space.com/30100-comet-landing-discoveries-rosetta-philae-lander.html
www.space.com/30088-philae-comet-landing-discoveries-rosetta-infographic.html



##

Roseta Reveals Comet's Water-Ice Cycle

www.esa.int/Our_Activities/Space_Science/Rosetta/Rosetta_reveals_comet_s_water-ice_cycle



Past **TTSIQ** issues are online at: www.moonsociety.org/international/ttsiq/ and at: www.nss.org/tothestarsOO

23 September, 2015 – Comets are celestial bodies comprising a mixture of dust and ices, which they periodically shed as they swing towards their closest point to the Sun along their highly eccentric orbits. As sunlight heats the frozen nucleus of a comet, the ice in it – mainly water but also other ‘volatiles’ such as carbon monoxide and carbon dioxide – turns directly into a gas. This gas flows away from the comet, carrying dust particles along. Together, gas and dust build up the bright halo and tails that are characteristic of comets.

On 13 August 2015, the comet reached the closest point to the Sun along its 6.5-year orbit, and is now moving outwards. Using Rosetta’s Visible, InfraRed and Thermal Imaging Spectrometer, VIRTIS, have identified a region on the comet’s surface where **water ice appears and disappears in sync with its rotation period**, replenishing the surface of the comet with fresh ice at every rotation. ##

How Rosetta’s Comet Got its Shape

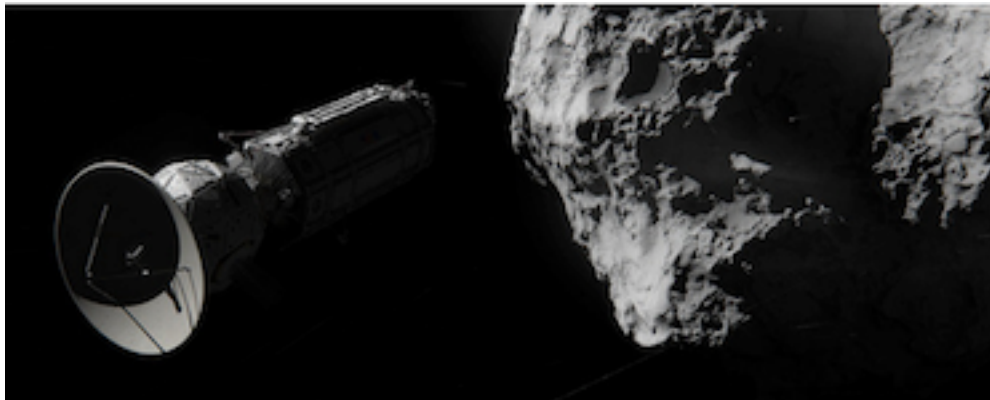
www.esa.int/Our_Activities/Space_Science/Rosetta/How_Rosetta_s_comet_got_its_shape



28 September, 2015 – Two comets collided at low speed in the early Solar System to give rise to the distinctive ‘rubber duck’ shape of Comet 67P/Churyumov-Gerasimenko. Now, scientists have an unambiguous answer to the conundrum. By using high-resolution images taken between 6 August 2014 and 17 March 2015 to study the layers of material seen all over the nucleus, they have shown that the shape arose from a low-speed collision between two fully fledged, separately formed comets. ##

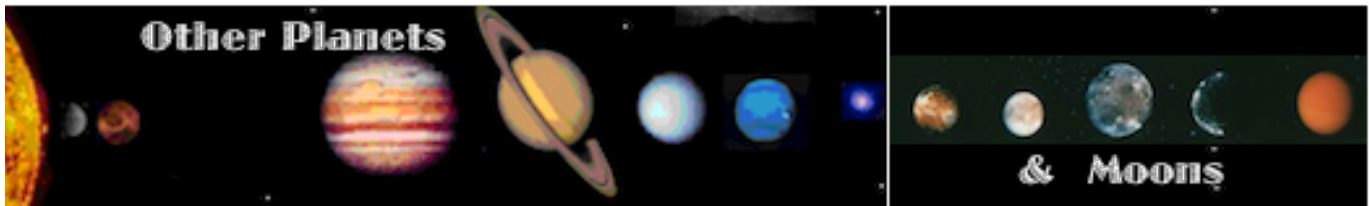
Wild ‘Hithiker’ Spacraft idea could Harpoon Comets

3 September, 2015 – www.space.com/30451-nasa-comet-hitchhiker-concept-mission.html



This artist concept shows Comet Hitchhiker, an idea for traveling between asteroids and comets using a harpoon and tether system.

A spacecraft could sling itself from one comet or asteroid to another using a harpoon and a superlong tether for multiple targets in the main asteroid belt or the Kuiper Belt, even five to 10 in a single mission.



[From now on, we will give the URL web address of the article, its title and date, and a key image if there is one. We leave it up to the reader to explore further - Peter Kokh kokhmmm@aol.com]

MERCURY

Mercury's Speedy Spin Hints at Planet's Insides

11 September, 2015 - www.space.com/30517-mercury-spins-faster-than-thought.html

New research shows that the planet completes a rotation on its axis roughly 9 seconds faster than scientists previously charted — and that data will help scientists understand more about the planet's molten core.

Mercury is a rocky planet. Based on the data collected from NASA's Messenger orbiter, scientists think most of Mercury contains a molten core that takes up 70 % of the planet's mass. The newly measured rotation rate can be used to help calculate the proportions of solid and liquid within.

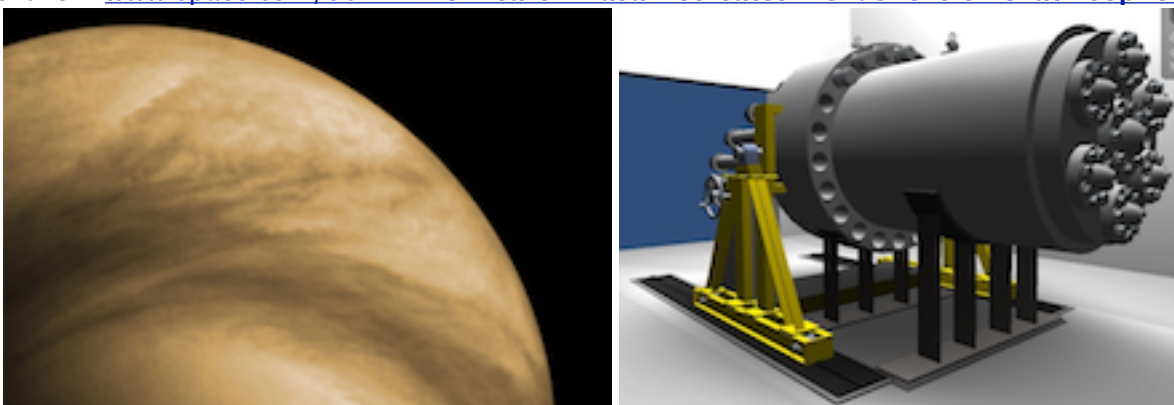
One possible explanation for Mercury's faster rotation is that Jupiter influences its orbit, and as a result its distance from the sun varies, which, in turn, affects the planet's rotation speed. ##

Editor: Mercury's orbit is the most eccentric (7°) of all the planets, excluding the Pluto-Charon binary (17°). Likewise, the deviation of its plane from that of the Sun and other major planets (0.21), is higher than all other planets, again excluding the Pluto-Charon binary (0.25).

VENUS

Hell On Earth: NASA Recreates Venus' Extreme Atmosphere

2 Sept. 015 - www.space.com/30447-hell-earth-nasa-recreates-venus-extreme-atmosphere.html



L: False-color view of cloud features on Venus taken by Europe's now-defunct **Venus Express** spacecraft.
R: Glenn Extreme Environment Rig

An option besides expensive, one-off space missions. A new test rig at NASA's Glenn Research Center in Ohio can replicate the planet's lead-melting temperature, crushing pressure and noxious mix of atmospheric gases to create a similar hell on Earth.

Scientists interested in studying Venus, as well as other extreme places in the solar system, now have an option besides expensive, one-off space missions. The new **Glenn Extreme Environment Rig**,

Past **TTSIQ** issues are online at: www.moonsociety.org/international/ttsiq/ and at: www.nss.org/tothestarsOO

or **GEER** at NASA's Glenn Research Center in Ohio can replicate the planet's lead-melting temperature, crushing pressure and noxious mix of atmospheric gases to create a similar hell on Earth.

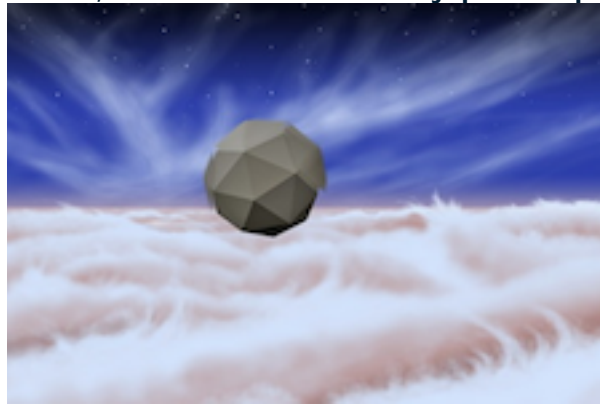
Inside the 14-ton, stainless steel, (3x6-ft) chamber, temperatures can soar beyond 480 °C (900 °F), hotter than the surface of Venus. At the same time, pressure can reach nearly 100 times the weight of Earth's atmosphere at sea level.

Add carbon dioxide, which comprises 96 % of Venus' atmosphere, nitrogen and a sprinkling of other chemicals and scientists can replicate the superfluid physics that shape another world. ##

JUPITER & ITS MOONS

NASA's Wild 'Windbot' Concept Aims to Sail in Jupiter's Sky

28 July, 2015 - www.space.com/30067-nasa-windbots-jupiter-exploration-space-tech.html



This artist's illustration depicts a NASA "windbot" soaring through the skies of Jupiter, powering itself by the planet's powerful winds. The polyhedron design shown here is a notional concept that would spin to absorb wind energy, creating lift to stay aloft.

- The windbot has rotors on sides of the probe that spin independently to navigate and create lift.
- The design is similar to how dandelion seeds seem to float effortlessly through the air on Earth ##

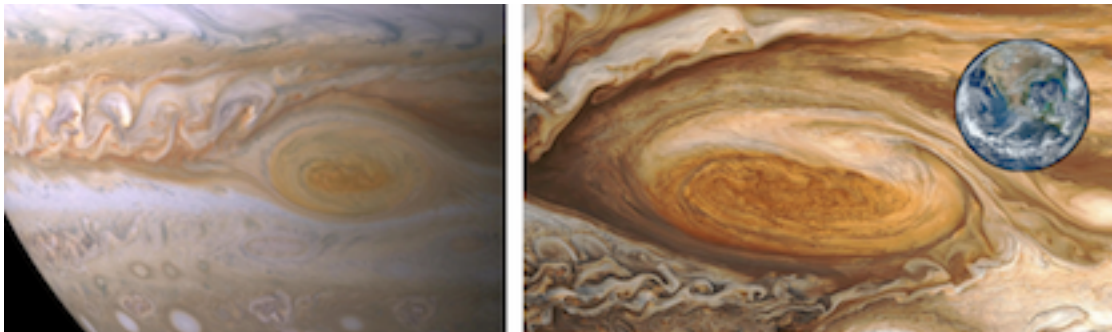
JUICE-y Mission to Jupiter One Step Closer to Reality

30 July, 2015 - www.space.com/30107-jupiter-moons-mission-moves-forward.html

The European Space Agency took a step closer to ambitious exploration of Jupiter and its icy moons. July 16, ESA awarded a 350.8 million euros (\$385 million) contract to Airbus Defence & Space in France, whose engineers will [design](#), develop, integrate and test the mission's JUICE spacecraft. The spacecraft will also study three of Jupiter's planet-size, icy moons: **Callisto**, **Europa** and **Ganymede**. ##

Jupiter's Great Red Spot May Yield Its Colorful Secret in a Lab

14 August, 2015 - www.space.com/30236-jupiter-great-red-spot-color-secrets.html

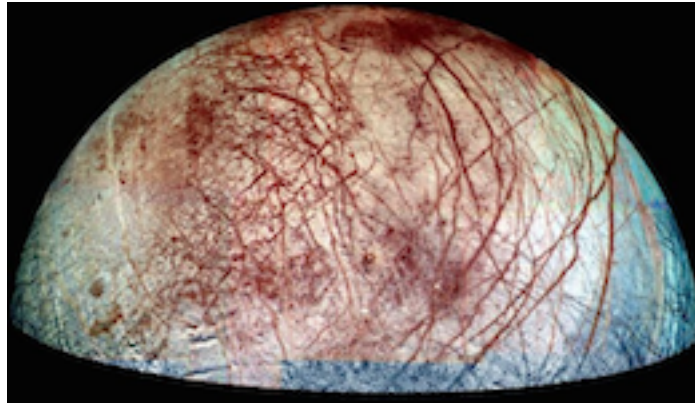


Despite 150 years plus of study, the Great Red Spot on Jupiter remains a mystery. The mammoth storm, twice as wide as Earth, swirls across the face of the largest planet in the solar system with winds peaking at about 644 km (400 mi) per hour. Yet what could be causing the storm remains unknown.

In an attempt to probe the mysteries of the enormous storm, a team at NASA's Goddard Space Flight Center in Greenbelt, Maryland, is baking some components of Jupiter's atmosphere with radiation, mimicking cosmic rays, to determine if they can be altered to produce the reddish color of the Spot. ##

Blood-red scars and veins on Europa

7 June, 2015 - www.esa.int/spaceinimages/Images/2015/07/Blood-red_scars_and_veins_on_Europa



There is something undeniably biological about this image, sent back by NASA's Galileo spacecraft - the moon is scarred by deep red gashes, like the vibrant red veins flowing across a human eye.

- Galileo's data supported the theory that Europa hosts a deep underground liquid ocean, and clay-like minerals were detected in the moon's icy crust. The probe also found evidence for an 'exosphere' around Europa, as well as around the Jovian moons Ganymede and Callisto. This exosphere is a thin atmosphere surrounding the moons where molecules remain gravitationally trapped.
- Europa, Ganymede and Callisto will be explored further by ESA's JUPITER ICy moons Explorer (JUICE) mission when it reaches the system in 2030.
- Europa is also earmarked for a further NASA mission some time in the 2020s.
- The red scars criss-crossing Europa are not biological, but actual cracks and ridges marking weak lines within the moon's ice crust, emphasised and exacerbated by the swelling and falling of tides due to Jupiter's gravitational pull.

More:

www.spacedaily.com/reports/Advances_in_Robots_Needed_to_Explore_Icy_Moons_999.html

www.esa.int/Our_Activities/Space_Science/Preparing_to_build_ESA_s_Jupiter_mission

www.space.com/29978-nasa-juno-one-year-jupiter.html ##

NASA's Next Megarocket Could Launch Mission to Europa

29 July, 2015 - www.space.com/30082-nasa-sls-megarocket-planetary-missions.html

<http://i.space.com/images/i/000/012/137/i300/space-launch-system-new-nasa-rocket-110914d-02.jpg>

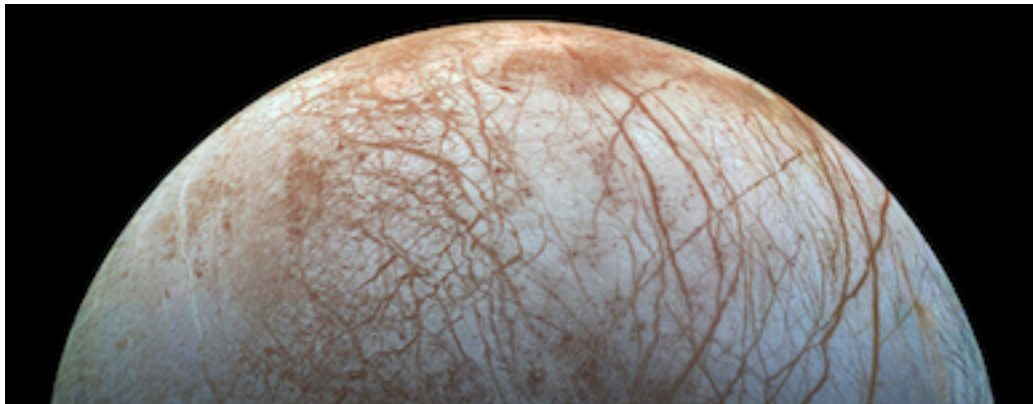


The huge rocket NASA is developing to get astronauts to an asteroid, Mars and other distant destinations should also greatly aid robotic exploration efforts. The megarocket, scheduled to fly for the first time in 2018, will blast unmanned spacecraft toward their targets at incredible speeds, dramatically reducing interplanetary travel times. ##

NASA's next Europa Mission may land on this ocean-bearing moon

8 September, 2015 – www.space.com/30476-nasa-europa-mission-lander-possibility.html

NASA's upcoming mission to Europa may actually touch down on the potentially life-harboring Jupiter moon. While the main thrust of the Europa mission, which NASA aims to launch by the mid-2020s, involves characterizing the icy satellite from afar during dozens of flybys, the space agency is considering sending a small probe down to the surface as well. ##



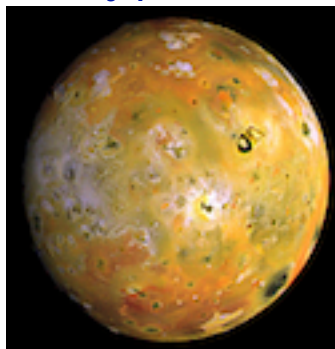
Editor's comment

The many fractures in Europa's crust are apparently colored by something in the ocean water below that has oozed up the cracks towards the surface. Could the coloring come from soon to be dead, frozen life forms that got a free ride to the surface from the ocean water rushing up through the briefly open cracks in the ice? Is there another explanation for the color?

If this is the case, or one of several explanations, we may not have to drill through the several kilometers/miles thick ice to search for samples of life in Europa's ocean. PK

Magma oceans on Jupiter's moon Io may solve Volcano mystery

14 September – www.space.com/30530-jupiter-moon-io-magma-volcano-mystery.html

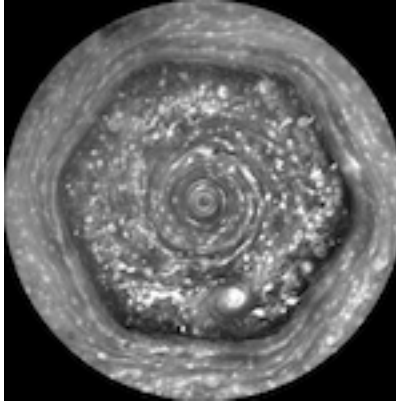


Something strange is happening on Io: The Jupiter moon's vigorous volcanoes are mysteriously offset from where scientists expected, and its underground magma oceans may be the cause.

A new model suggests that worlds caught in an intense push and pull of gravity, like the volcanic moon Io, are likely to have below-ground oceans of magma or water that stick around for a long time — in the water's case, providing a potential hotspot for the development of life. ##

SATURN & ITS MOONS**Bizarre Giant Hexagon on Saturn May Finally Be Explained**

22 September, 2015 – www.space.com/30608-mysterious-saturn-hexagon-explained.html



Hexagon observations made by Cassini in 2012 in wavelengths ranging from UV to IR.

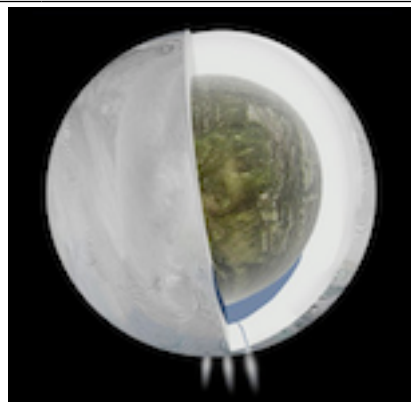
The bizarre hexagonal cloud pattern was first discovered in 1988 by scientists reviewing data from NASA's Voyager flybys of Saturn in 1980 and 1981. Nothing like the hexagon has ever been seen on any other world. The structure contains a churning storm at its center, is about 32,000 km (20,000 mi) wide, and thermal images show that it reaches roughly 100 km (60 mi) down into Saturn's atmosphere.

The points of the hexagon rotate around its center at almost exactly the same rate Saturn rotates on its axis. A jet stream air current, much like the ones seen on Earth, flows eastward at up to about 360 km/h (220 mph) on Saturn, on a path that appears to follow the hexagon's outline.

Now researchers have developed a model they suggest matches the hexagon's features better than previous attempts. The scientists ran computer simulations of an eastward jet flowing in a curving path near Saturn's north pole. Small perturbations in the jet — the kind one might expect from jostling with other air currents — made it meander into a hexagonal shape. And this simulated hexagon spun around its center at speeds close to that of the real one. ##

Enceladus**What's Inside Saturn Moon Enceladus? Geyser Timing Gives Hints**

7 July, 2015 – www.space.com/29865-saturn-moon-enceladus-structure-geysers.html



Does a liquid-water ocean exist beneath the icy crust of Saturn's moon Enceladus? The timing of explosive geysers from its surface could indicate what's happening underneath. ##

Saturn's moon Enceladus has a fluffy heart

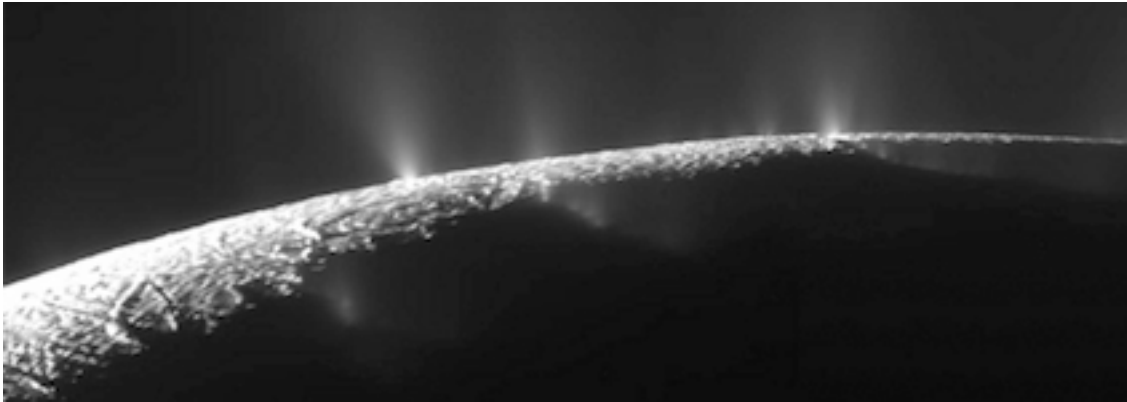
21 August, 2015 – www.news.sciencemag.org/space/2015/08/saturn-s-moon-has-fluffy-heart

A new model suggests the satellite has a rubble-filled pile of boulders and ice at its core, rather than a more conventional solid stone center. This “fluffy core” could help solve the mystery of the moon’s underground ocean. A watery layer beneath Enceladus’s crust has long been suspected to exist because of the constant eruption of geysers at its southern pole.

But scientists have said that any such ocean should have frozen over the lifetime of the Saturn system. Tidal heating that warms the insides of moons and planets in orbit would simply not be enough to keep this ocean in a liquid state if Enceladus had a solid core. And antifreezing agents such as ammonia would eventually separate from the water if they were present in large enough amounts to prevent ice from forming. But this new model makes antifreeze irrelevant while resurrecting the tidal heating hypothesis: = read the article. ##

Sampling Enceladus: Is Earth Ready for Pieces of this moon's Plumes?

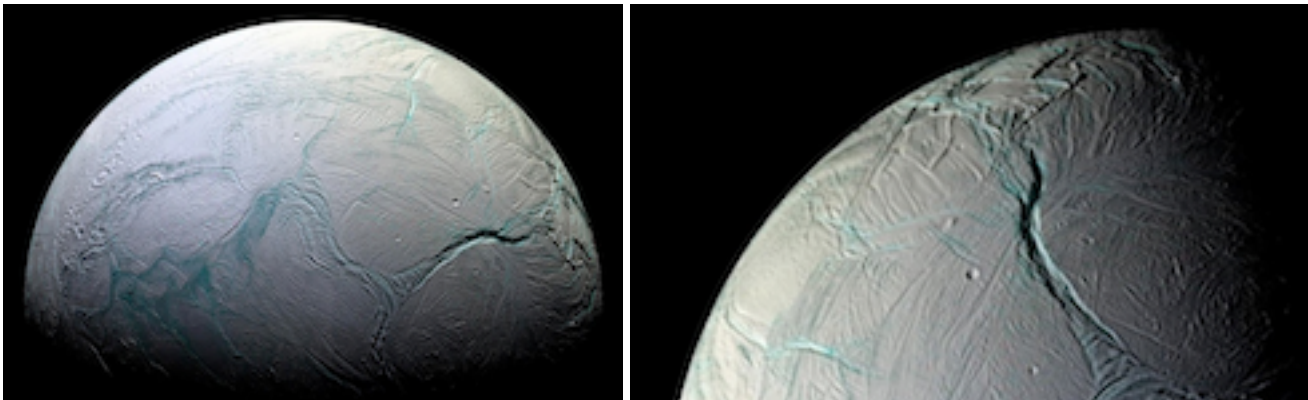
27 August, 2015 – www.space.com/30384-enceladus-sample-return-mission-timeline.html



Many astrobiologists are champing at the bit to bring back samples from Saturn's ocean-harboring moon Enceladus, but others say it may be risky. ##

NASA Mulling Life-Hunting Mission to Saturn moon Enceladus

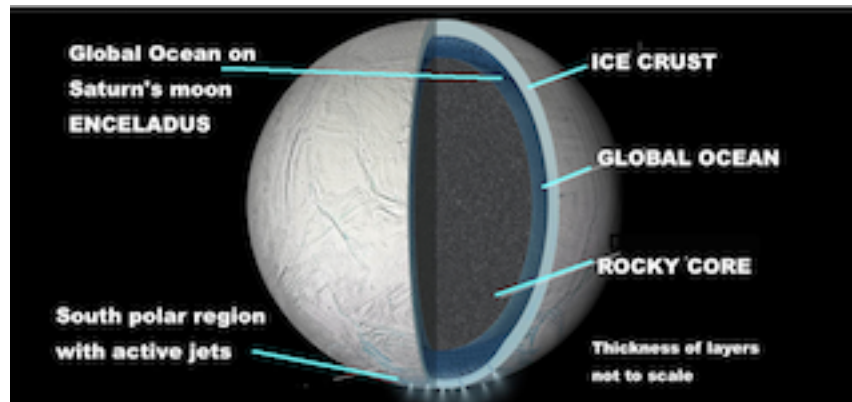
31 August, 2015 – www.space.com/30419-alien-life-search-enceladus-mission.html



NASA already plans to launch a spacecraft toward the Jupiter moon Europa in the early to mid-2020s, and it's mulling a mission to the Saturn satellite Enceladus that would lift off by the end of 2021. Europa and Enceladus are both thought to harbor oceans of liquid water beneath their icy shells, and as the solar system's two best bets to host alien life. **Enceladus Life Finder (ELF)**, is one of two dozen or so concepts submitted earlier this year for consideration by NASA's Discovery Program. ##

Cassini finds Global Ocean in Saturn's moon Enceladus

www.nasa.gov/press-release/cassini-finds-global-ocean-in-saturns-moon-enceladus



15 September, 2015 – A global ocean lies beneath the icy crust of Saturn's geologically active moon Enceladus, according to new research using data from NASA's Cassini mission. The magnitude of the moon's very slight wobble, as it orbits Saturn, can only be accounted for if its outer ice shell is not frozen solid to its interior, meaning a global ocean must be present. Previous analysis of Cassini data suggested the presence of a lens-shaped body of water, or sea, underlying the moon's south polar region.

However, gravity data collected during the spacecraft's several close passes over the south polar region lent support to the possibility the sea might be global. The new results -- derived using an independent line of evidence based on Cassini's images -- confirm this to be the case. ##

Life-Hunting Mission Would Bring Samples Back from Saturn Moon Enceladus

21 Sept. 2015 – www.space.com/30598-saturn-moon-enceladus-sample-return-mission.html

Scientists are developing a mission concept that would send a probe flying through the plume created by the 100-odd geysers erupting from the south polar region of Saturn's ice-covered moon Enceladus. These geysers blast water, salts and organic compounds from the satellite's subsurface ocean far out into space. The mission, known as Life Investigation for Enceladus (LIFE), would collect samples of this stuff, then send it winging back to Earth in a return capsule. ##

Titan

Early Titan Was a Cold, Hostile Place For Life

5 July, 2015 – www.spacedaily.com/reports/Early_Titan_Was_a_Cold_Hostile_Place_For_Life_999.html

Titan's atmosphere is 95% nitrogen, but it also has a tad bit of methane, close to the surface, which contributes to a slight greenhouse effect, although its average temperature is still a frigid -180°C (-292°F). Without this greenhouse effect, the methane would freeze at the surface and make it difficult for any life that might be present to survive.

What produces the methane on Titan is a mystery. On Earth it comes from biological processes and volcanoes, among other sources. Titan's methane is thought to be less than a half billion years old, What Titan's atmosphere looked like early in its history when there was little to no methane present is unclear. Could it reflect what early Earth might have looked like before life arrived? ##

Pluto Flyby May Reveal Secrets of Saturn's Moon Titan

14 July, 2015 – www.space.com/29925-pluto-reveals-secrets-saturn-moon-titan.html

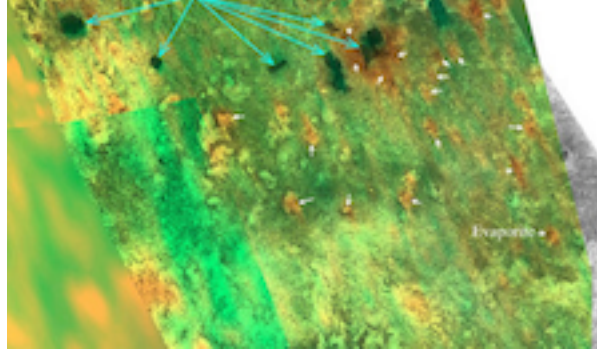
Data collected by the New Horizons probe during its historic July 14th flyby of Pluto may reveal insights into not only the dwarf planet, but also Saturn's huge moon Titan. With its nitrogen and methane atmosphere, Pluto bears a strong resemblance to Titan — or at least how Titan may have been in the past. ##

NASA Funds Titan Submarine, Other Far-Out Space Exploration Ideas

15 July, 2015 - www.space.com/29953-titan-submarine-nasa-niac-proposals.html

'Bathtub Rings' On Saturn Moon Titan Suggest Dynamic Seas

29 July, 2015 - www.space.com/30093-bathtub-rings-suggest-titans-dynamic-seas.html



Cassini VIMS/RADAR hybrid image of filled and dry lakes south of Titan's methane sea Ligeia Mare. Blue arrows indicate current lakes, while the white arrows point to evaporates on dry lakes

NASA funds Titan Submarine, Other Far-Out Space Exploration Ideas

15 July, 2015 - www.space.com/29953-titan-submarine-nasa-niac-proposals.html

Animation:

www.space.com/28551-submarine-explores-saturn-s-moon-titan-in-nasa-animation.html



NASA has just funded seven far-out space-exploration concepts, including a submarine that would explore the hydrocarbon seas of Saturn's huge moon Titan, The proposal has been awarded funding, up to \$500,000, under Phase II of the NASA Innovative Advanced Concepts program, or NIAC.

The grants are intended to encourage development of potentially transformative space technology, and offer the resources to test the feasibility and intricacies of brand-new ideas

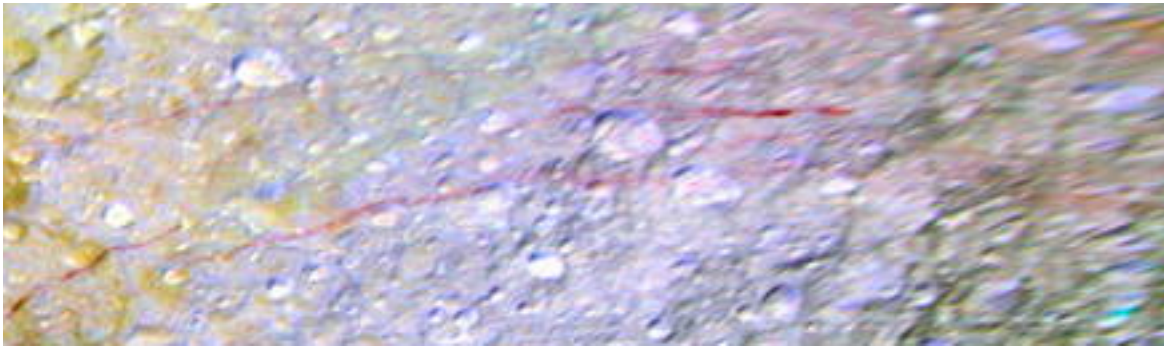
Tethys

These Weird Red Arcs on Saturn's Moon Tethys Can't Be Explained

www.space.com/30095-mysterious-blood-red-streaks-on-saturns-moon-detected-video.html

www.spacedaily.com/reports/Unusual_Red_Arcs_Spotted_on_Icy_Saturn_Moon_999.html

The red arcs (image below) must be geologically young, because they cut across older features like impact craters, but we don't know their age in years



Bright Basin on Tethys

29 July, 2015 - www.spacedaily.com/reports/Bright_Basin_on_Tethys_999.html



With the expanded range of colors visible to Cassini's cameras, differences in materials and their textures become apparent that are subtle or unseen in natural color views. Here, the giant impact basin Odysseus on Saturn's moon Tethys stands out brightly from the rest of the illuminated icy crescent.

URANUS

NASA to Study Uranus and Neptune Probes

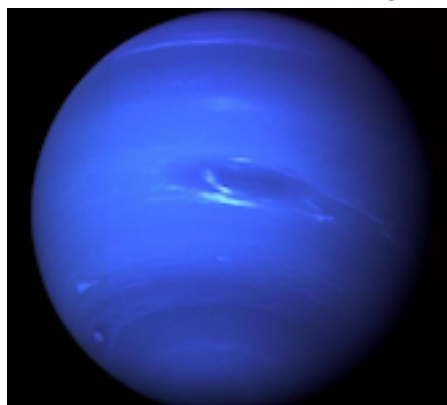
31 August, 2015 - www.space.com/30390-nasa-studies-uranus-neptune-orbiters.html

NASA's **Jet Propulsion Laboratory** (JPL) has begun an early feasibility study for missions to the distant, mostly ignored ice-giants Uranus and Neptune. The one year study is a long way from a NASA commitment to send a probe to either planet. ##

NEPTUNE

Neptune's Strange Magnetic Field Stretches Arms in New Model (Video)

8 July, 2015 - www.space.com/29875-neptune-strange-magnetic-field-video.html



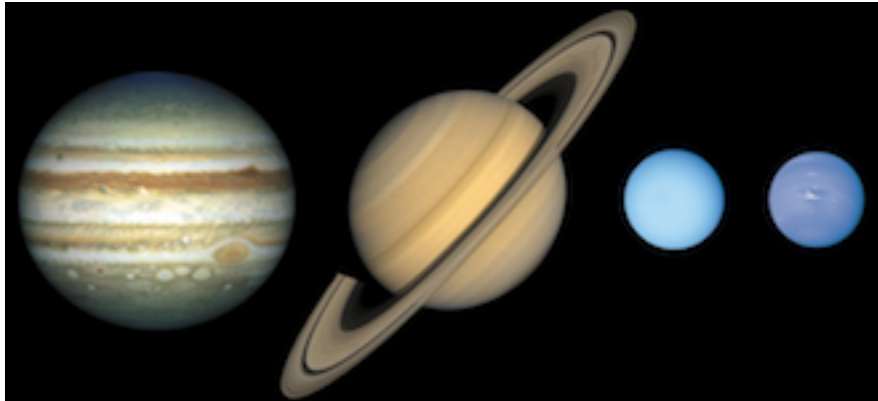
Our early solar system may have been home to a fifth giant planet

<http://news.sciencemag.org/space/2015/08/our-early-solar-system-may-have-been-home-fifth-giant-planet> - 11 August, 2015

A cluster of icy bodies in the same region as Pluto could be proof that our early solar system was home to a fifth giant planet, according to new research. That planet may have “bumped” **Neptune** during its migration away from the sun 4 billion years ago, causing the ice giant to jump into its current orbit and scattering a cluster of its satellites into the Kuiper belt in the outer solar system.

Gas Giants: Facts About the Outer Planets

25 August, 2015 - www.space.com/30372-gas-giants.html



Above: Jupiter, Saturn, Uranus, and Neptune – in order of distance from Sun (and Earth)

Composed mostly of gases, such as hydrogen and helium, with relatively small rocky core, the gas giants of our solar system are Jupiter, Saturn, Uranus and Neptune. Jupiter and Saturn are substantially larger than Uranus and Neptune, revealing that the pairs of planets have a somewhat different composition.

Jupiter is mostly made of hydrogen and helium surrounding a dense core of rocks and ice, with most of its bulk likely made up of liquid metallic hydrogen, which creates a huge magnetic field.

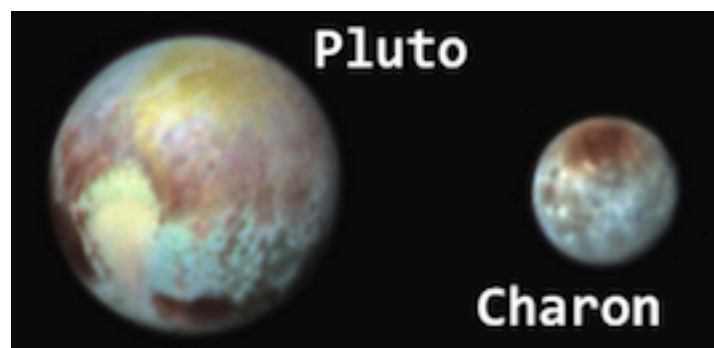
Saturn is characterized by large rings; their formation circumstances unknown. It has 53 known moons and nine more awaiting confirmation, It is mostly made up of hydrogen and helium that surround a dense core and was also tracked by ancient cultures. Its atmosphere is similar to Jupiter’s.

Uranus, the only planet tilted on its side, rotates backward, implying a huge collision disrupted it long ago. The planet has 27 moons, and its atmosphere is made up of hydrogen, helium and methane,

Neptune. Like Uranus, its atmosphere is mostly made up of hydrogen, helium and methane. It has 13 confirmed moons and an additional one awaiting confirmation.

Formation and similarities & current research - read the article ##

PLUTO-CHARON – our solar systems only “binary planet”



Pluto (right) and **Charon** (left) are proving to be far more interesting and fascinating worlds than anyone

Past **TTSIQ** issues are online at: www.moonsociety.org/international/ttsiq/ and at: www.nss.org/tothestarsOO

had expected, as well as being the only known “binary planet” in our Solar System, a fact that clamors for recognition and reinstatement as one of the family of Solar System planets – editor

<https://solarsystem.nasa.gov/planets/plutotoolkit.cfm>

www.space.com/29872-names-pluto-map-new-horizons.html

www.space.com/29850-new-horizons-pluto-flyby-complete-coverage.html

www.space.com/29842-latest-pluto-photos-new-horizons.html

www.space.com/29853-new-horizons-glitch-pluto-flyby.html

www.space.com/29853-new-horizons-glitch-pluto-flyby.html

www.space.com/29863-pluto-dark-spots-new-horizons-photos.html

www.space.com/29866-plutopalooza-marketing-promo-nasa-video.html

www.space.com/29886-new-horizons-documentary-mission-pluto-video.html

www.space.com/29885-pluto-atmosphere-to-be-revealed-by-nasa-new-horizons-spacecraft.html

www.space.com/29884-pluto-heart-new-horizons-photo.html

www.space.com/29880-nat-geo-s-mission-pluto-documentary-first-5-minutes-video.html

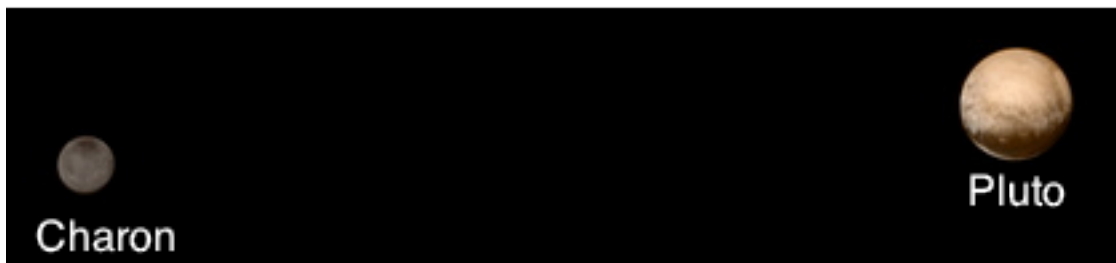
www.space.com/29887-new-horizons-pluto-flyby-begins.html

www.space.com/29899-pluto-binary-planet-star-wars-tatooine.html

www.space.com/29904-pluto-charon-different-new-horizons-photos.html

www.space.com/29963-pluto-charon-photos-mysteries-new-horizons.html

http://news.sciencemag.org/space/2015/07/pluto-almost-here-what-weve-seen-so-far-and-whats-coming-next?utm_campaign=email-news-weekly&u



- New photos by approaching New Horizons probe capture Pluto and Charon, in fascinating detail.
- The new images, taken July 8 from a distance of 3.7 million mi (6 million km) — show that **Pluto and Charon** are very different bodies, though they circle a common center of gravity and are separated by a mere 12,200 miles (19,640 km).
- At 750 miles (1,200 km) in diameter, Charon is about half as wide as Pluto itself. The two bodies' center of mass lies outside Pluto, so many researchers regard Pluto–Charon as a binary system. (Pluto has four other moons — Nix, Hydra, Kerberos and Styx — all tiny.) ##

www.space.com/29920-star-wars-invades-comic-con-hamill-ford-and-more-video.html

www.space.com/29919-pluto-charon-cliffs-craters-and-chasms-new-pics-reveals-features-video.html

www.space.com/29923-pluto-is-unexpectedly-large-new-horizons-mission-video-update.html

www.space.com/29951-new-horizons-calls-mom-after-pluto-fly-by-nominal-flight-video.html

www.space.com/29946-pluto-flyby-success-nasa-new-horizons.html?

www.space.com/29944-pluto-charon-false-color-image.html

www.space.com/29961-pluto-ice-mountains-nasa-photos.html

www.space.com/29959-flying-by-pluto-charon-4-days-of-images-compiled-video.html

www.space.com/29957-pluto-charon-fly-by-high-resolution-imagery-revealed-by-nasa-video.html

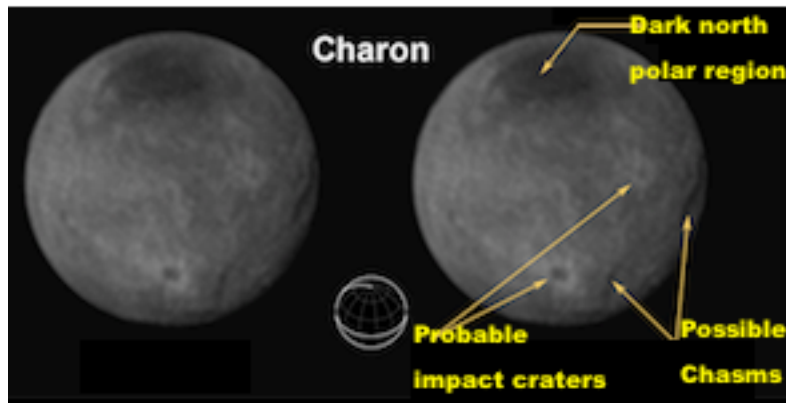
www.nasa.gov/press-release/from-mountains-to-moons-multiple-discoveries-from-nasa-s-new-horizons-pluto-mission

www.space.com/29956-will-nasa-send-an-orbiter-or-lander-to-pluto-exclusive-interview-video.html

www.space.com/29941-pluto-charon-could-spout-icy-plumes.html

www.space.com/29971-pluto-heart-named-for-clyde-tombaugh.html

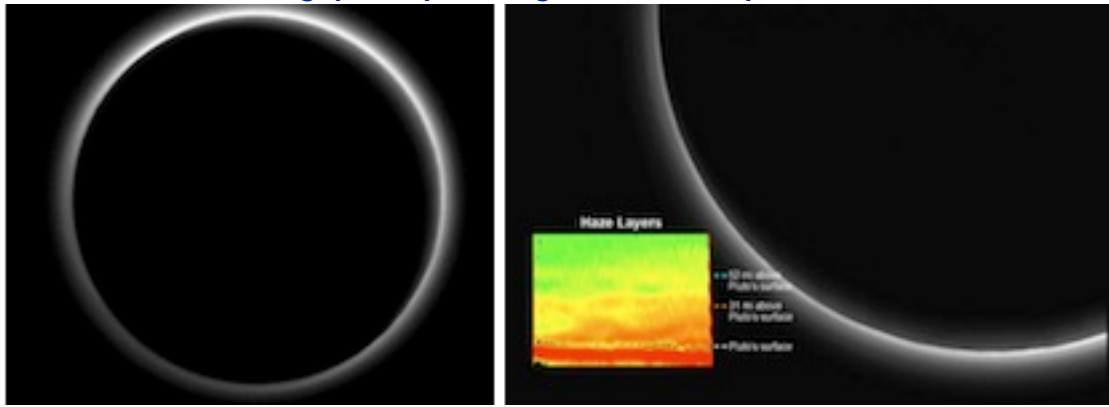
www.space.com/29970-pluto-moon-charon-mountain-photo.html?



www.space.com/29982-pluto-ice-plains-new-horizons-video.html

www.nasa.gov/press-release/nasa-s-new-horizons-discovers-frozen-plains-in-the-heart-of-pluto-s-heart

www.space.com/30046-amazing-pluto-photos-glaciers-atmosphere.html



Left: The hazy atmosphere of Pluto, backlit by the sun, is seen in this breathtaking farewell photo taken by NASA's New Horizons spacecraft on July 15, 2015 just after its historic flyby of the dwarf planet. Scientists can study the ring-like halo around Pluto to learn more about its atmosphere.

Right: This NASA graphic shows a view of Pluto's hazy atmosphere as seen by NASA's New Horizons spacecraft on July 14, 2015 during an historic flyby of the dwarf planet.

The inset image shows the height of different haze layers on Pluto seen by New Horizons.

<http://news.sciencemag.org/space/2015/07/potential-geysers-spotted-pluto>

www.space.com/29988-new-horizons-pluto-probe-future.html

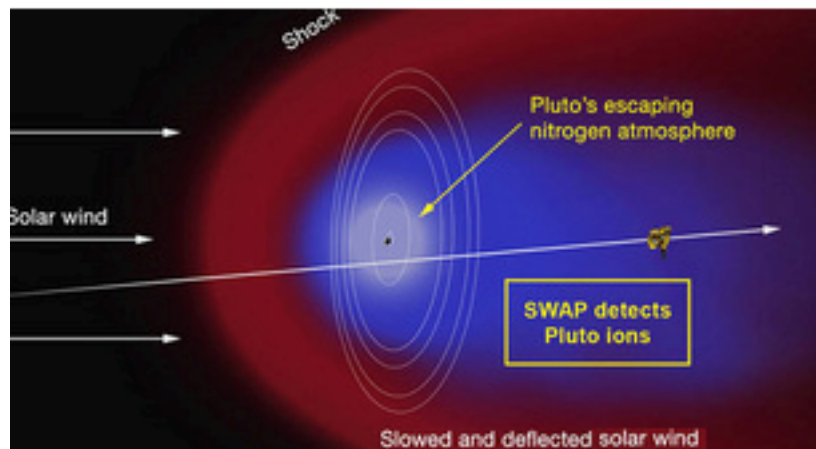
www.space.com/30015-queen-s-dr-brian-may-assembles-first-stereoscopic-pluto-image-video.html

www.space.com/30003-pluto-s-moons-oddly-shaped-hydra-and-color-nix-images-reach-earth-video.html

www.space.com/30002-pluto-heart-has-second-mountain-range.html

<http://astronomynow.com/2015/07/20/build-your-own-pluto/>

www.space.com/30001-pluto-atmosphere-swept-comet-tail.html



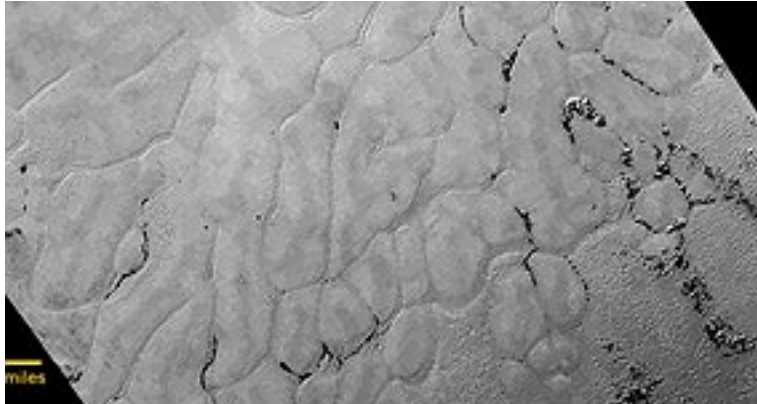
Artist's concept of the interaction of the solar wind (the supersonic outflow of electrically charged particles from the sun) with Pluto's predominantly nitrogen atmosphere.

<http://news.sciencemag.org/space/2015/07/how-plutos-most-spectacular-image-was-made-and-nearly-lost>
www.space.com/30000-camera-behind-awesome-pluto-imagery-explained-video.html
www.nasa.gov/mission_pages/newhorizons/main/index.html

Pluto revealed raises questions about its origins

22 July, 2015 – www.abc.net.au/science/articles/2015/07/22/4278762.htm

“In the space of just 24 hours, from just before New Horizons arrived at Pluto and the historic post-flyby press conference of July 15, our perception of Pluto and Charon changed from that of being very ancient worlds with surfaces heavily cratered like those of Moon and Mercury, to apparently young worlds with surprisingly few craters, just pock-marked here and there.”



The polygon structures on Pluto's plains are telltale signs of convection

“The surfaces of Charon and Pluto may be barely 100 million years old. This is barely a blink in the 4560-million year age of the solar system.”

If Pluto Keeps Spewing Nitrogen, Why Is It Still Full of It?

17 August, 2015 – www.space.com/30265-pluto-nitrogen-atmosphere-mystery.html

Something mysterious is happening on the surface of Pluto: No matter how much nitrogen the atmosphere releases into space, it's still chock-full of the stuff. New [work](#) examines the possible culprits for the stealthy nitrogen resupply, hinting at active geologic activity inside the dwarf planet.

Realistic Pluto Fly-By Animation Created From Photos, Trajectory Data | Video

www.space.com/30409-nasa-s-one-year-astronaut-takes-spin-in-soyuz-video.html

Beyond Pluto: 2nd Target Chosen for New Horizons Probe

28 August, 2015 – www.space.com/30415-new-horizons-pluto-mission-next-target.html

The New Horizons team has selected an object named **2014 MU69**, which lies 1.6 billion km (1 billion mi) beyond Pluto as the next target for up-close study by the spacecraft to take place in 2019, pending NASA approval.

https://en.wikipedia.org/wiki/2014_MU69

2014 MU69 (formerly labeled **1110113Y** in the context of the Hubble Space Telescope, and **11and PT1** in the context of the New Horizons mission) is a Kuiper Belt KBO. It is the candidate selected among potential flyby targets for the New Horizons probe in August 2015.

2014 MU69 was selected for a flyby on 1 January 2019. At that time New Horizons was still sending back data from the Pluto system flyby. ##

Editor's comment: It will be interesting to see how chemically similar **2014 MU69** is to Pluto and/or Charon. If there is a significant difference, it might indicate that Pluto is not a Kuiper belt object after all, but the outermost “planet”, kicked into a Kuiper Belt by Neptune's gravitational influence. PK

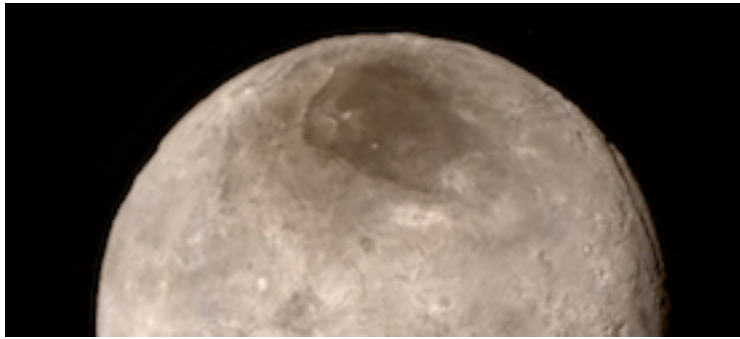
Pluto Probe Starts Beaming Home 'Treasure Trove' of Flyby Data

9 September, 2015 – www.space.com/30491-new-horizons-pluto-flyby-data.html

New Horizons spacecraft has begun beaming home the best data from its epic July 14th Pluto flyby. July 14, New Horizons sent images and measurements after the encounter, but stored the vast majority onboard for later transmission. **That transmission** — which involves tens of gigabits of information — began in earnest on September 5th and **should take about a year to complete.**

Why Pluto's Big Moon Charon Has a Red Polar Cap

10 September, 2015 – www.space.com/30503-pluto-moon-charon-polar-patch.html



Charon's surface is dominated by water ice, and the 1,200 km (750-mi)-wide moon is mostly a solid grayish-white as a result. But Charon also harbors a reddish polar patch. Pluto's surface is reddish-brown as well, and that's no coincidence, likely caused by **complex compounds called tholins.**

On both Pluto and Charon, the tholins are probably created when galactic cosmic rays and ultra-violet (UV) light from the sun interact with methane on the two worlds' surfaces and atmospheres. ##

Pluto's Chaos Region Explored In New Probe Pics | Video

www.space.com/30514-pluto-s-chaos-region-explored-in-new-probe-pics-video.html

New imagery has been processed. High detailed views of the Sputnik Planum and the Chaos region give you the perspective from 1,800 km (1,100 mi) above Pluto's equatorial area. ##

Seeing Pluto's "icescapes" in a brand new light – video

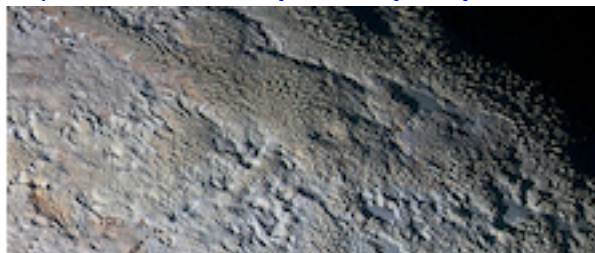
www.space.com/30579-seeing-pluto-s-ice-scapes-in-a-new-light-video.html

www.space.com/30577-pluto-sunset-atmosphere-photo-new-horizons.html

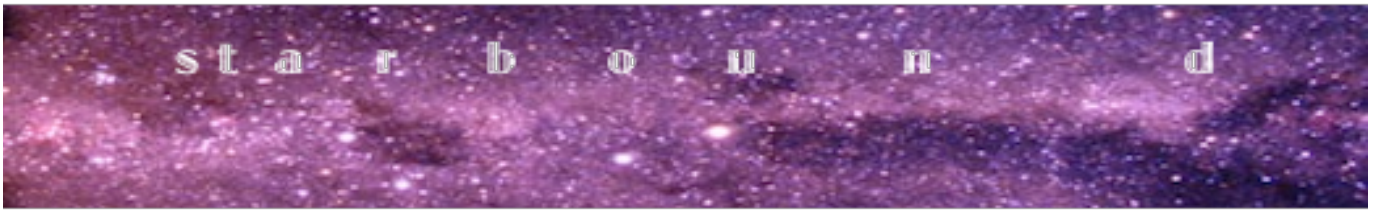
Backlit by sunset over Pluto, NASA's New Horizon's probe captured rugged ~ 3,350m (11,000ft) mountains and wide glaciers of nitrogen ice. Pluto is surprisingly Earth-like...and no one predicted

Pluto Mystery Tour: A Weird 'Snakeskin' Landscape?

25 September, 2015 – www.space.com/30658-pluto-mystery-tour-snakeskin-landscape.html



In this extended color image of Pluto taken by the New Horizons spacecraft, rounded and bizarrely textured mountains, informally named the **Tartarus Dorsa**, rise up along Pluto's day-night terminator and show intricate but puzzling patterns of blue-gray ridges and reddish material in between.



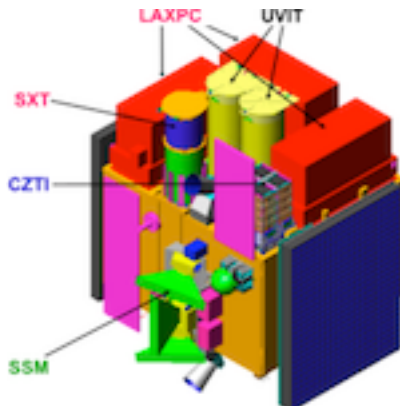
[From now on, we will give the URL web address of the article, its title and date, and a key image if there is one. We leave it up to the reader to explore further - Peter Kokh kokhmmm@aol.com]

EARTH-BOUND TELESCOPES

SPACE TELESCOPES

India plans space telescope launch in second half of 2015

www.theregister.co.uk/2015/05/21/india_plans_space_telescope_launch_in_second_half_of_2015/
www.mobiletor.com/india-set-to-launch-dedicated-space-telescope-named-astrosat-in-october-2015/
<https://en.wikipedia.org/wiki/Astrosat>

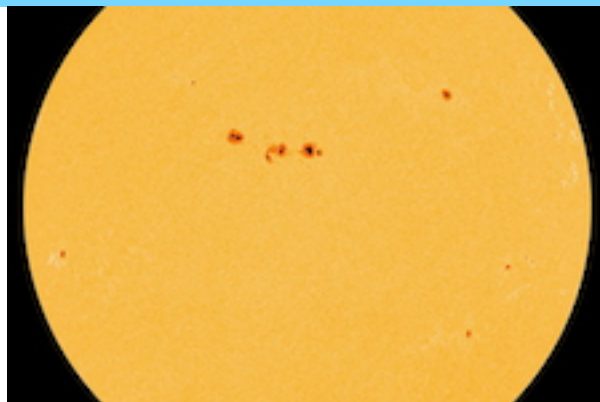


Planned for a launch in October 2015. Astorsat will be released into space by PSLV C-34 once it reaches a height of roughly 650km (404 mi) in equatorial orbit around the Earth.

Similar to NASA's Hubble telescope, ASTROSAT will be the first observatory set up in space by the ISRO – mission to record observations in Ultraviolet (UV), optical, low and high energy X-ray wavebands.

OUR CLOSEST STAR: THE SUN

Wild Sunspot Activity Looks Tamer in 400-Year Recount



July 15, 2018 Spts today no more numerous than a hundred yellows

Past **TTSIQ** issues are online at: www.moonsociety.org/international/ttsiq/ and at: www.nss.org/tothestarsOO

OTHER STARS, EXO-PLANETS & SEARCH FOR LIFE

'Exomoons' Capable of Supporting Life May Be Common

29 June, 2015 - www.space.com/29785-alien-planets-moons-goldilocks-zone.html
www.space.com/23910-habitable-zones-alien-planets-stars-infographic.html

A new study fills in an important gap in the developing theoretical framework regarding exomoons. The paper looks at a special set of exomoons located in the habitable, or "Goldilocks zone" — the not-too-cold, not-too-hot band where water neither freezes nor boils off a planet's (or moon's) surface.

Powerful Space Telescope Would Scan Alien Planets for Signs of Life

8 July, 2015 - www.space.com/29878-alien-life-search-hdst-space-telescope.html



This side by side simulated image of a galaxy 10 billion light years away demonstrates how images taken by **HDST (High Definition Space Telescope)** (right) would compare to those taken by **Hubble** (left). HDST's mirror would be more than 5 times the width of Hubble's mirror, offering 25 times Hubble's resolving power. Hubble detects the galaxy's bulge and disk but only HDST resolves the galaxy's star forming regions and its nearby dwarf satellite

Ancient Exoplanets Raise Prospects of Intelligent Alien Life

9 July, 2015 - www.space.com/29879-intelligent-alien-life-ancient-exoplanets.html

Can life survive for billions of years longer than the expected timeline on Earth? As scientists discover older and older solar systems, it's likely that before long we'll find an ancient planet in the habitable zone. Knowing if life is possible on such a world would have immense implications for habitability and the development of ancient life. ##

Ingredients for Earth-Like Planets Are Found All Around the Milky Way

July 10, 2015 - www.space.com/29898-earthlike-alien-planets-recipe.html

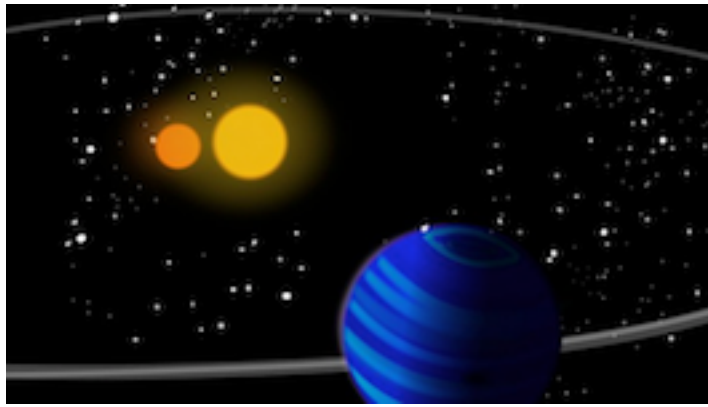
Carbon, oxygen, magnesium and silicon, the building blocks to create another Earth are found on rocky planets everywhere in our solar systems across our Milky Way galaxy. ##

How a planet could survive a collision between its two suns

[http://news.sciencemag.org/space/2015/07/how-planet-could-survive-collision-between-its-two-suns?](http://news.sciencemag.org/space/2015/07/how-planet-could-survive-collision-between-its-two-suns?hpid=hp-main-story)

While searching for Earth-like planets, NASA's Kepler spacecraft has come across 10 that share one very un-Earth-like quality: they orbit two stars, instead of one. The worlds are aptly named "circumbinary planets" ("circum" = around, "binary" = two objects orbiting a common center of gravity.) In this type of binary system, the planet orbits the two stars (as the planet Tatouine did in the first-released Star Wars film). Some stellar binaries that lack planets have a different third party—a distant star so massive, that its gravitational fluxes actually changes the orbit of the stellar binary, causing the two stars to shrink together in a process called orbital decay until the stars eventually collide together in a violent, calamitous explosion. What would happen if a circumbinary planet were in the mix?

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(Tatooine Situation)

Is Life Possible Around Binary Stars? (Podcast)

July 17, 2015 - www.space.com/29985-is-life-possible-around-binary-stars.html

(The Tatooine Situation from the first Star Wars film)

Stephen Hawking Helps Launch Search for Intelligent Life

www.space.com/29990-stephen-hawking-intelligent-alien-life-initiative.html

20 July, 2015 0- “The project will survey the 1 million stars in the Milky Way closest to Earth, as well as the 100 closest galaxies.”

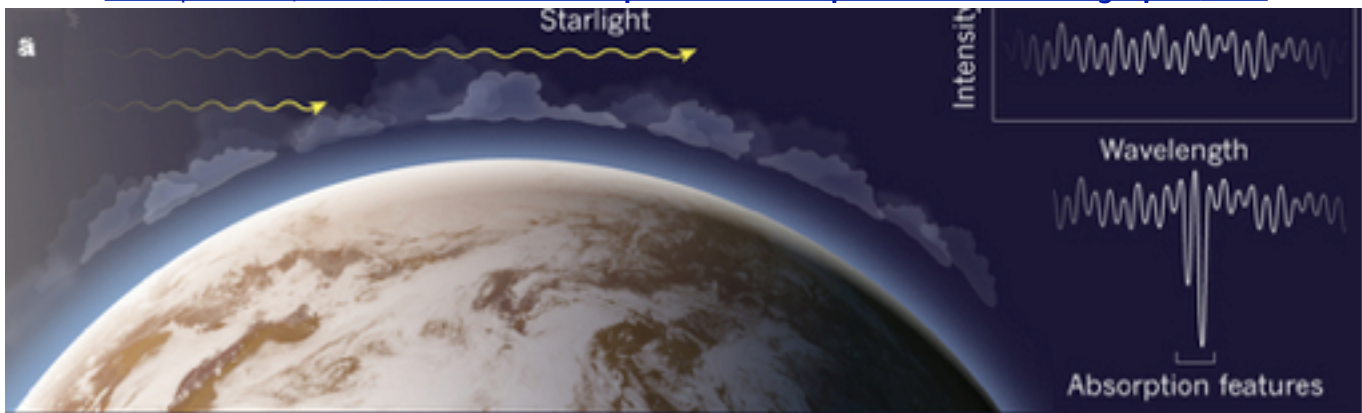
Breakthrough Listen, the first of the two initiatives announced, will be the most powerful search ever taken for signs of intelligent life beyond Earth: a survey of the 1 million stars in the Milky Way closest to Earth, as well as the 100 closest galaxies.

The second initiative, **Breakthrough Message**, will fund an international competition to determine the content of any messages that might be sent by us to alien civilizations. ##

New Method Finds Best Exoplanet Candidates for Telescope Time

21 July, 2015 - www.space.com/29976-new-method-finds-best-exoplanet-candidates.html

www.space.com/30030-earth-cousin-kepler-452b-exoplanet-details-infographic.html



If life exists on planets beyond our solar system, its presence could be obscured by the haze and clouds in the planet's atmosphere. Even next generation telescopes — such as the James Webb Space Telescope (JWST) as well as ground-based telescopes like the European Extremely Large Telescope (E-ELT) — will have a hard time penetrating such hazy worlds in search of “biomarkers.” A new technique checks if a planet has clear skies, making it easier to target the most promising exoplanet candidates for life. ##

NASA Finds Closest Earth Twin Yet in Haul of 500 Alien Planets

23 July, 2015 - www.space.com/30026-earth-twin-kepler-452b-exoplanet-discovery.html

[Read Editor's Definition of an "Earthlike" / "M-Class" Planet in Article Section below]

Earth's Bigger Cousin is 60% bigger and that's a good thing (Video)

www.space.com/30029-earth-s-older-cousin-60-percent-bigger-and-that-s-a-good-thing-video.html

Kepler-452b size is important because it receives 10 percent more energy from its Sun than we do from ours. That mass protects it from experiencing "runaway greenhouse effect and the loss of its water inventory, ##

Bang! Exploding Star Reveals Lithium Discovery

12 August, 2015 - www.space.com/30233-exploding-star-lithium-discovery-video.html

Nova Centauri 2013 - The brightest nova of the century blasted **lithium** into space at 2 million km/h (1.2 million mph), cracking a long-standing mystery about the chemical balance of the universe.

Your Vote Wanted to Help Name 32 Alien Worlds

12 August, 2015 - www.space.com/30232-exoplanet-naming-contest-iau.html

A global contest to name 32 alien planets is underway. The public can now vote on a list of proposed common names for the 32 exoplanets, as well as most of their host stars, in the International Astronomical Union's "NameExoWorlds" competition.

Voting is open through Oct. 31, and the winning names will be announced in mid-November,

Why Water Worlds Won't Host Life

<http://news.sciencemag.org/environment/2015/08/why-water-worlds-won-t-host-life>

14 August, 2015 - Although ocean worlds are swimming in what is thought to be a key ingredient for life—water—their lack of land may limit how much of it they can host. Water covering the surface interacts with carbon dioxide in the atmosphere in ways that can turn chilly planets frigid and make warm ones even hotter.

Baby Jupiter Discovery a Step Toward Rewriting Planet Formation Models

16 August, 2015 - www.space.com/30261-baby-jupiter-rewriting-planet-formation-model.html

Over the last two decades, the discovery of thousands of exoplanets outside our solar systems has shaken up old theories about how planets form; the recent discovery of an "infant Jupiter," rich in methane, may be one step toward writing a new one.



Artist's conception of exoplanet 51 Eridani b

A very young gas giant planet, **51 Eridani b**, **96 light-years** away, has a methane rich atmosphere, just like Jupiter. This is a first: the handful of gas giant atmospheres scientists have been able to study contain only trace amounts of methane, despite what has been anticipated for those types of planets,

Past **TTSIQ** issues are online at: www.moonsociety.org/international/ttsiq/ and at: www.nss.org/tothestarsOO

Earth-Like Alien World Could Have Vast Oceans

17, August 2015 – <http://www.space.com/30260-earth-sized-planet-could-have-oceans.html>

A small, rocky planet, dubbed Kepler-62f, with a diameter 40% larger than that of Earth (c. 11,000 mi / 18,000 km) could host liquid water on its surface, if it also contains a carbon-dioxide atmosphere which could keep the planet warm enough.

Dark energy survey spots new neighbors

19 Aug, 2015 – <http://news.sciencemag.org/sifter/2015/08/dark-energy-survey-spots-new-neighbors>

The Dark Energy Survey's (DES') ultra-high-powered digital camera has snapped pictures that reveal eight more celestial bodies faintly glowing, Astronomy Magazine reports. Scientists suspect that these distant bodies are dwarf satellite galaxies, small galaxies that orbit bigger ones like the Milky Way. This year alone, the Dark Energy Camera has detected 17 dwarf satellite candidate galaxies.

Has Stephen Hawking just solved a Black Hole Mystery?

25 August, 2015 – www.space.com/30366-stephen-hawking-black-hole-mystery.html
<http://www.space.com/30366-stephen-hawking-black-hole-mystery.html>

Stephen Hawking may have just solved one of the most vexing mysteries in physics — the “information paradox.”

Einstein's theory of general relativity predicts that the physical information about material gobbled up by a black hole is destroyed, **but the laws of quantum mechanics stipulate that information is eternal.** Therein lies the paradox.

Hawking has come up with a possible solution: The quantum-mechanical information about infalling particles doesn't actually make it inside the black hole. The information is stored at the boundary as two-dimensional holograms known as “**super translations.**” ##

Scientists Send Kombucha to Space in Search for Extraterrestrial Life

27 August, 2015 – www.space.com/30386-can-kombucha-survive-in-space.html



Microorganisms that cluster together and can stick to a surface are known as a biofilm. This Kombucha biofilm is similar to one that was recently sent into space by the European Space Agency.

How to Find Strange Life on Alien Planets

28 August, 2015 – www.space.com/30404-alien-life-search-super-earths.html

A team of scientists examined models of “super-Earths” — exoplanets slightly larger than Earth — to determine how easily signs of life could be spotted. They determined that such biosignatures could be identified more easily on planets orbiting stars producing relatively low amounts of radiation — but even then only if everything worked out just right.

Where SETI should search for intelligent life

28 August, 2015 – <http://news.sciencemag.org/space/2015/08/where-seti-should-search-intelligent-life>

The inner region of the Milky Way could be the best place to search for intelligent extraterrestrial life – because it hosts the right materials for life to evolve

Tiny Space Telescope to Aim at 'Super-Earth' Atmospheres

30 August, 2001 – www.space.com/30408-tiny-space-telescope-super-earth-atmospheres.html

With a budget of just 50 million pounds (\$79 million), the Twinkle satellite team plans to launch into low-Earth orbit in three to four years if it can get the funding. There, it will study the infrared (heat) signatures of at least 100 nearby worlds a few hundred light-years away. This will be possible even with a tiny mirror of 50 cm (20 in) compared to a larger telescope like Hubble (2.4 m/8 ft)

Alien Oceans' Glint Could Reveal Habitable Water Worlds

2 September, 2015 – www.space.com/30439-alien-oceans-habitable-exoplanets.html

The bright glint of alien oceans may be visible from afar, allowing astronomers to flag potentially habitable exoplanets. As a planet travels around its sun, it moves through phases much like the Moon when seen from afar. The planet's oceans reflect a great deal of light, especially during the crescent phase. Excessive brightness at the crescent phases could be a telltale signal of ocean planets,

Tatooine-Like Planets with 2 Suns Need Perfect Ingredients to Form

2 September, 2015 – <http://www.space.com/30440-tatooine-planets-twin-suns-formation.html>

Astronomers have long struggled with how young planets form around pairs of stars without destroying themselves, but new research suggests it can be done with the perfect setup: a massive, slightly elongated disk of debris from the star.



Planets forming around a star with another stellar neighbor nearby must somehow overcome the gravity of the second star during the formation process. A new view of the process suggests that the material in two-sun system similar to "Tatooine" in "Star Wars" can indeed overcome the star's destructive pull and form planets, even very small ones — if the planet-forming material around the star is sufficiently massive and the disk of material is slightly stretched. ##

LISA Pathfinder to Refine Hunt for Gravitational Waves

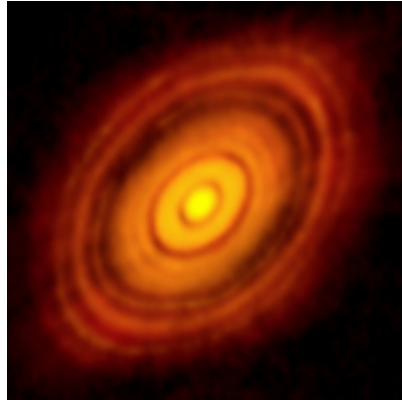
3 September, 2015 – www.space.com/30393-lisa-pathfinder-refine-hunt-gravitational-waves.html



The fabric of spacetime is continually being stretched and squeezed due to the motion of all the bodies of the universe. These fluctuations are called gravitational waves and an upgraded, ground-based set of stations called the Laser Interferometer Gravitational-Wave Observatory (LIGO) is currently trying to probe them with unprecedented sensitivity. <https://ligo.caltech.edu/>

First Look at Planet Birth Shows Tightly Packed Worlds

11 September, 2015 – www.space.com/30511-tightly-packed-giant-planets-birth-image.html



A new study confirms that a controversial space image of the system **HL Tau**, unveiled last year, does indeed show the first picture of planets being born. At first it had sparked controversy over whether or not grooves in the disk of dust surrounding the star could be explained by the presence of newly formed giant planets carving out the disk out of which they are forming.

A new paper suggests that the orbit of those planets could serve to stabilize rather than eject one another, as had originally been suggested. That means this image is the first time scientists have observed a forming planetary system, and a tightly packed one at that. ##

Giant Radio Telescope Could Detect E.T.'s Call

17 September, 2015 – www.space.com/30566-alien-civilization-signals-ska-radio-telescope.html
www.space.com/15883-worlds-largest-radio-telescope-ska-array.html



The Square Kilometer Array (SKA), planned to begin construction in 2018, could enable the search for intelligent life to piggy-back on other scientific observations, scouring the galaxy with unprecedented precision.

The SKA is an enormous radio telescope that will be built in South Africa and Australia. Funded by a consortium of different countries, the SKA will combine thousands of small antennae across the globe instead of a single large dish, allowing unprecedented sensitivity in radio astronomy. ##

OTHER GALAXIES**Enormous Black Hole Is Too Big for Its Galaxy**

9 July, 2015 – www.space.com/29893-supermassive-black-hole-too-big-galaxy.html

A newfound giant black hole nearly as massive as 7 billion suns is dozens of times larger than astronomers expected given its host galaxy's size. This finding may call most current models of galaxy formation into question. ##

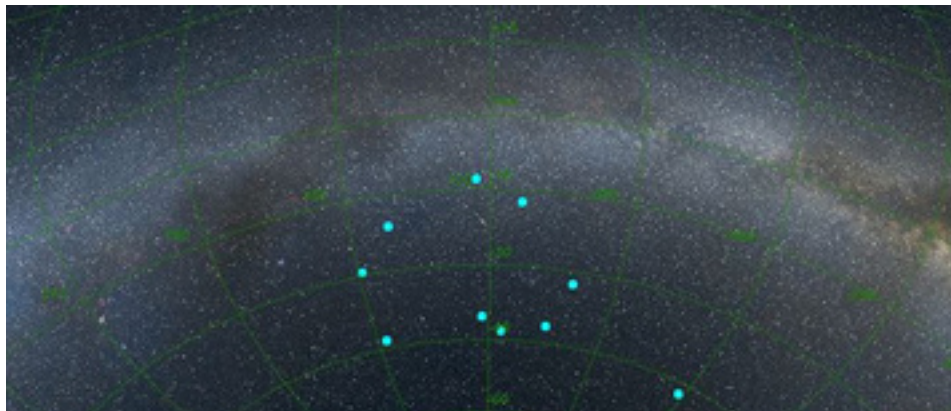
Mysterious 'Blooming' Galaxy – Cosmic Crash Site? | Video

www.space.com/29894-mysterious-blooming-galaxy-cosmic-crash-site-video.html

Giant Mystery Ring of Galaxies Should Not Exist

7 August, 2015 – www.space.com/30166-giant-galaxy-ring-should-not-exist.html

Researchers have announced the discovery of a truly monstrous structure consisting of a ring of galaxies around 5 billion light-years across. The galactic ring, which was revealed by 9 gamma-ray bursts (GRBs), is located 7 billion light-years away and spans an area of the sky more than 70 times the diameter of a full moon.



An image of the distribution of GRBs (Gamma Ray Bursts) on the sky at a distance of 7 billion light years, centred on the newly discovered ring. The positions of the GRBs are marked by blue dots and the Milky Way is indicated for reference, running from left to right across the image. ##

RIP Universe – Your Time Is Coming... Slowly | Video

www.space.com/30194-rip-universe-your-time-is-coming-slowly-video.html

Stars Wander Far From Home – Here's How We Know | Video

www.space.com/30192-stars-wander-far-from-home-here-s-how-we-know-video.html

Amazing glimpse into one tiny corner of our vast universe] Video

www.space.com/30291-1-7-billion-year-old-star-cluster-snapped-by-eso-observatory-video.html

A must watch video! – Editor

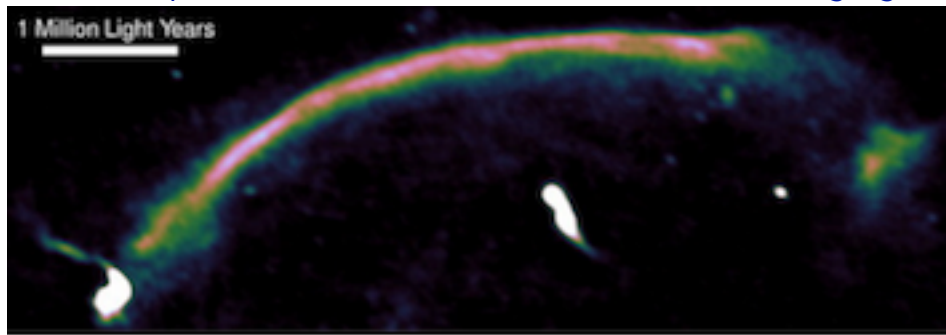
Giant Galaxies May Be Better Cradles for Habitable Planets

www.space.com/30335-giant-galaxies-habitable-planets.html

Galaxies like the Milky Way may not be the best cradles of life in the universe — giant galaxies devoid of newborn stars and at least twice as massive as the Milky Way could host 10,000 times more habitable planets.

'Cosmic Tsunami' Shocks Comatose 'Sausage' Galaxy Cluster Into Star Formation

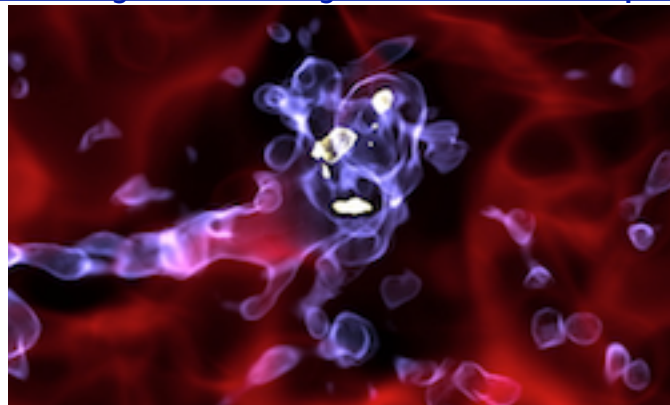
9 September, 2015 – www.space.com/30500-cosmic-tsunami-wakes-sausage-galaxy-cluster.html



This radio image shows a shock wave (bright arc from bottom left to top right) in the 'Sausage' merging cluster of galaxies as seen by the Giant Metrewave Radio Telescope. The shock wave was generated 1 billion years ago, when two clusters collided, and is moving at 5.6 million mph (9 million km/h). ##

Mystery Solved? How Universe's Brightest-Ever Galaxies Formed

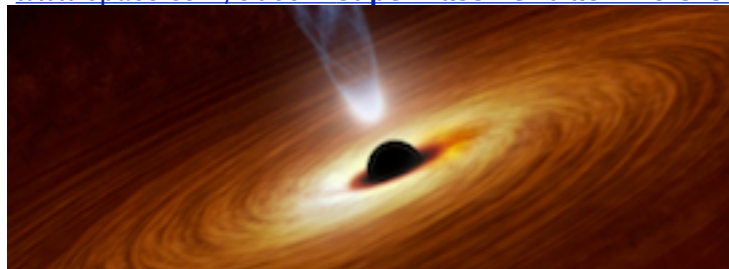
23 September, 2015 – www.space.com/30628-brightest-galaxies-universe-formation-mystery.html
www.space.com/30626-ancient-bright-starburst-galaxies-framed-the-present-universe-video.html



Gas density distribution of one instance in time of the model starburst galaxy, spanning approximately 650,000 light-years. Extreme star formation in the central galaxy is fueled by significant gas inflows,

Oddly Gigantic Supermassive Black Hole Puzzles Scientists

25 September, 2015 – www.space.com/30651-supermassive-black-hole-surprisingly-large.html



Artist's conception of what a massive black hole might look like

The supermassive black hole at the heart of a recently discovered galaxy is much larger than it should be, and astronomers don't know why.

The galaxy, known as **SAGE0536AGN**, lies about **2 billion light-years from Earth** and contains roughly **25 billion times the mass of the sun**. Galaxies of this size typically harbor central black holes with the equivalent of 12 million solar masses or so, but SAGE0536AGN's is about 30 times that heavy, weighing in at 350 million solar masses. ##x

To The Stars International Quarterly Editorial Team

TTSIQ is a project of the National Space Society's International Committee



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NOTE: Opinions expressed in the Articles & Essays section below are those of the individual writers and do not imply any editorial philosophy of TTSIQ. The TTSIQ editorial team consists of persons of various backgrounds who are free to express their own opinions and interpretations.

**We welcome additional co-Editors and Contributors
As well as Reporters from various nations and student groups**

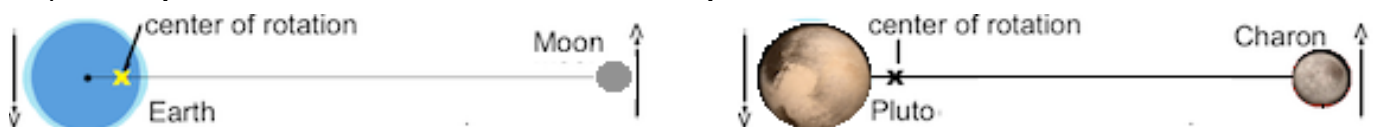
ARTICLES & ESSAYS & MORE

Replace “Pluto the Dwarf Planet” with “Pluto–Charon Binary Planet”

By Peter Kokh

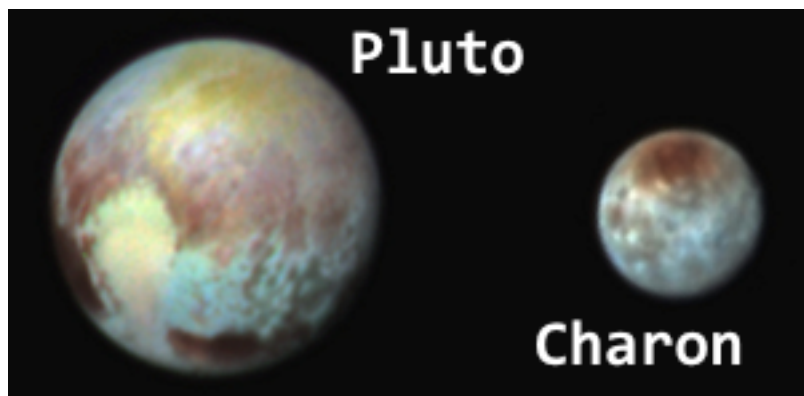
Some Basic Information about Pluto–Charon (Charon is pronounced “chair-on” (not “care-on”))

- Pluto’s day (and Charon’s too) is 6.4 Earth days
- From Pluto, the Sun would look like Jupiter does from Earth — like a fat star — though much brighter.
- Pluto has a “moon/companion planet” – Charon – which is much larger in comparison to Pluto than The Moon is in comparison to Earth
- **As the center of gravity of the Pluto–Charon pair is between them, they constitute a “binary planet system” by the same standards that define “binary stars”**



- **Not to replace “Pluto” with “Pluto–Charon binary planet” is dishonest.**
- **Pluto–Charon are rotationally locked** – Each body rotates on its axis in the same period so that as Charon orbits Pluto, the same hemisphere of Pluto always faces the same face of Charon. This This hemispheric “locking” creates the unprecedented opportunity for the facing sides of both worlds to be joined by a **space elevator**, creating one economy for settlers so that Pluto and Charon together make one “binary world.” as far as their civilization and economy goes.

The Truth about the amazing Pluto–Charon “Binary Planet” system

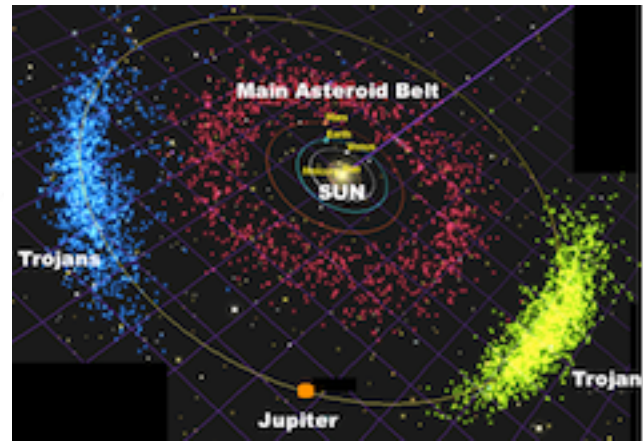
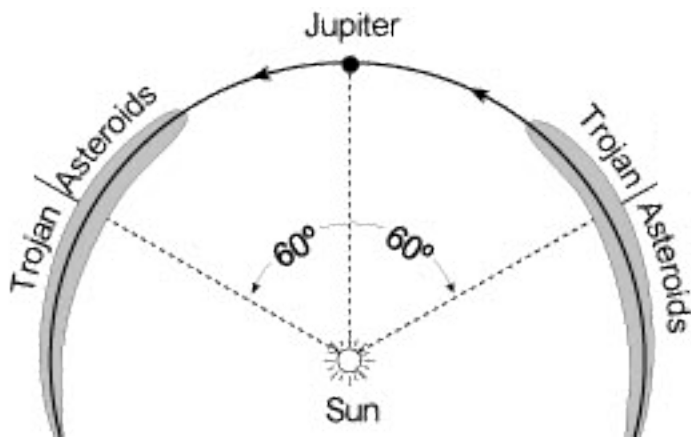


BOGUS STANDARDS: “CLEARING ITS ORBIT”

Famed astronomer **Neil Degraesse Tyson** has defended the current misclassification of Pluto (not even correctly calling it “Pluto–Charon”) on the “official” claim that **“Pluto has not cleared its orbit of asteroidal type debris.”**

- Every planet’s orbital region situation is different. The further from the Sun, the volume to be “cleared” grows exponentially, perhaps “fair” for the massive “gas giants” – Jupiter, Saturn, Uranus, and Neptune – but hardly for a small body such as Pluto–Charon.
- If Pluto were as big and massive as Earth, by these “official standards” it would still be denied planetary status, as Earth, placed in Pluto–Charon’s orbit, would not have satisfied this bogus standard either.

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- One could argue that **only Jupiter has cleared its orbits to the extent that it has marshalled orbital debris in its “orbital region” into “Greek” and “Trojan” clouds** 120 degrees ahead and behind the planet in its orbit around the Sun. Actually, we have found a sparse few Trojans in the orbits of Uranus and Neptune, but hardly “clouds” of them in the orbital domain of either,
- As a “popularizer,” Tyson has done us all (and his own reputation) a misservice by endorsing the “official” view of a small fraction of astronomers still attending the conference where this rubric was proclaimed, after most of the attendees had gone home. **“Truth” trumps the “Party Line.”**
- One could also argue that **any planet’s surface saturated with impact craters, is testimony that the planet has indeed “been clearing” its orbit, an ongoing process.**

TWO QUESTIONABLE STANDARDS

- One “legitimate argument” that Pluto–Charon should not be included in the family of “Planets” is that this binary planet’s orbit around the Sun is **“significantly out of the plane”** in which the other 8 planets are found
- **Orbital inclination** of the Other Eight: 0° to 7° (Mercury, the innermost) to Pluto–Charon’s 17° – **On what grounds is Mercury’s 7° inclination okay, and Pluto–Charon’s 17° inclination is not okay?** [It is traditional to use Earth’s plane as the standard, but this is also illegitimate. 75% of the orbital momentum of the entire Solar System, Sun included, is in Jupiter’s orbital plane, not Earth’s!]
- The other rubric is that Pluto–Charon’s **orbital eccentricity is significantly out of the range** of orbital eccentricities of the other eight planets. **On what grounds is Mercury’s orbital eccentricity of 0.21 okay and the 0.25 of Pluto–Charon not okay?**
- It would seem far more likely that Neptune’s mass and gravitational might have worked to kick Pluto–Charon into their more excentric orbit and high inclination than the party line that Neptune “captured” Pluto–Charon from the Kuiper Belt. In fact, that Pluto–Charon has an orbital resonance with Neptune would seem to cement the opposing argument, throwing the proclamation of a minority clique of astronomers into the trash heap of history where it belongs.

Other Outstanding Characteristics of the Pluto–Charon system

- Pluto–Charon’s other 4 moonlets have orbit periods in synch with the rotation of Pluto and Charon around one another. To observers on any of these mini–moons, Pluto–Charon will resemble the stellar binary “Tatooine” of Star Wars fame.
- **Pluto and Charon both present the same face to the other, permanently, dividing both worlds into partner–facing and outward–facing hemispheres.** Whereas the Moon shows the same face to Earth, but not vice versa.
- Comparison of Pluto–Charon with Earth–Moon (the largest “moon” in the solar system’s “first 8” in comparison with the planet around which it revolves)

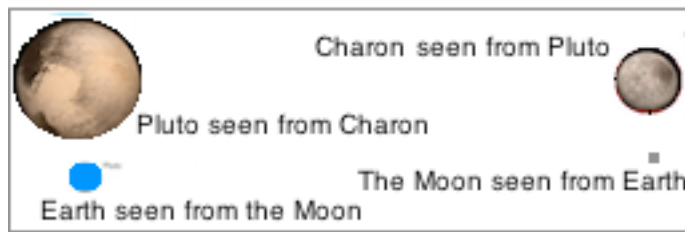
COMPARITIVE ANGULAR SIZES:

Earth–Moon

Earth c. 2° in diameter as seen from the Moon; The Moon is c. 0.5° in diameter from Earth

Pluto–Charon

Pluto ~ 8° diameter as seen from Charon (4 x the diameter of Earth seen from the Moon)
Charon ~ 4 x diameter as seen from Pluto, 8 x the diameter of the Moon seen from Earth



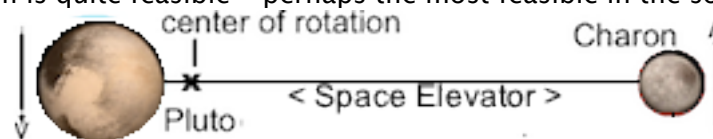
COMPARITIVE MASSES

Earth is 80 times as massive as the Moon – clearly a planet <> moon relatio

Pluto is only 8.5 times as massive as Charon, clearly a binary planet pair, not “a planet & moon.”

Pluto and Charon are a closer match than Earth and the Moon, not only in relative size and mass, but in appearance from one another (as illustrated above).

- As Pluto and Charon both show the same face to one another, and their distance is constant, a “space elevator” between them is quite feasible – perhaps the most feasible in the solar system.

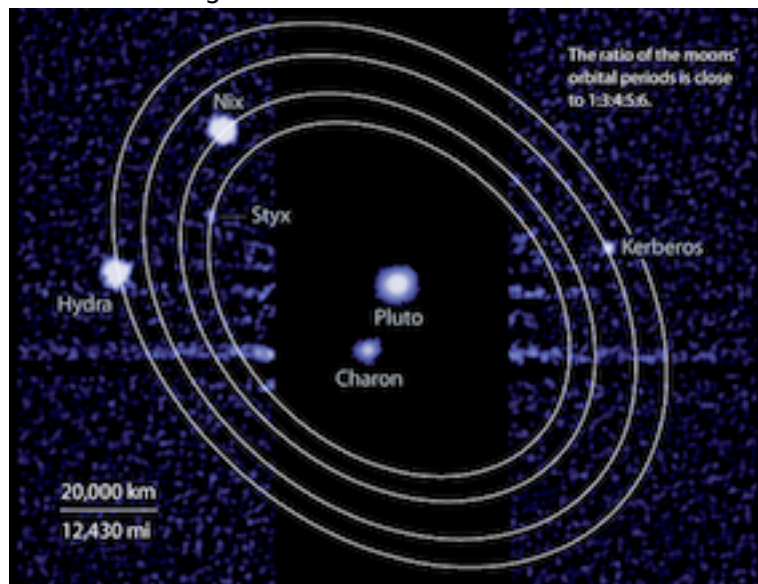


Thus their center of rotation about one another is in between them, rather than inside the bigger more massive body as is the case with Earth and the Moon.

Evidence from Pluto-Charon's (other) 4 moons

Styx, Nix and Hydra are linked by a “**resonance**,” a sort of gravitational sweet spot in which orbits of multiple celestial bodies are related by a ratio of two whole numbers. .

- The resonant relationship between Nix, Styx and Hydra makes their orbits more regular and predictable, and prevents them from crashing into one another



Pluto's “status” needs rethinking!

It doesn't stop here. The pair has 3 “moons” and that also commands respect. In comparison, Mercury and Venus have none, Earth but one, Mars but two. Among the traditional “planets” the Earth-Moon pair is the closest to a “double planet” but fails our test: the center of rotation of the Earth-Moon system is not between the two, because the Moon's mass relative to Earth's is not as great as Charon's mass is relative to Pluto's.

We'll go out on a limb here and predict that after the astromical and space community digests all the information about this “binary” planet, far more fascinating than we had imagined, there will be a strong push to **reclassify Pluto-Charon as a “binary” planet.**, deserving of its membership in this club of nine planets. ##

Kepler Shipyards: an Innovative force that could reshape the future



<http://keplershipyards.com>

Technologies to Explore the Next Frontiers and Settle New Worlds

SPACE VEHICLES

Kepler Shipyards Space Vehicles division focuses on three primary classes of vehicles that are conceived around common cores, or similar architectures: launch vehicles (LVs), landers, and micro-gravity transport vehicles.

The **931 and 12-331: microsat-sized launch vehicles** that use the same tankage and engines as used in the Speck Lunar Lander, further reducing costs. They are composed of a many very inexpensive common modules. These modules use the same tankage and engines as used in the Speck Lunar Lander, further reducing costs.

The **"Speck" Lunar Lander System**, currently under construction, is only the first of a large family of **modular, reconfigurable landing systems to provide simple, straightforward transportation for goods and passengers between the Earth and the Moon.**

"The Hawk", the next larger variant, will be **an open-seated lander with a large gantry and an open bay in the middle.** Constructed from Speck lander components—when you land three Speck landers on the surface, you can then build a Hawk out of the parts. Used to pick people or cargo up from lunar orbit and bring them back down to the Moon, or for long-distance surface transport. Its large open central bay can be reconfigured for a variety of missions, from personal transport to bulk cargo transport to tankage. The Hawk will be the backbone of early lunar and cislunar transport.

The **"Sled"** is another Hawk variant designed specifically **to operate in micro-gravity, never to touch a planetary surface.** Used for a variety of missions: close-in exploration, personnel transport, satellite servicing and refuelling. Designed to exist in space, it will operate more efficiently than a spacecraft that has operated in another environment first.

The **eventual goal?** We envision **an Aldrin-styler cyler in a continuous orbit around Earth and the Moon** – like a ski gondola, always moving, able to transfer people on and off. With Hawks or other spacecraft at either end, travel will be convenient and feasible for people not trained as astronauts or pilots. That means a lot less time spent in a space suit, too.

SURFACE STRUCTURES – <http://keplershipyards.com/surface-structures>

If humans are to explore and eventually colonize other worlds, we'll need a place to live, work, and recover—a home away from home. **The two most immediate needs for any long-term expedition**

are a general-purpose shelter and workspace, and a form of life support (in other words, a way to procure food, water, and air).

We're partnering with the **OpenLuna foundation** to develop their **Mk 1 Outpost and Aquaponics Module** for deployment on the lunar surface.

Before we can engage in long-duration exploration and colonization of space, we need to resolve the issues of oxygen supply, CO2 scrubbing, water treatment, waste handling, and food production. On planetary surfaces, all of these issues can be resolved by employing a single solution: aquaponics, combining hydroponics and fish farming. The same setup can also be used on Earth to solve these same problems.

We'll be building the Outposts on Earth as quick-deploy shelters for emergency situations and in remote environments, in areas where food and clean water are needed and cannot be provided by more conventional methods, such as developing areas or disaster sites.

SPACE ACTIVITY SUITS

Current spacesuits are no longer capable of providing support for the wide ranging missions Mankind will soon be tasked with; these suits are large, complicated, bulky, and difficult to move in. Kepler is solving this problem with a common core "pressure liner" that can be worn as a daily wear uniform that is worn, and can be reconfigured with armour and PLSS (Portable Life Support System) to match the mission at hand. Some expected options include;

SAS – THE SPACE ACTIVITY SUIT

This is the suit commonly thought of as the Space Suit. It will be used for all on-orbit activities.

LUNAR SUITS

The **Lunar Excursion suit** is meant for short two day to a week duration on the Lunar surface. It won't include the advanced medical support systems of the Expedition grade suit.

The **Lunar Expedition suit** is meant for durations of up to a month on the Lunar surface.

MARTIAN SUITS

The **Martian Excursion suit** is meant for up to a week duration on the Martian surface—without the advanced medical support systems found in the Expedition grade suit.

Excursion – Meant for much longer duration on the Martian surface.

ASTEROID OPERATIONS SUITS

In addition to the Space Activity Suit common cores ballistic armour and solar shielding, the **Asteroid exploration and mining suit** will integrate the armour of the Lunar and Martian surface suits and more advanced grappling tools designed for the target asteroid.

JUMP SUIT – a protective suit designed for jumping onto a planet's surface from the outer atmosphere—the Earth's, Mars's, wherever. The immediate practical applications: the as-yet untried sport of spacediving (parachuting from space) back to Earth's surface. This will require a suit specifically configured for this purpose from the Kepler Space Activity Suit common core.

INTERGROUP TECHNOLOGIES

Intergroup Tech is the intersection of two or more other divisions. To run a suborbital experiment, with assistance with flight operations and suits, we can help. To explore and mine a near-Earth object, we can set you up with the suits, habitation, and flight operations support. We can also provide equipment and training, and even arrange flight integration.

If you're looking to set up an incredibly remote long-term mining or relief operation and need habitation, clean water, food, power, and communications, WE can fulfill your needs.

If you want to build a Lunar or Martian colony, we can do that, too. The OpenLuna Foundation has selected us as the prime contractor for all their non-volunteer manufacturing.

COMPANY: THE MISSION OF KEPLER SHIPYARDS:

"to provide reliable, cost effective space exploration technologies to expand humanity's reach beyond our planet of origin." Kepler Shipyards was Incorporated in January 2014 in Austin, Texas. This new company represents a coming-together of decades of engineering expertise, proven technology, and real-world experience.

Primary purpose: to develop space exploration technologies with adaptability.

Technologies designed for use on other planetary surfaces can be retooled for terrestrial use and commercialization. The surface lander can be reconfigured to transfer cargo back to orbit. A jump suit differs only in a few key details from a space suit.

Redundancy is mandatory: waste is not an option. The past inspires but does not limit us.

We're not afraid to take on what other people call impossible challenges.

We are endlessly innovative, but we never reinvent the wheel just because we can.

Most of all, we bring competence and experience to the table. We know what we're doing, and **we're interested only in solving the problem in the most cost-effective way possible.**

Kepler Shipyards: experienced, hard-edged, intuitive, and iconoclastic, we build **the very best.**

CAREERS

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P.S.: Kepler Shipyards "factory" is located in London, Ontario, halfway between Detroit and Toronto.

Kepler Shipyards: a sudden setback, but determined to continue.

From Paul Graham (Open Luna Foundation, and Kuiper Shipyards)

A Setback for Kepler Shipyards: [email received September 12, 2015]

From Paul Graham to Peter Kokh

"I've hit a bit of a slowdown recently. My shop was broken into, and amount \$100k in other stuff, all of my prototypes, plus the documentation photos were stolen. This is basically a year's setback for me." - paul@openluna.org

Editor's Comment: Paul is not looking for handouts, but gracious donations could speed up the effort to get Kuiper Shipyards back in business in this bold, pioneering enterprise to open Moon and Mars for settlement. I have been out of touch with Paul for a while. He was my Crew Commander on my first 2 week crew at the Mars Desert Research Station, #34, the "retrofit crew" in 2005. I commanded The National Space Society/Moon Society/Lunar Reclamation Society crew, #45, at the station, building the simulated "Heinlein Tunnel" between the Hab and Greenhab, with Paul's design approval, as then head of the MDRS Engineering team.

Together in 2010, Paul and I, as designers of a team headed by Maria Catalina, worked on an effort to design a "Moon, Mars Atacama Research Station" to be built in northern Chile around a core module, the fuselage of a retired C130 air freighter, to be supplied by the Chilean Air Force. This effort was undercut by the University of Antofagasta, Chile, which on the one hand chose our plan as the best, but on the other hand, dismissed our crew, saying that they would build the station themselves. After hundreds of hours of planning, this was a big blow to our crew, Paul and I in particular.

Since then, Paul launched Open Luna Foundation in , a co-sponsor of the **To The Stars International Quarterly.**

I have the greatest respect for Paul. It is great to see what he has come up with and it makes eminent sense (which NASA plans seldom have.)

Moon Fans + Mars Fans => Collaboration on Joint Project Areas

By Peter Kokh – reprinted from MMM #133, March 2000 and updated

FUTURE ROBOTIC PROBES

- **Push development of instruments to map near subsurface voids (lavatubes).** Such instruments can be test flown in Earth orbit where ground truth is in hand to calibrate the readings. We suspect these in shield volcanoes (Olympus Mons, and the three Tharsis Ridge volcanoes, Arsia, Pavonis, and Ascreaus) on Mars, and in lava sheet flows (maria) on both worlds.
- **Software to detect any exposed lavatube entrances** by their shadows in photos taken at high noon lighting conditions – to narrow down the list of sites to be searched, and openings to be probed..
- **A radar “flashbulb” impactor** with two parts that would “telescope” on impact, creating a signal illuminating subsurface voids within 8 kilometers, the signal to be received by an orbiter overhead.
- **Push development of permafrost-mapping instruments** that can also detect concentration (percentage soil moisture) and depth. A Permafrost Mapper could be tested in orbit above the Earth, where, with the advantage of available ground truth, we can establish the capacity and calibrate instruments

LIST AND DEFINE ELEMENTS OF COMMONALITY: Structures, systems, infrastructures, and procedures needed for exploration and outpost establishment Missions on both Moon and Mars – without prejudice to separately designing things that must be different.

This will result in shared cost assignments, or in the case of items designed and engineered for the Moon first, part of the Moon front effort, with only incremental cost of any needed adaptations being assigned to the Mars front effort.

MODULAR ARCHITECTURES FOR HABITAT & BIOSPHERE EXPANSION

- **Develop a versatile “language” of habitat modules**
 - ✓ That can be manufactured from locally processed building materials such as metal alloys, cast basalt and basalt fiber composites, glass-glass composites, and fiberglass reinforced concrete.
 - ✓ That can be quickly and safely assembled on location with minimal man-hours on the surface, saving labor-intensive customization for indoor customizing.
 - ✓ A family of modules that allow diverse habitat designs.
 - ✓ Connections must be quick, secure, leak-resistant, durable. Utility run interfaces must be standard.
- **Toilet / greenhouse modules** that provide primary treatment of human wastes will allow settlement biospheres to grow in modular fashion along with the mass and maze of interlinked habitat structures.
- **Modular Factory & Modular Industrial Park Concepts.** Capital equipment is likely to be sized to fit available cargo holds and farings en route to the Moon or Mars. Developing a Container architecture and infrastructure will allow industrial parks to grow modular fashion. Modular Power Units, thermal management, and product and by-product movements should all be part of such designs, along with designing for both human tending and teleoperation.

There is already considerable progress made on developing container factories for use in the Third World. That is experience we can build on.

- **Work on the “Economic Case for Mars”** incorporating Moon-Mars Trade along with the mutual development of other “in-space” sources and markets to include Earth-orbiting stations, factories, and tourist facilities; and asteroid mining efforts. Phobos and Deimos moonlets may have an important role to play.
- **Design & Test dust control measures** to impede migration of dust into habitat interiors through airlocks. Space-suit design and airlock design should be integrated. Entry and exit of goods and materials should be handled separately. Dust repellent surfaces, especially surrounding airlocks, are worth developing. Dust can render lubricants nonfunctional. We must protect bearings and other lubricated areas.
- **“Spin-up, not off”: List & Define the various technologies, not yet developed, that we will need on the frontier.**
 - ✓ Then brainstorm these technologies for potentially profitable terrestrial applications.
 - ✓ Next layout the basis for a business plan for an enterprise that would develop such technologies just for those terrestrial applications.
 - ✓ The hoped for result is that these technologies will be on the shelf, ready to apply when we need them, the cost of their development reimbursed by consumers.

- ✓ If we don't do this, and leave it to NASA, some of these technologies may be victims of budget cuts, others developed in expensive crash programs paid for by taxpayers. By pursuing the spin-up route we are taking charge, making sure that the technologies we need to open the lunar and Martian frontiers are there when we need them, and not subject to budget scrutiny.
- ✓ Many, not all, of these future frontier technologies will be needed on both worlds. Many of the technologies needed on the Moon, but not applicable to Mars, may be needed on Phobos and Deimos

OUTPOST SIMULATION: some Moon Society members could volunteer to crew an MDRS in Utah, to further simulate conditions common to both frontiers from a new perspective.

JOINT CONFERENCE COSPONSORSHIPS: The Moon Society has offered to host the Moon track at the National Space Society's annual International Space Development Conference. We could invite Mars Society personnel to help us turn this into a Moon & Mars track. We might also want to contribute presentations to future Mars Society Conventions on topics of shared interest.

UNITED PUBLIC POSTURE: coordinating our public positions on the Moon-to-Mars initiative. This can include joint position papers and press releases, when appropriate, and when touching on area of mutual interest and collaboration.

JOINT PUBLISHING VENTURES, for example "Lavatube Sanctuaries on the Moon and Mars" (alternate title, "The Hidden Valleys of the Moon and Mars" // "Pioneering New Worlds: The Moon and Mars," etc., etc. Again, spreading the message of a united front. Another idea is joint CD-ROMs on Moon and Mars

This is but the START OF A LIST of what Moon and Mars enthusiasts and supporters can fruitfully pursue together. The areas of collaboration and cooperation are open and fluid. The above are but some suggestions that appear to be especially worth pursuing to mutual advantage.

Note: Moon enthisoasts should pursue such a collaborative and cooperative posture even if corresponding good will is not always shown by those interested only, or primarily, in the opening of the Martian Frontier. And, of course, vice versa.

Suggestions and constructive criticism are invited.

Peter Kokh – kokhmmm@aol.com

Editor's List of Needed Science Missions

By Peter Kokh

The MOON

- Lavatube Mapper – www.moonsociety.org/competitions/engineering/SkylightExplorerer.ppt
- Lavatube Skylight Explorers:
<http://eselenology.offworldventures.com/wp-content/themes/mimbo2.2/images/SelArticleSpr2011.pdf>
www.moonsociety.org/competitions/engineering/SkylightExplorerer.ppt

MERCURY

- Lavatube Mapper & Probe (see links above)

MARS

- Lavatube Mapper and Skylight Explorers (see above)
- Permafrost Mapper
- Flight Demonstration first in Hellas Planitia, then in Valles Marineris
- High resolution mapper looking for **relics of ancient shorelines** in the Hellas basin and elsewhere

VENUS & GAS GIANTS

- Aerostat Atmosphere Probes
https://en.wikipedia.org/wiki/Colonization_of_Venus#Aerostat_habitats_and_floating_cities
http://www.moonsociety.org/publications/mmm_papers/venus_rehabpaper.htm

EUROPA

- Ice Crack Explorer

TITAN

- Great Lakes Boats, Subs { www.space.com/29953-titan-submarine-nasa-niac-proposals.html }

NEPTUNE & URANUS

- Cassini type missions

Note: The following is something I wrote back in October 2008 that I would like to share with readers.

“SKYFIELDS”

By Peter Kokh, from my summer cottage outside Florence, Wisconsin,
near Iron Mountain in Michigan’s Upper Peninsula (“Occupied Wisconsin”)

I don’t ever recall writing something like this for MMM, but there is a time for everything. When I was 8 years old in 1946, I went with my maternal grandparents to visit their hometown of Florence, with a view to buying vacation property. They found two acres, surrounded by farmland at the time – now new forest on one side planted by birds and squirrels and wind – on a dead-end country road. I am always amused when friends who’ve never been here, put down the location because it is not on a river or lake where you can have the benefits of more bugs, more crowding, more noise and higher taxes.

Here instead I have just peace and quiet with scarcely a half dozen cars going by all day. In the sixty-two [now sixty-nine] years since, I have not failed to get up here at least once a summer except in 1961 when I was in England all year. Geologically, this is an interesting area on the edge of the Laurentian Shield, the ancient heart of North America, where all over the place little waterfalls carry brooks and streams over this edge onto the newer sedimentary-glacial part of the continent to the south. Hiking into hidden waterfalls with my dogs has been a decades old-long pastime.

Thirty-some years ago I found a waterfall on a county map that only a few old timers knew about. I set out to find it and parked as close as I could get at the end of a sandy road. After walking this way and that for two plus hours, I finally found it. I made it back to the car, went back to town and bought a can of yellow spray paint then drove back to the end of the road. This time having found the shortcut,

I marked trees at 30 foot intervals. Today there is a nice trail and many people have seen what to me back then was a very private spectacle. I tell this story to locals, ending with “Now, as Paul Harvey would say, you know the rest of the story.”

It is here that I realized that there is a difference between beauty and awe, the beauty of life which strives to impose order, the awesomeness of the geological terrain which could care less about the life that learns to thrive on it. It is this combination of beauty and awe which touches the soul most deeply. Are the heavens only awesome? Or is life pervasive, imposing beauty? The “planned” faux geology of space settlements is too dishonest for me, proud to be a “planetary chauvinist.”

Well, it was beginning to look as if 2008 was going to be the second year since 1946 that I would not make it up here. No car, high car rental and gasoline prices! Why I could fly from Milwaukee to Los Angeles and back for the cost of renting a car to come here for a weekend! But then as the 2008 summer season started to recede into memory, on the last day of October, I had a break. A friend of mine was going to Atlanta, and if he picked me up so that I could drive him to the airport, pick him back up on his flight home, and if I took care of his little aging Schnauzer Mitzi while he was gone, I could use his car. The temptation was too great and with a combination of guilt and joy, after dropping my friend at the airport, I picked up Mitzi and we headed north.

I have such a nice cozy place, an old 8’x30’ 1955 house trailer set on a foundation twice as wide, with two more rooms on the other half, and a conventional roof over all of it that I had designed and had built for a song in the mid-70s. The trailer I had found and had put there in 1969. For almost 40 years [46 now] I have enjoyed the solitude in the northern woods under star spangled skies.

Above my cottage sofa is a plaque I designed that proclaims “**these** are the good old days,” in defiance of my grandmother’s insistent claim that “**those** were the good old days.”

Mitzi loved it as do all my friends, amazed at how much better peace and quiet with only the squirrels to scold you for intruding on their property, how much better that is than being on a lake or river! Mitzi and I only stayed one night. It was not worth opening up only to close up in the morning.

But this night the skies were incredible – not quite as unbelievable as the moonless skies in SC Utah at the Mars Desert Research Station, a hundred miles from the nearest town of size, but almost.

Mitzi and I took a walk down the unlit asphalt road with nothing but the stars to light our way. Dogs do not imagine bears or goblins or monsters laying in wait along the roadside at night, and having strolled down this carless road many a time at night with my dogs, I have lost all such fear as well.

This night the Milky Way was out in all its glory. I was walking toward Perseus and Cassiopeia. For a while I thought I was looking at Andromeda (the great M31 spiral galaxy 2–3 million light years away) which I’ve seen many times in those northern dark skies. Tonight it looked as big as my thumb

extended at arm's length. But then, to my embarrassment, I spotted the V of Hydra and knew that I had been looking at the Pleiades all the time. Oh well, by any name it was wondrous. Actually, except for Andromeda here in the north and the Magellanic Clouds in southern skies, all we see by the naked eye lies within our own Galaxy – vast and wondrous enough!

The big dipper was below Polaris, but here at 47 degrees north you could clearly see all of it above the trees. The summer triangle was obvious with Deneb, Vega and Altair, the latter two pointing to Fomalhaut, a dimmer star that still dominated the south. If you ever read the “Star Kings” (alternate title “Beyond the Moon”) a 1950s galactic soap opera (better than Star Wars), by Edmond Hamilton, you will remember Fomalhaut as a key kingdom in the galactic alliance.

As a boy of 9 during the great 1947 Flying Saucer scare, I used to hope one such celestial vehicle would land in those fields and whisk me away to see the wondrous sights of more advanced worlds. And through the years, many an MMM article has been started or finished here, or on the way here or on the way home.

I have always been puzzled that there are so many astronomers, amateur and professional, who can study the stars and never feel sucked up by them, never feel the need to go out there, to meet the stars half way, to look at them from the other side, that is from somewhere else looking this way. I always loved the stars and that is why I always wanted to go out there among them. As the King (Yul Brunner) would say in Rogers and Hammerstein's *The King and I*, “it is a puzzlement.”

I named my little hideaway “Elm Vue” because on the far side of these fields stood a tall solitary gigantic elm, long since the victim of Dutch Elm Disease and lightning. Were I to rechristen my sanctuary today, it would be as “Skyfields,” for while, true, this place is not on a riverbank or lakeshore, it is on a “beach” that opens up to the sun and cloud-ruled sky by day and to the Milky Way and Northern Lights by night.

Others can have their rivers and lakes, I am on a beach to the Universe!

Someday people will be on the farside of the Moon. If they have crystal clear visors that catch no glare, they will see the Milky Way as no one can see it on Earth, not from Northern Wisconsin, not from South Central Utah, not even in the middle of a six-month deep night in the heart of Antarctica.

With no atmosphere, no haze, no clouds, no wind, one might see stars down to the 7th and even the 8th magnitude. Hundreds of stars, at any rate, to each one we can see in the ever fewer Dark Sky areas left on Earth. In the cities, one sees only a few hundred of the brighter ones at best. Is it any wonder that our young people don't get hooked on the heavens! Why they can't see them any more!

But thank heavens for the Moon. It is the clearly round globe of the Moon that lets us visualize other planets in our own system and perhaps around most of the solitary (non binary) stars in the galaxy. As a young man, I fancied myself employed by a Farside observatory, Earth forever out-of-sight, out-of-mind. I've always had a bit of a monastic streak. I'd be dedicated to studying the heavens, and especially listening for whispers from the stars, intelligent ones. But I hear them now anyway. Nature never does anything once, you know.

Some people have a dogmatic or emotional need to believe we are alone and misweigh or misinterpret every shred of evidence accordingly. But “they,” our counterparts must be everywhere -- granted too far apart in both space and time to be contemporary neighbors, though all averages include exceptions.

But it is enough to know they are there, that however different we may be physiologically or culturally, we all share the same creative condition. We are born, we struggle to make sense of it all, we die. I look out there and say “Hi all of you,” knowing that in all corners of the universe others are looking up, realizing this very commonality as well, and saying “hi” in return. Who needs words? Who needs messages? Who needs proof?

Meanwhile we all give glory to the wondrous creative forces that have brought us into being and nourished us to the point where we are aware of one another even if only in such a mystical way.

Everywhere, life must be hard, full of hardships and tribulations, joys and suffering, yet eminently worth the struggle. And are we not all, wherever and whoever we are, made of stardust? Stardust from brighter stars that have lived fast and hot and then strewn their fusion dust into the void to become the stuff of planets and plants and creatures?

“Of stardust thou art and to the stars thous shalt return.”

Well, maybe not literally. But even if not, it is difficult to look up at these spangled skies and not feel that you have returned to them, and to celebrate life with all who share it “whenever, wherever, however.” In the omniverse, we all give praise.

I hope you enjoyed this little essay, this brief exposure to some of the things that have shaped my vision. Maybe some of these thoughts will nourish your own contemplations of the wondrous world we live in and the unknown wonders of the worlds we live among. In everything, down to the slug, the cockroach, the dandelion, there is wonder – and up to the clouds, the stars and beyond.

Feed the wonder in your soul. There is so much nourishment out there with which to do so. And remember, life here is all too short! Absorb all you can and expand your soul with whatever you can.

For “these are the good old days! “ – October 23, 2008 <PK>

Alan Bean: from “Moonwalker” to Artist

By Peter Kokh

Born March 15, 1932 in Wheeler, TX, Alan Bean, now 83, is one Apollo astronaut who found a way to keep his experiences on the Moon live and vivid, by producing art to inspire others. Bean was the 4th person to set foot on the Moon, the lunar module pilot on Apollo 12, in the second lunar landing in the Ocean of Storms, Oceanus Procellarum, November 20, 1969, accompanied by mission commander Charles “Pete” Conrad.

Bean resigned from NASA in June 1981 after 18 years as an astronaut, to devote his time to painting. Many of his paintings hang on the walls of space enthusiasts. He said he was fortunate enough to visit worlds and see sights no artist's eye, past or present, has ever viewed firsthand and he “hoped to express these experiences through his art.”

As a painter, Bean wanted to **add color to the Moon.** **“I had to figure out a way to add color to the Moon without ruining it,”** he remarked. **In his paintings, the lunar landscape is not a monotonous gray, but shades of various colors.**

He is the only artist to use **real moon dust** from keepsake **patches from his space suit dirty with moon dust**; **tiny pieces of the patches** to his paintings to make them unique; **the hammer used to pound the flagpole into the lunar surface**, and **a bronzed moon boot**, to texture his paintings.



Editor's selection of five of Bean's paintings

You Tube: <http://airandspace.si.edu/exhibitions/alan-bean/>

Available Alan Bean originals: http://www.alanbean.com/available_originals.cfm

DVD: “Alan Bean Artist - Astronaut” (the You Tube video above is a shorter version)

Editor. We strongly recommend this thorough explanation of his work by the artist himself. Bean also had a featured role in the documentary Lunarcy, along with Peter Kokh and Chris Carson of both the Moon Society and the National Space Society ##

Past **TTSIQ** issues are online at: www.moonsociety.org/international/ttsiq/ and at: www.nss.org/tothestarsOO

Economic Assessment and Systems Analysis of an Evolvable Lunar Architecture that Leverages Commercial Space Capabilities and Public-Private-Partnerships

Outline of Important Study available at Future Issues
<http://www.nss.org/docs/EvolvableLunarArchitecture.pdf>

Forward; Date of Publication July 13, 2015

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NexGen Space LLC Page 1 Evolvable Lunar Architecture

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An Evolved Commercialized International Space Station

By David Dunlop – September 27–2015

Commercial Space Stations

On September 22, The Secure World Foundation and the Alliance for Space Development hosted a panel on Commercial Space Station in Washington D.C and the Canegie Endowment for International Peace. Charles Miller CEO of the Alliance For Space Development remind the audience that President Obama said “ The US government will not build another space station.” That is an implicit recognition of the interest of the private sector in the development of successor space stations but Charles Miller expressed concern that the US might suffer another “space station gap” if we terminate the present station in 2014 when our Russian partners has stated they will disconnect the Russian components. We might be stranded on Earth with no ready commercial replacement if we “drift” down the river and are not sufficiently proactive. It is a significant challenge to the existing ISS coalition because the Russian segments have their own solar array and heat radiators, the docking systems. Their segment also has the rocket booster system which reboosts the station when the ongoing resistance of the Earth’s atmosphere lowers its orbit. Without these periodic reboosts the space station will leave orbit and break-up and burn up in the Earth’s Atmosphere.

The deorbit of the ISS after the Russian departure would seem to be close to criminal negligence if indeed nothing is done proactively to pursue a more constructive course of action. To let a \$115 Billion dollar investment of several nations drop into the Pacific in 2024 seems something only a President Homer Simpson would consider.

Options in confronting the departure of the Russians from the ISS?

First, we might take action to preserve our optiona to maintain this station by installing our own booster rocket capabilities. The US did indeed plan to put its own rocket booster system on the ISS but decided to save money, put the hardware on the shelf, and trust the Russians with this critical responsibility. This booster hardware still exists and a plan to install it US booster would remedy the current lack of ISS booster capacity so we could keep the station aloft by ourselves.

Second, the US would also need to insure docking capacity on ISS for itself and remaining ISS partners.

Third is to look at the remaining useful life of the ISS components and to decide what additional options exists for an evolutionary and cost effective use of the ISS. The station has a useful life that can continue until 2024 and more than likely beyond this to 2028.

We must look at the comparative cost of upgrading and extending the useful life of ISS. A former shuttle commander addressed the ISDC conference in 2013 and indicated that the station has taken a battering from space debris and looks like “someone has taken a machine gun to the exterior. The Europeans have their Columbus Lab, the Japanese have their Kibo Lab. The US has its DiscoveryLab and it has also designated the ISS as a national laboratory facility.

Fourth we must consider a “next generation” Commercial Space Station or stations. Private investors and commercial companies are interested in this options but may not act on their own in time to prevent a gap between the end of the ISS as it currently exists and the beginning of private commercial stations. It is clearly questionable of President Obama to foreclose a combined public private initiative and leave the potential of a space station gap occurring by default. Nothing less than a permanent US presence in space should be acceptable to the US public and Congress. The next US President should reverse this short sighted position of the existing administration and each candidate running for this office should be pressed to address this issue in the upcoming campaign.

The loss of US independent manned access to the ISS has been a significant blunder in US domestic policy. Congress has caused the US to fund the Russian space program at the expense of developing its own domestic US industry at an adequate pace. US companies such as Boeing, Sierra Nevada, and Space-X could have had their manned programs in operations already if the Congress had not consistently under funded their development but instead continued to fund manned US access through the Russians.

Projected Lower Launch Costs of Reusable Rockets

Space-X corporation is expected to be successful in demonstrating its reusable Falcon 9 system next year. Each of its space station supply missions is a largely paid for opportunity to test and advance this capability. It is reasonable to expect this to be firmly in hand by 2020 and that will drop the cost of

a Falcon 9 launch to the ISS to about \$10M down from about \$60M at present. The Vulcan ULA rocket with a recoverable first stage engine system has also been announced to compete with the Falcon 9R.

The Europeans are also working on the development of a flyback first stage for the Ariane 6 rocket which is their response to the challenge of rocket reuse. This would significantly lower the cost of European supply missions to the ISS or other international space stations including perhaps both the Russian and Chinese stations.

So the prospective cost of maintaining the ISS and evolving its capabilities would never seem better. Lower launch cost should make the ISS more affordable for commercial users as well as the US government, ESA, governments without their own space infrastructure. Can the Russians and the Chinese be far behind in the race for reuse?

India is also pursuing advance propulsion technology and S Korea has launched its first satellite from its own launch facilities. Brazil is making investments with Ukraine in its new launcher and in launch facilities in Alcantara but cannot yet be considered a mature space faring power. More Competition in LEO

Fifth, we must look at the plans of other nations and consider the prospective market and requirements of other nations in relation to what the US is planning. NASA used to represent well over 50% of the global civil space by itself, more than the combined efforts of all the other space faring nations combined. That former US dominance in civil space is a thing of the past.

The US is clearly the “big dog on the block” now down to about 40% of global civil space effort. This is perhaps a natural result of more growth of the international GDP in the BRIC nations. The Russians were very reluctant to sacrifice their old Mir Station and clearly want to regain an independent national capacity. The Russian design and components of the ISS were clearly designed for this option and other modules to expand on this foundation have been in planning for a long time. The Russians have also shown every inclination to be entrepreneurial and a Russian “International Space Station may well have other international participation.

The Chinese also will have their space station in operation by 2024 and are welcoming international participation in their project. Their space program has been largely a military space program but they have not yet hit their stride. They are making a significant investment in launch facilities as well as launcher production on Hainan Island. They also plan to take a page from US experience by making a significant international tourist attraction of these facilities.

Bigelow

At the Washington Commercial Space Station presentation Mike Gold, the Director of the Washington DC Office of Bigelow Aerospace discussed the history of Bigelow’s \$500 M development of inflatable habitation modules. The BEAM module is manifested on the Space-X 8 supply mission and expected to arrive at the ISS in 2016 and be the first private module occupied by US astronauts. The tests of the Genesis modules launched by the Russian indicate they would maintain their pressurization for 100 years. The successor to the BEAM module is the BA330 so named for its internal volume of 330 cubic meters.

Three BA 330 modules would exceed the interior volume of the existing ISS but at only 1/10 the cost of traditional space station modules. Perhaps that is the strongest threat to the argument for a status quo ISS. Reduced launch cost plus reduced costs for larger inflatable modules mean new commercial capacities have a strong cost advantage.

What Might An Evolved ISS Look Like?

- 1 The ISS may have some interesting options to Evolve by taking advantage of reduced launch cost to reduce its supply chain costs for existing partners as well as new partners.
- 2 The requirement to replace Russian docking capacity open the potential of using the BA 330 system for significant new crew capacity beyond the current 6 person crew. These would create the capacity for more foreign astronauts to visit and use the facilities. These would also create more opportunities for commercial space tourism on the ISS.
- 3 Charles Miller indicated that there are four markets for commercial space stations:
 - A Microgravity
 - B Propulsion
 - C Transportation nodes as destinations in their own right or as transfer points for other destinations.
 - D On orbit Assembly of spacecraft.

Missing from this analysis are

E The potential of power beaming platforms and

F Large communications networks and platforms

The On Orbit Assembly option.

The space station has a long truss with a mobile serving platform running along tracks with a capable robotic arms. this gives the station an ability to grapple and the ability to build other things. One alternation for the ISS is its use as a construction shack for other structures.

The ISS As a Construction Shack

What if the ISS could to some extent replicate itself by building a long truss with docking, communications, both ion and chemical thrusters, large solar and radiator arrays, and its own mobile construction capabilities? Such modules might be largely robotic in operation and could be used in a variety of different locations:

- 1 Other LEO space stations power construction and communications requirements might be provided with augmented capabilities. They might supply other Russian Chinese or Commercial stations with larger power , docking, and communications capabilities.
- 2 They might be used to augment the capabilities of an Earth Moon Gateway station at L1 or L2.
- 3 They might also be moved to GEO to provide the beginning of the first GEO platform with large power supplies and redundant transponder farms and advanced tele-robotic servicing. Several large corporations are now focused on providing communications and connectivity to “The Other Three Billion”. This strong commercial interest may be an opportunity to create an in-space construction industry beginning at an evolved ISS
- 4 There will be a need for fuel depots and their fabrication might also be enhanced at the ISS.
- 5 These modules might also support free flyer manufacturing facilities such as the Dragon Lab or Cygnus Lab modules.
- 6 The development of GEO platforms is a significant evolutionary step toward the creation of space solar power satellites even if at the preliminary test bed level. The ISS can be a place where the subassemblies for the Space Station Alpha proposed by John Mankins are assembled, tested, and sent to GEO GEO space-based assembly. Demonstrating these abilities at the ISS is a critical stage of extending our industrial reach beyond Low Earth Orbit.

XISP is now proposing a series of demonstration power beaming missions at the ISS beginning with cube-sat feel demonstrations, moving to large commercial satellite free flyers, including power beaming propulsion applications, and using the ISS as a construction shack to produce the power, communications, and construction modules discussed above.

The Potential of Public Private Partnerships

These technical possibilities create opportunities for Public Private Partnerships between NASA and commercial companies and private capital investment. They also create the potential for expanded international participation and an increase in the tempo of space development. The market categories listed by Charles Miller are likely to be interactive and reinforcing of a cislunar market. A variety of countries space agencies as well as their primary space contractor agencies and broadly based international investment partnerships are likely to follow a similar path.

The scenario I have spun above is in the context of the evolution of the ISS but will not occur in isolation of the ambitions and potential of Russian, Chinese, and independent space station development. The commercialization of space stations is one dimension of a more diverse and globalized program of space development. The use of Public Private Partnership proposed for an Evolvable Lunar Architecture by NexGen LLC also described by Charles Miller and his coauthors is another that would similarly apply to the development and support of an Earth Moon Gateway station.

Twelve of the 14 national space agencies have developed a Global Exploration Roadmap for space exploration which is yet another dimension of the projected activities in cislunar space and beyond.

Summary

The evolution of the current ISS is a prospect for significant expansion of the space economy and an opportunity for the US to exert a renewed leadership in space development with both international partners and commercial partners. To expect anything less would be a failure in political and technical leadership. The next US President and Congress have an opportunity to seize the reins again with a for-

ward leaning program extending and adding to the investment foundation of the ISS. Existing US international partners can also be in a win/win position and new international partners can provide additional resources and investments to share both the cost and the benefits of expanded activities in cislunar space. Some 13 of the G-29 group nations coordinate their planning activities in the International Space Exploration Coordination groups but 8 of the large economics of G-20 group of nations are missing. There is room at the top for more participation on the ISS, in GEO, and beyond on the surface of the Moon and exploration extending to Mars and more distant destinations. The US must not abandon our expensive and hard won beach head in LEO but expand and evolve it. ##

Remembrance of Dr. APJ Abdul Kalam

By David Dunlop

It was my privilege to meet Dr. Kalam for the first time in Canada as the result of a nod invitation of one of his close friends to come to Canada and to hear him speak in a private venue political club established by Canada's first Prime Minister, where members of the Canadian Parliament from a variety of political parties were present, as well as distinguished community members from the Toronto area. I had the opportunity to present an award to him from the Moon Society in recognition of his role in supporting the launch of the Chandrayaan I lunar mission on that occasion as well as his role in developing the technology in India that made that possible.

I remember him as someone who I might describe as a "radiant presence" because of his personal warmth, optimism, self confidence, and kindness. These qualities only amplified his intellect and his positive visions of the future. I also saw him give a virtual address our 2010 ISDC Conference in Chicago on a Sunday morning. He graciously extended himself to give that address when the hour was very late in New Dehli speaking about the challenges and opportunities of space solar power in meeting India's power requirements and by extension critical global requirements as well.

Dr. Kalam again extended his hand when one of our NSS members Dr. Feng Hsu (who has attended several of the China Energy and Environment Summit Conferences and made friends with their organizers) suggested that he be invited to give a virtual address to that Conference in Beijing which I attended in person in 2011.

That cut through the barriers of political protocol and state formalities that accompany personal visits and provided Chinese scientific leadership with the opportunity to experience Dr. Kalam's vision and positive optimistic presence. That resulted in a subsequent personal invitation to Dr. Kalam and his personal visit in China the next year. That meeting resulted in the invitation by the Chinese through Dr. Kalam as the past President, to the Indian government for collaborative work on space solar power.

My final encounter with Dr. Kalam in 2013 was at our NSS ISDC Conference in San Diego, California where he was the recipient of our National Space Society Von Braun space pioneer award. He recalled having met Dr Werner Von Braun very early in his career when Von Braun visited India and he was assigned as a young engineer to accompany him in touring India's space facilities. During his acceptance speech he also presented his vision and a plan for a global think tank initiative for space solar power.

I also had the privilege of meeting privately with him and a group of NSS leaders prior that his speech. We had several hundred young Indian students attending our conference who were participating in the Space Settlement Design award and who were permitted to come into the formal dinner and stand around the perimeter of the banquet room to listen to him. Of course careful attention was paid to security arrangements for his every move during his visit with us. Dr. Kalam had "rock star" status for those students and they challenged our security arrangements by their eager attempts to get close to him, shake his hand, get an autograph or just speak with him. They made use of cell phone texts to try to determine his route to his limousine. We were just able to safely get him into his car before a tidal wave of of these student engulfed him.

It is a rare privilege to have encountered Dr. Kalam, someone of rare abilities who made technical contributions to India's space and other scientific programs but who was also an inspiration to the world as a force for optimism and positive change. We can feel appropriately sad for ourselves to have lost this great man. Our consolation is best directed in a celebration of his extraordinary achievements, the example of his positive spirit, and our renewed dedication to his vision of the use of space based energy and resources for a better and sustainable world. DD

The Problem of Rational Investment of Capital in Sustainable Futures on Earth and in Space

By David Dunlop – September 27, 2015

The conventional wisdom in economic modeling and planning is not to fantasize about large budget increases. The “careful and prudent” course is to rather assume a steady state in projecting purchasing power in government space programs. Even this assumption has been disappointed in the case of NASA which has seen it share of the national budget shrink from some 4% in the glory days of Apollo to about one half of one percent today’s approximately \$18B.

This assumption was used in both the NextGen Evolvable Lunar Architecture Study by Charles Miller and the JPL study of a sustainable Mars program done by the Aerospace Corp. Both studies concluded that going to the Moon or Mars respectively could occur with stable purchasing power in as little as five to seven years for the Evolvable Lunar Architecture study and some twenty years for the Mars option.

Not everyone accepts these constraints in looking forward. James Wertz has projected a 1000 person lunar base and an associated geometric increase in space funding. Jim Keravala has also presented a picture of many strands of lunar development reinforcing each other’s growth in a “virtuous spiral of growth”. He has attempted to start a multi-billion dollar investment program Off World Consortium fund in 2015 but this initiative is now delayed. No simple “killer app” that would support these more geometric growth projections is apparent as a near term driver.

Another context however may present an independent perspective is what not only may be possible but make be necessary. In “The Case for Space Based Solar Power” John Mankins has documented the demand for clean energy that will be needed on Earth by a growing population and a population that has expectations of higher per capital energy consumption. Currently this growth in demand is being met by an increase in fossil fuels utilization and the attendant rise in the CO2 levels in the atmosphere to about 400 ppm. Mr. Mankin’s projections are also supported by many other authoritative sources and they point out the dire consequences of continuing down the path of growing use of fossil fuels. 1

In May of 2015 the Organizations for Economic Cooperation and Development issued a report on Channeling Investment to Sustainable Alternatives to the Finance Ministers of the G-20 group countries which presented some sobering facts. Of approximately \$93 Trillion dollars of global capital investments less than 1% were directed toward sustainable non-fossil fuel energy supplies. This was not at all forced on space development or space solar power as one options among the “All of the Above” Energy Development strategy recommended by President Obama.

By comparison with the projections of what might be needed to go to the Moon or Mars with single digit \$ Billion annual budgets there are approximately 1 Trillion \$ of subsidies provided to fossil fuel companies to find more sources which cannot be used if we wish to not destroy the Earth’s current climate with CO2 increases and global warming. In the same report it was estimated that about 100 Trillion may be needed to meet global energy demands with more expensive non-fossil “alternative terrestrial energy supplies.

The potential of space based solar power to mitigate climate change and supplant fossil fuels over the next several decades is not at all on the radar of those controlling the vast majority of global capital both public and private. This is the goal of Chip Proser’s Celestial Mechanics video production for the Climate Change conference in Paris. There is increasing concern by the global public and recent public polls indicate that this is the number 1 issue of concern to the international public.

The upcoming Climate Change Conference in Paris in December of 2015 is a pivotal point for the G-20 nations and especially for China, India, and the US which use large amounts of coal. There is increasing pressure on the part of both some companies and advocacy groups such as 350.org to advocate for divestment from fossil fuel companies. Aviva, a UK based large insurance company has made very strong statements about their fiduciary responsibility to divest their portfolio from fossil fuels to avoid stranded investments in these companies if carbon taxes and other utilization restrictions energy in the coming years.

If \$ Trillion annually is diverted to alternative sustainable energy investments this shift in capital might also be a significant driver of space economic infrastructure development related to space based solar power. If even 1% of this amount, some \$10 Billion were to find its way to space infrastructure development it would increase NASA's current budget by over 50%. This is not at all to say that only NASA would be the beneficiary of such investments. National governments under intense scrutiny from their public about their climate change strategies might move to increase research and development in space based solar power. A diversion of 5% of the fossil fuel subsidies, or some \$ 50 B, to space solar power development would more than double the entire global civil space program.

Clearly, the challenges of Climate Change will require some Apollo level or Manhattan Project level of effort to assuage the global public concerns of increasing severe climate change consequences of more and stronger hurricanes and Monsoons, patterns of drought, melting of polar ice caps, and shifts in the temperature bands further north.

The global investment community is complex and diversified ranging from The World Bank/IMF and other large regional development banks, to governments, to hedge funds, to retirement funds, Commercial banks, and government retirement systems at both the local, state and Federal levels. There is no magic bullet or simple answer to the problem of under investment in alternative sustainable energy investments. Clearly the macro structure of the global economy and structure of investments must be shifted if there is to be a sustainable global civilization including a sustainable future for the human species beyond the Earth.

The valuation of fossil fuel companies such as Exxon or Shell is in part based on their "proven reserves" of drivable oil or natural gas or coal. The valuation of solar power satellites and the space solar power industry could similarly be based on accessing the solar energy flowing through geosynchronous Earth orbit.

Today's venture capital community looks at new space technologies and new companies which are positioned to experience significant growth in new markets. They have short term requirements for return on investment usually looking out no more than 5 years for a return of their capital with a substantial position in new markets. By contrast long term industrial and tax free municipal bonds have a lower rate of return but offer shelter and a supposed safe harbor for long term investors less interested in higher risk but a steady tax free return and the preservation of their capital base.

Talk of twenty year windows for the first space solar power satellite demonstration as John Mankins has done in The Case for Space Solar power is not different from the financing of major industrial and infrastructure projects which may take several decades. Today these prospects are not on the radar of groups such as the OECD, the G-20 Finance ministers, or of the UN Millennium Development goals.

1 Space Based Solar Power is one of the credible options that could mitigate Climate Change and provide a path to replace fossil fuels with clean sustainable space based solar energy.

2 There are also analysts that advocate an intensive investment program in terrestrial solar power, smart grids, and national and regional enterprises.

3 Fission power has suffered from the Fukushima accident as well as the Chernobyl accident but clean energy demand. The example of France's apparently well managed nuclear. Fission plants and a US nuclear Navy program with decades of safe operations make this technology another competing investment options for global investors.

4 International Cooperation in funding research and development for the ITER reactor in France is a strong precedent for parallel international development in space based solar power. The International Lunar Decade Campaign is but the initial phase of developing international collaboration in lower the cost of access to space in general and the Moon in particular. As Phase I Infrastructure it does not offer venture capital the rate of return that they are looking for. If fusion reactor technology is developed successfully it could very well preclude the development of space solar power satellites. In that case lunar infrastructure might be intensively focused on the harvest of Helium three gas from the high titanium basalts found on the lunar surface and so highly prized.

Summary

It does seem clear that the careful and conservation steady state purchasing power scenario we began with is a very narrow interpretation of what could be radical changes in the flow investment capital in coming years. Something's gotta given in conjunction with the fossil fuel connections with climate

change and rising public concerns about the negative consequences more and more clearly tied to this aspect of the global investment communities. energy supply system and the rising call for divestment. The 350.org new mantra is Off (divestment from fossil fuels) and On (reinvestment of \$1 Trillion in fossil fuel subsidies to alternative sustainable energy investments) Together (a coordinated international strategy of largely global terrestrial solar power investment).

What is divested must be reinvested and the space advocacy movement. Those concerned with capital investment requirements for a sustainable space investment program must explore the potential of favorable returns on investment in the short to intermediate terms if space development is to really take-off in the way that commercial aviation took after WWII.

An All of the above strategy is likely to provide a flexible investment climate for new energy supply alternatives of which some long term infrastructure development has growing niche of support from both governments and private investors. A more focused study might be undertaken by the OECD on the potential of space based resources such as both solar power satellites and helium 3 and associated transportation infrastructure and operations. These are likely to remain in the realm of government financed and operated programs but connected with financial instruments such as tax free municipal bonds or long term corporate bonds. ##

Recommendations to Overcome Non-Technical Challenges to Cleaning Up Orbital Debris

By Alfred Anzaldúa

Summary of Recommendations

- 1) Companies involved in launching spacecraft: A) use the shortest-life and least-crowded orbit compatible with the mission; B) include cost-effective spacecraft shielding against small impactors; and C) obtain insurance and FAA-approval of plans to safely deorbit or re-use dead spacecraft through private contractors.
- 2) The international space community slowly phases out 25-year post-mission free orbital parking by periodically shortening the allowed post-mission periods, grandfathering in all spacecraft launched and operated in compliance with regulations then in force.
- 3) With the exception of companies launching to specified very low orbits, launch providers/satellite owners eventually be required to present to the FAA proof of deorbit insurance, as well as liability insurance in order to obtain a launch permit.
- 4) Public and private spending be greatly expanded to develop cost-effective deorbit technology.
- 5) Insurance companies participate in any national or international agreements dealing with orbital debris mitigation or remediation.
- 6) The White House create by executive order a new national entity called the Space Traffic Management Executive Committee to carry out space debris cleanup in collaboration with analogous entities in space-faring countries worldwide.
- 7) Debris remediation funding come from the following three sources and systems:
 - A) Minimal, mission-duration "parking" fees, on companies launching new spacecraft into any Earth orbit.
 - B) A fee of perhaps 0.1% on the bills of all consumers of commercial satellite services worldwide for remediation in commercially dominated orbits, and C) General government revenues for debris remediation involving orbital bands in which dominate government owned satellites providing public services.
- 8) A bounty system be used to facilitate commercial participation in remediation efforts.
- 9) The United States actively seek to include Russia in its international, public-private efforts to clean up orbital debris. US political leaders remove the law banning cooperation with China in space in order to promote further international cooperation for both mitigation and remediation of orbital debris.
- 10) Spacefaring countries, along with public and private space-related entities within their borders, organize and participate cooperatively in an International Orbital Debris Convention, in compliance with OST Article IX, to clarify legal responsibility and ownership issues for cleanup of debris objects.
- 11) All countries involved in space activities, along with the public and private space-related entities within their borders, participate in an International Orbital Debris Convention, in compliance OST Article

IX, to resolve remaining international policy and law issues as part of the process in laying out internationally coordinated programs for orbital debris mitigation and remediation.

The above recommendations are explained and expanded upon below. In general, existing orbital debris should be cleaned up and future debris generation suppressed to the point where little to no anthropogenic debris is generated to threaten active spacecraft.

Introducing the Problem

Orbital debris is any human-made and uncontrollable litter left in Earth orbit. It includes inactive satellites, rocket stages, and fragments created by collisions, explosions, or even normal operations. There are over 21,000 Earth-orbiting debris objects larger than a softball (10 cm) and over 500,000 shrapnel fragments between 1 and 10 cm. The number of shrapnel smaller than 1 cm exceeds 100 million (NASA 2013). With relative impact velocities higher than 22,000 mph (Olliges 2015), even debris as small as 0.5 cm can take out a spacecraft (Liou 2014). The number of debris objects larger than 1 cm will reach around 1 million in year 2020 (European Commission 2013).

The destruction in 2007 of the Chinese Fengyun satellite and the 2009 catastrophic collision between a defunct Russian Cosmos satellite and an operating Iridium satellite have together contributed to nearly as many currently tracked fragments as all previous fragmentation events together (NASA 2015).

Orbital debris is an ever-growing hazard to the International Space Station (NASA Orbital Debris Quarterly News 2015) and the approximately 1,300 operating satellites, which represent only about 7 percent of the tracked objects in orbit (Baiocchi & Welser 2015). The imperiled operating satellites include those that provide communications for television, radio, GPS, pagers, cell phone applications, navigation, search and rescue, weather and climate reporting, and national defense. We may have already reached a “tipping point” whereby orbital debris in congested Low Earth Orbit (LEO) altitude bands is already colliding in a runaway debris-generation scenario, often called the Kessler syndrome (McKnight & Kessler 2012). Although it is difficult to determine what percentage of satellite failures are due to orbital debris, as opposed to other causes such as meteoroid impacts, annual economic losses in the satellite industry have been growing, and the increasing amount of orbital debris is undoubtedly a factor. In fact, claims paid out by insurance companies for spacecraft failures just in 2013 reached \$800 million (OECD Publishing 2014). Future LEO space stations, hotels, settlements, and possible large structures in GEO, such as platforms holding satellites with Internet and solar power beaming capabilities will be vulnerable to orbital debris, which will grow from future collisions, even if we put no new spacecraft into Earth orbit (Moskowitz 2011; Liou 2010). Yet, space companies are planning thousands of new satellites for the near future (Davis 2015).

There are both non-technical and technical challenges to cleaning up orbital debris. Because the greatest debris threats lie in LEO (160 – 2000 km, particularly 750 – 1000 km) and GEO (35,786 km), this paper focuses mostly on those altitudes. However, some of the technologies and policies we recommend will apply to dealing with orbital debris at other altitudes as well.

Non-technical challenges consist of 1) adverse economic factors, 2) policy and legal barriers, and 3) geopolitical sensitivities. These non-technical challenges overlap with each other and complicate the below technical challenges.

Technical challenges include 1) inadequate debris detection, tracking, and conjunction reporting and 2) lack of ready technology for removing or using orbital debris.

This article only deals with overcoming the non-technical challenges listed above. A separate paper dealing with overcoming the technical challenges will be forthcoming.

MITIGATION (ALONE) WILL NOT STOP THE THREAT FROM GROWING

In this paper, mitigation refers to any policy, activity, or technology that seeks to prevent orbital debris from coming into being or seeks to prevent debris from knocking a spacecraft out of service. Examples of debris mitigation include lowering a spacecraft at its end of life (EOL) to force the satellite to deorbit naturally within 25 years (“the 25-year guideline”), or raising the orbit of a Geosynchronous (GEO) spacecraft at its EOL to a graveyard orbit (Liou 2011), or shielding a spacecraft so that it will not be damaged by debris.

Mitigation is important to help slow the growth of orbital debris. However, the space community is planning thousands of new launches within several years (Davis 2015), and even without new launches and with 90% compliance with the 25-year deorbiting-after-use guideline, orbital debris, because of future collisions, will continue to grow in quantity and threat for at least the next 200 years (Liou 2014; Liou 2011).

Remediation refers to active debris removal (ADR) or the active rehabilitation (ADRe) of defunct spacecraft to produce operational ones. ADR means to remove objects from orbit using measures be-

yond mitigation (Liou 2015). ADRe means taking actions to rehabilitate spacecraft by either refueling or repair. Repair could be accomplished by attaching functioning parts to spacecraft or their parts in a process called “cellularization” (Barnhart 2014). Remediation also includes the possibility of recycling a defunct spacecraft or its parts for use as feedstock metal for on-orbit fabrication (Anzaldúa 2014).

The altitudes with the largest number of objects pose the greatest current risk or threat to satellites. However, the altitudes with the highest overall mass represent the greatest future threat, because the more mass is involved in collisions, the more destructive will be the debris (McKnight & Kessler 2012). Based on these criteria, and accounting only for trackable objects 10 cm/1kg or larger, orbits around 780 km are the most hazardous (current threat greatest), and orbits around 780 km, 840 km, and 920 – 1000 km pose the greatest future threat or risk in LEO (McKnight & Kessler 2012). The good news is that NASA estimates that the LEO environment can be stabilized during the next 200 years with an ADR rate of five carefully selected (based on mass and collision probability) objects per year.

Unfortunately, in terms of future debris creation, only around 40% of the about 6000 tons of material in Earth orbit is in LEO. The rest is in higher orbits (Liou 2010), half in and near GEO, and most of the rest between LEO and GEO. Worse yet, the most dangerous debris, at least in LEO, consists of shrapnel currently too small to detect and track, i.e. objects smaller than 10 cm/1 kg. Shrapnel between 1 – 10 cm number around 600,000 objects (European Commission 2013), and objects as small as 0.5 cm can take out a spacecraft (Liou 2014). Below 1 cm, orbital debris objects number into the tens of millions (McKnight & Kessler).

Z The space community must therefore face the hard reality that it must as soon as possible carry out, not only orbital debris mitigation, but orbital debris remediation of objects over 0.5 cm in size. Effect debris remediation in turn urgently calls for a great improvement in international orbital debris detection, tracking, and conjunction reporting, and general surveillance known as space situational awareness (SSA).

MITIGATION OF SPACE DEBRIS IN THE FUTURE

We* recommend that companies involved in launching spacecraft:

- 1) **Use the shortest-life and least-crowded orbit compatible with the mission;**
- 2) **Include cost-effective spacecraft shielding against small impactors; and**
- 3) **Obtain insurance and FAA-approval of plans to safely deorbit or re-use dead spacecraft through private contractors.**

[* The author in consultation with concerned orbital debris observers.]

The Federal Aviation Administration (FAA), as the entity currently responsible for issuing launch permits, is the logical agency to judge the adequacy of deorbit-plans and insurance policies. These tasks are similar to those currently involved in insuring that a launch has proper liability insurance and meets range safety requirements. The FAA would be able to coordinate internationally with analogous institutions in other countries, through a national Space Traffic Management entity we propose below under the title, “Remediation of Extant & Future Orbital Debris.”

A policy exists, which complicates implementation of the above mitigation system. Under USG Orbital Debris Mitigation Standard Practices (U. S. Government 2015), satellite companies are not required to deorbit or otherwise move to graveyard orbits their satellites until 25 years have passed after the end of the satellite’s mission. This policy, being adopted internationally, amounts to 25 years “free parking” post-mission. While an improvement over the previous no-limit-while-dead-on-orbit situation, free orbital parking for any object that does not actively avoid all dangerous conjunctions still endangers operating satellites and other operating spacecraft.

Therefore, we recommend that the international space community slowly phase out 25-year post-mission free orbital parking by periodically shortening the allowed post-mission periods, grandfathering in all spacecraft launched and operated in compliance with regulations then in force.

What happens if the space company with an FAA-verified plan nevertheless fails to carry out the plan as promised? **We recommend that, with the exception of companies launching to specified very low orbits, launch providers/satellite owners eventually be required to present to the FAA proof of deorbit insurance, as well as liability insurance in order to obtain a launch permit.****

**The only exception to this requirement would be for a spacecraft whose area, mass, attitude, and orbit result in an expected orbit life of less than two years.

At this time, deorbit services upon failure of automated deorbiting mechanisms are not commercially available, so pricing such insurance would currently be difficult. Therefore, **we also recommend that public and private spending be greatly expanded to develop cost-effective deorbit technology.**

Such insurance would be fundamentally similar to purchasing insurance against launch vehicle failure. However, rather than simply paying out damages, the insurance companies would undertake actively to dispose of or rehabilitate the orbital debris through commercial contractors, as described below. While the purchase of de-orbit insurance is in part of a mitigation strategy, details of debris cleanup will be covered under the heading of “Remediation of Extant & Future Space Debris” below.

In general, orbital debris cleanup would be facilitated if insurance companies offered lower premiums to companies utilizing reusable boosters, automatic deorbiting mechanisms, locator beacons, or other technologies facilitating either orbital debris mitigation or remediation. For these reasons, **we recommend that insurance companies participate in any national or international agreements dealing with orbital debris mitigation or remediation.**

REMEDICATION OF EXTANT & FUTURE ORBITAL DEBRIS

The worldwide space community needs national and international entities to coordinate the cleanup of extant and future space debris and to generate policies and guidelines for that cleanup. From the standpoint of international law, extant and future operating spacecraft and debris are the responsibility of each space-faring government (Treaty on Principles... 1967). Therefore, to honor this responsibility in matters of remediating existing or future debris, **we recommend that the White House by executive order create a new Executive entity to carry out space debris cleanup in collaboration with analogous entities in spacefaring countries worldwide.**

A Space Traffic Management Executive Committee (STM ExCom) could be established in full compliance with international law. Under Article VI of the Outer Space Treaty (OST), the U.S. Government has agreed to authorize and continuously supervise the space activities of both its governmental agencies and its non-governmental entities (Treaty on Principles..., Art. IV 1967). Ideally, the ODM ExCom and its connected offices would:

- 1) Be established quickly through Executive action;
- 2) Function within the Executive Branch of the U.S. Government (USG);
- 3) Have input from both appropriate USG agencies and private experts connected to Space;
- 4) Be flexible and nimble, i.e. able to react quickly to changing circumstances;
- 5) Have permanent staff provided by connected agencies, yet have the ability to form ad hoc committees to plan and solve particular problems; and
- 6) Be able to interact cooperatively and transparently with national and international entities and persons, both public and private.

As it turns out, a national entity already exists that fulfills the above conditions and could serve as a model for a separate orbital debris management entity. The National Executive Committee for Space-Based Positioning, Navigation, and Timing (PNT ExCom), was created by Executive action in 2004, serves under the White House, and deals nationally and internationally with planning and problems arising from the GPS and Space-Based PNT (“U.S. Space-Base...” 2004).

.We therefore specifically recommend that the White House, through executive order, establish the Executive Committee for Space Traffic Management (STM ExCom) structured and staffed similarly, but with important variations, to the PNT ExCom.

The **organizational chart below** is only notional, and we expect it to be later refined. Although the STM ExCom would be the overall supervisory body, the **STM Coordination Office** would organize the actors, coordinate the action, carry out day-to-day work, and house permanent staff provided by the relevant Federal agencies.

Note that we are also proposing an **International Working Group** connected to the STM Coordination Office. The International Working Group, chaired by State, would be the body coordinating with the International Telecommunication Union (ITU), UN Office for Outer Space Affairs (UNOOSA), spacefaring countries, and international space entities, such as the Space Data Association.

We recommend that the space entities responsible for any spacecraft already in orbit be grandfathered under the policies in existence at the time of their launch, so that they are not penalized by any new anti-debris policy, which the STM ExCom develops in coordination with international entities.



ECONOMIC ASPECTS AFFECTING REMEDIATION

Adverse Economic Incentives in LEO

Although the space community is poised for massive growth in commercial LEO operations, almost all current users in LEO are public entities providing social benefits (Weeden 2013 & 2012). Publicly provided societal benefits, such as national security, science, climate and weather monitoring, disaster response, natural resource management, and space exploration, are not particularly responsive to prices and markets. Total private benefits from LEO amount to \$3 billion (Weeden 2013 & 2012). Complicating the picture, governments, especially their military agencies, are not particularly open to mutually agreed-upon regulation of the LEO commons. So how do we economically incentivize cleanup in LEO?

Until the commercial satellite industry begins using LEO, and while no market exists for recycled or repurposed objects taken from orbiting scrapyards, there is no current market-based way to incentivize cleanup in LEO without first producing a fund to pay for it.

Consumers of Public & Private Satellite Services Must Pay Now or Pay More Later

Commercial satellite companies, providing communication services for television, telephone, radio, and Internet tend to operate in GEO. This will soon change, however, as commercial entities are making plans for services to be supplied from LEO as well (Davis 2015). Therefore, an economic incentive already exists to clean up debris in GEO, and there will soon be one in LEO. However, the technical challenges to carry out remediation at any orbital band are daunting because of varying trajectories; tumbling debris; lack of adequate tracking of both small and large debris; and fueling systems and electronics employed without thought to later repair, replacement, or resupply.

Developing and utilizing technology and international systems for orbital debris cleanup is bound to be expensive. If the past is any indication, public and private space entities will eventually pass these costs, through either through taxes or higher service fees, to the consumers of satellite services. However, the consumers of commercial and government-provided satellite services should understand that they are already in a “pay now or pay **more** later” situation. If they wait until there are more catastrophic orbital collisions, these consumers will suffer disruption of satellite services, and their bills for cleanup will be much higher than if cleanup proceeds proactively (McKnight 2012). For this reason, our proposed funding mechanism below entails bringing in the end-consumers of satellite services before cleanup costs rise further.

FUNDING & FUND USE FOR DEBRIS CLEANUP

We recommend that debris remediation funding come from the following three sources and systems:

- 1) **Minimal, mission-duration “parking” fees, on companies launching new spacecraft into any Earth orbit.** Large heritage companies would pay minimal parking fees from the first day of their institution. Small startup companies in their first 10 years of operation would pay only one-half the otherwise assessed parking fee for their spacecraft. The STM Coordination Office described above, working closely with the FAA and Department of Commerce, and in consultation with international entities such as the Satellite Industry Association (SIA) and Space Data Association, would assess very low parking fees based roughly on a calculation of the increased debris-creation threat that each new launch represents. That calculation in turn would be based on an estimate of the mass density of the orbit into which the new spacecraft is being launched, with higher fees being assessed on companies launching to the most densely crowded orbits. Space

companies will therefore likely try to avoid launching into the most crowded orbits, and this will help to hold down the threat. In all cases, the STM Coordination Office would not assess parking fees that would represent a barrier to small startup space companies or put a damper on space innovation and enterprise.

- 2) **A fee of perhaps 0.1% on the bills of all consumers of commercial satellite services worldwide for remediation in commercially dominated orbits.*** We suggest that the charge appearing on the end-consumer's bill be specifically identified as an "Orbital Debris Mitigation and Remediation Fee." A fee, so imposed, will have two very beneficial effects: 1) it would raise over \$80 million/year (The Tauri Group... 2015) and 2) it will instantly make consumers aware that there is a need for orbital debris remediation in the orbital band from which they are receiving satellite service. Consumers will also realize that they are playing an important part in maintaining satellite services to them.

[*Because most commercial satellites are currently in GEO, this will affect consumer bills tied to that orbit. However, space companies are planning to launch thousands commercial satellites into LEO soon (Davis 2015). Therefore, LEO orbits will eventually generate commercial fees as well.]

- 3) **General government revenues for debris remediation involving orbital bands in which dominate government owned satellites providing public services.**

What would be the most effective use of funds so gathered? **We recommend that a bounty system be used to facilitate commercial participation in remediation efforts.** We further recommend that the STM Coordination Office award the bounty money to private companies only based on competitive service-bids leading to successful debris remediation. Insurance companies, paying for deorbiting in lieu of satellite company action, would also necessarily pay for remediation through the STM Coordination Office. In this way, no entity need pay for expensive development projects, or for failures, but only for results. With sufficiently high bounties, private entities would compete creatively using various technologies to remediate both large and small debris. Private companies attempting remediation would necessarily have to collaborate, perhaps via sub-contracts, with Space Situational Awareness (SSA) entities in order to carry out successful remediation. Thusly, SSA entities, in particular the commercial ones, will be able to evolve their technologies based on actual remediation efforts instead of theoretical ones.

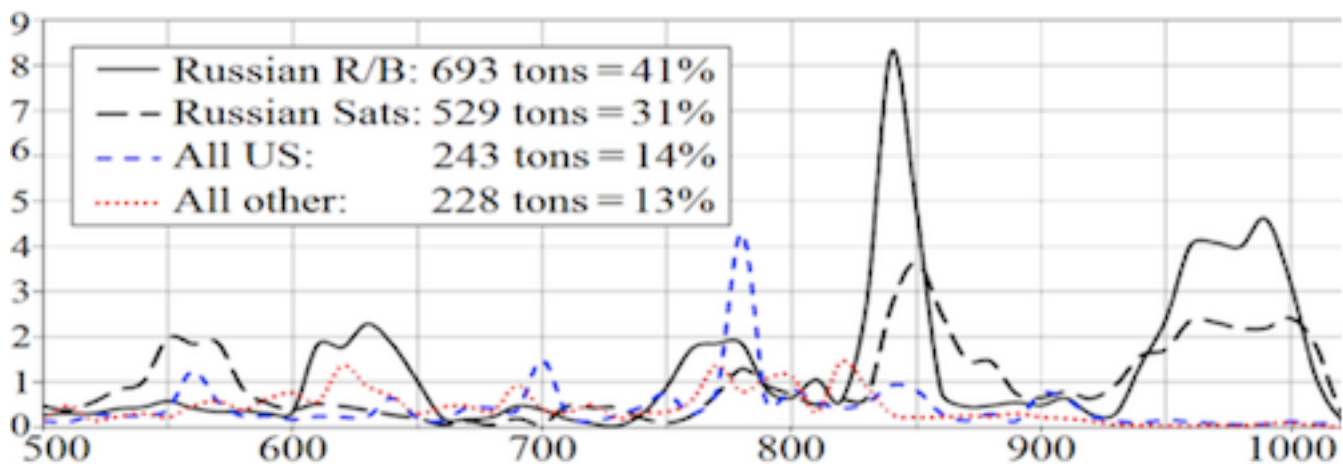
Our proposed STM Coordination Office would allow the bounty fund to grow incrementally until it is large enough to entice service-bids from private entities looking to take on debris remediation missions. The STM Coordination Office, working closely with the FAA, the Aerospace Engineering Forum, its International Working Group, and other connected entities would thereupon examine the bid-service offering and either reject it or negotiate a pay-for-services agreement based on a specified, successful debris cleanup mission in exchange for a particular bounty payout. Cost-plus contracts would not exist in such a contract and payout system, and the contracts would resemble the NASA contracts for commercial delivery of materials and crew to the ISS.

GEOPOLITICAL CONSIDERATIONS

The ISS, while it serves as a testbed for emerging orbital debris cleanup technologies and techniques, offers us an ongoing way to engage the international community and overcome geopolitical rivalries. Russia, however, will no longer be participating in ISS activities after 2024. Moreover, Russia and the United States were the major producer of debris composed of empty upper stages, which are sure to be the major source of future debris in LEO (Pearson 2012; Carroll...speaking 2014).

Launching countries are naturally sensitive about the nature of their satellites. Therefore, to induce international cooperation to remove, repurpose, recycle, or rehabilitate large debris objects, it is best to start with these much less sensitive, but still dangerous, upper stages (i.e. usually mostly aluminum-alloy tanks), which make up about half of the LEO debris mass. Capturing aluminum tanks would also be a lot less complicated than grabbing or manipulating satellites with solar arrays, antennas, and nuclear reactors. In addition, in-orbit recycling may be more practical with such tanks than with most other materials or objects.

The US can take action to remove 97 of the 100 oldest objects in LEO, which are US-owned, and demonstrate the technology needed to clean up its own mess. About 900 of the 1100 tons of rocket bodies in LEO is Russian. Removing only Russian rocket bodies from LEO could reduce shrapnel creation by nearly 62% (Pearson 2012). *This exceeds the 48% reduction that would occur if all non-Russian mass were removed from LEO.*



LEO Mass Ownership, Tons/Km Altitude (Carrol 2015)

There exists another approximate 800 tons of rocket bodies in Geosynchronous Transfer Orbit (GTO) and similar low-perigee eccentric orbits. However, they pose less collision risk in LEO since they spend little time in LEO. Rocket bodies not deorbited in either orbital band could be put into salvage orbits for later use as feedstock for large structures such as space stations; rotating habitats; platforms holding solar power satellites and Internet satellites; and transportation hubs “for repair, refueling, upgrading, and in-situ construction” (Wall 2015).

As the US Government, in coordination with US companies, takes steps to clean up its own debris, Russia could be encouraged to clean up its share, either unilaterally – or even better – through bilateral collaboration. A good start would be for talks between Russia and the US on the range of space operations and safety considerations, i.e., space situational awareness, respective catalogs of space objects, national research and regulations for debris mitigation, conjunction analysis, etc.

Although United States – Russia relations have fallen to the lowest level since the cold war,” there is a shared interest in and responsibility for ensuring that the space environment is safe and sustainable. Throughout such talks, the goal should be to demonstrate to Russia that it is in its own best interest to address the threat of orbital debris, regardless of what the U.S. and other countries do. What can we therefore say to the Russians along these lines?

First, those Russian debris pieces, large and small, carry with them strict liability for reentry damage and liability “if at fault” (undefined!) for damage cause in orbit under the 1972 Liability Convention. **Second**, cleaning up the debris represents enormous potential value in terms of already emplaced debris objects for repurposing and recycling. **Third**, if Russia collaborated with the US to remediate orbital debris, it would have a chance to advance its own space technology and industries, while keeping an eye on the advancement of space technology (including possibly laser technology) of other countries. **Fourth**, cooperation with the U.S. would offer a way to lower geopolitical tensions.

There is nothing for the U.S. and other countries to lose and much to gain by reaching out to Russia to clean up orbital debris. The same goes for reaching out to China, which has recently been signing agreements with Russia for cooperation in space, including in setting up a lunar station (Song 2015). Although a 2011 decree by the U.S. Congress that banned NASA from engaging in bilateral agreements and coordination with China regarding space, there is a growing debate over whether China and the United States should cooperate in space (David 2015).

No country alone can affordably clean up debris sufficiently to remove the threat of catastrophic collisions, and both Russia and China are potentially key players in cleaning up orbital debris.

We therefore recommend that the United States actively seek to include Russia in its international, public-private efforts to clean up orbital debris. We further recommend that US political leaders remove the law banning cooperation with China in space in order to promote further international cooperation for both mitigation and remediation of orbital debris.

OVERALL INTERNATIONAL COORDINATION

Besides the Article VI requirement for “continuing supervision,” Article VIII of the OST, calls on the Launching State to retain “jurisdiction and control” over any object it launches, whether that object, or even pieces of that object, cease to function or not. Removing a debris object or even its fragments

therefore requires the consent of the State Party on whose registry it was launched (Listner 2012). However, determining the State Party for various reasons can be a daunting task.*

*Most LEO mass is Russian, and most of that is launched into distinctively different inclination clusters whose mass is ~99% Russian. Most tracked fragments change inclination by <1 degree from their source object, and most are traceable to not just a source owner, but a source object. However, sun-synch orbit (roughly 97–99 deg.) is the second most popular inclination (after 81–83 deg.), and many countries use sun-synch. Therefore, if you do not detect and start tracking an object soon after it is launched, you may not be able to identify its owner or Launching State after you do find it (Carroll 2014 NewSpace Conference).

Complicating this picture is the fact that Article VI and IX of the OST pertain to the “Launching States,” who are not necessarily the owners of launched spacecraft. After all, the “Launching State(s)” for a rocket and its payload include the country owning the satellite at the time of launch, the country owning the rocket at that time, and the country from which the rocket was launched. Moreover, selling and re-registering an object does not transfer launching state liabilities to the new owner or registrant. Yet, no matter the owner, Articles VI and IX, place full responsibility for supervision, jurisdiction, and control of space objects (apparently including fragments) on the Launching State(s).

Moreover, there is no space equivalent for the ancient maritime Law of Salvage, which gives a private party the right to salvage an abandoned vessel after peril or loss at sea, no matter the owner or country of vessel registration. Nor is there a space equivalent of the 1972 London Dumping Convention, which prohibits the disposal at sea of vessels, aircraft, platforms, and other debris. Yet a motivated space community could indeed integrate space-appropriate characteristics of these maritime legal systems into an international legal system to deal with orbital debris, while simultaneously resolving the legal uncertainties introduced by Articles VI and VIII of the Outer Space Treaty (OST) by means of a comprehensive **International Orbital Debris Convention**. Is there justification for such an international agreement in the OST?

Article IX of the OST, inter alia, calls on the State Parties to avoid “harmful interference with the activities of other State Parties in the...use of outer space” and to “undertake appropriate international consultations before proceeding with any such activity or experiment.” (Emphasis ours.) Clearly, orbital debris is interfering now with the space activities of State Parties to the OST. **We therefore recommend that spacefaring countries, along with public and private space-related entities within their borders, organize and participate cooperatively in an International Orbital Debris Convention, in compliance with OST Article IX, to clarify legal responsibility and ownership issues for cleanup of debris objects.** Considering the current orbital debris threat, plus plans to put into LEO more than 4000 new satellites soon (Davis 2015, Goldman 2015), a move like this is long overdue.

Under the long tradition of Maritime Salvage Law dating back to the time of the ancient Greeks and Romans, a person who voluntarily preserves at sea any vessel, cargo, freight, or other recognized salvage from danger has traditionally been able to collect a reward proportionate to the value of the object salvaged. Maritime nations have most recently codified such custom and law in the International Convention on Salvage 1989. The Convention even considers protection of the environment as part of salvage, awarding a salvor who prevents oil pollution, for example, special compensation termed liability salvage instead of property salvage (“Law of Salvage” 2015).

An **International Orbital Debris Convention** also could promulgate similar rules for removal, reuse, recycling, or rehabilitation of orbiting objects by salvors, collecting bounties through the system described above. Such salvage rules could even address removing orbiting shrapnel clusters from the Earth-orbit environment by compensating salvors with liability salvage. Key to making such rules work, however, would be the **Convention** formulating legal mechanisms for claims of ownership and voluntary and involuntary loss of ownership of the objects to be salvaged. There would also have to be special salvage exemptions or other provisions for sensitive military satellites.

In sum, we recommend that **all countries involved in space activities, along with the public and private space-related entities within their borders, participate in an International Orbital Debris Convention, in compliance OST Article IX, to resolve remaining international policy and law issues as part of the process in laying out internationally coordinated programs for orbital debris mitigation and remediation. ##**

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 2015

- 12 ISDC 2015: Innovation in more than Technology – Clifford McMurray
- 16 Barrle of the Collossi – SLS vs, Falcon Heavy – Dale Scran
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- 29 HAYABUSA 2: A significant milestone on the road to Space Settlements –Dale Scran
- 30 Steam into Space: Silicon Valley Steam Colloquium Challenges Educators
– Tiffany Crawford and Tenesa Ellis
- 36 Return to the Moon International Lunar Decade Workshop – Dave Dunlop
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- 38 A Global Share-a-Thon: ISDC 2015 Highlights Three Student Contests – Lynne E. Zielinski
- 40 2015 International Sunsat Design Competition – Don Flournoy and Kyle Perkins
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- 44 NSS Joins forces with Space Frontier Foundation to form the Alliance for Space Development
– Dale Scran



www.MMM-MoonMinersManifesto.com

AUGUST 2015 – MMM # 287

- 2 In Focus: **NASA missions should all carry Cubesat secondary probes** – Peter Kokh
- 3 **Powering a Moon base through the lunar night** – Sacramento L5 Society NSS chapter Paper
- 7 **The Truth about the amazing Pluto-Charon "Binary Planet" system** – Peter Kokh

SEPTEMBER 2015 – MMM # 288

- 2 In Focus: **Beachheads on Moon & Mars for a fraction of the cost and time**
- 3. **NASA's new plans for higher speed, shorter trip, more frequent transportation between Earth and Mars**
- 4. **Economic Assessment and Systems Analysis of an Evolvable Lunar Architecture that Leverages Commercial Space Capabilities and Public-Private-Partnerships.**
- 5. **MMM Suggestions: of strategically thrifty ways to open the Moon**
- 6. **MMM's List of High Priority Planetary Science Missions**
- 7. **Alan Bean: astronaut/artist**
- 8. **Former President of India and Solar Power Satellite Advocate, Dr. Kalam Dies]**

OCTOBER 2015 – MMM # 289

- In Focus: **New Companies, Forces, Plans that could Accelerate the Future** – Peter Kokh
- 3. **The Moon: a Better Way to a Closer View** – Dave Duca
- 4. **Kepler Shipyards: an Innovative new force that could reshape the future**
- 6. **Kepler Shipyards: a sudden setback, but determined to continue**
While on things "Kepler" – Kepler Space Telescope Findings to date – Peter Kokh
- 7. **Early Conclusions from Kepler Telescope Findings** – Peter Kokh



International Space Advocacy Organizations Encouraging Student Participation

National Space Society (US) – <http://www.nss.org> – NSS

NSS currently has chapters in Australia, Canada, Germany, France, Netherlands, Brazil, and India
<http://www.nss.org> – <http://chapters.nss.org/a/lists/>

NSS' International Space Development Conference – ISDC

The “ISDC” is usually held the weekend of the last Monday in May (Memorial Day weekend) in various locations, hosts students from around the world, many of them presenting their entries to NASA’s annual Space Settlement Design Contest. Usually, The Moon Society and SEDS participate in this conference.
<http://isdcs.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 the Sociedad Espacial Mexicano, Mexico, with individual members in many countries.

The Moon Society’s **Moon Miners’ Manifesto India Quarterly** – the “older sister” to To The Stars International Quarterly, has been going to students and others in India and Elsewhere since August 2008. Older issues are available as free pdf downloads at:

<http://www.moonsociety.org/india/mmm-india/>

With the previous issue, TTSIQ#6, that publication replaces M3IQ.

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 Stars 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, Philip-pines**, and more; SEDS–Earth is a central node for communication between these worldwide chapters.

YURI’S NIGHT – <https://yurisnight.net> – http://en.wikipedia.org/wiki/Yuri's_Night

An Annual Celebration around the world, on April 12th, celebrating the first manned flight in space by Yuri Gagarin, of the Soviet Union, who piloted the first manned space capsule, **Vostok 1**, and made a complete orbit and landed safely in 1961.

STEM – The STEM Academy – <http://www.stem101.org/about.asp>

[STEM: an acronym for **Science, Technology, Engineering, and Math**]

The STEM Academy, Inc. is a national non-profit status organization dedicated to advancing economic development by improving STEM literacy for all students. State and national standards based K–16 STEM curriculum to create student pathways for industry and post-secondary advancement.

Available Space Topic STEM Videos

- <http://www.nasa.gov/audience/foreducators/expeditions/stem/>
- <http://www.nasa.gov/audience/foreducators/expeditions/stem/stem-science-index.html>
- <http://www.nasa.gov/audience/foreducators/expeditions/stem/stem-tech-index.html>
- <http://www.nasa.gov/audience/foreducators/expeditions/stem/stem-eng-index.html>
- <http://www.nasa.gov/audience/foreducators/expeditions/stem/stem-math-index.html>

US Teens Win International Rocketry Challenge

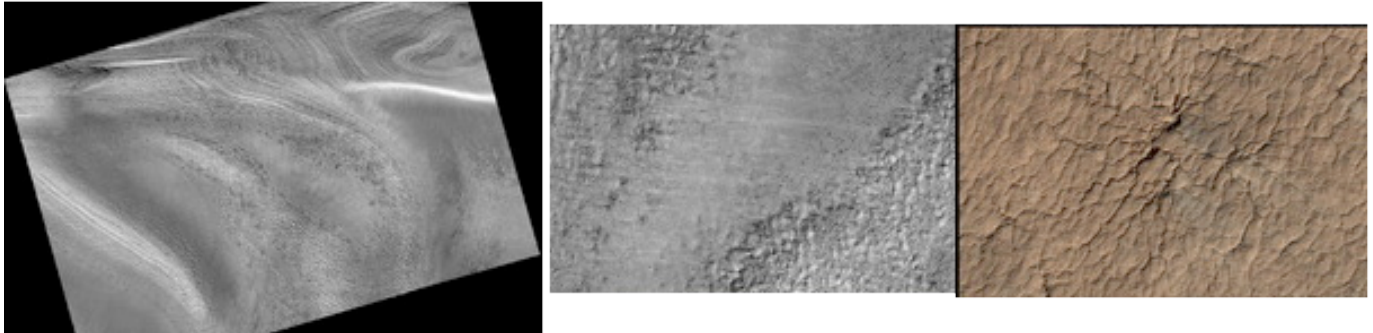
www.space.com/29803-us-teenagers-win-rocketry-challenge.html

29 June, 2015 – It was a question of precision: The rocketeers had to get their payload as close as possible to 244 m (800 ft) in the air within 46 to 48 seconds, taking weather, wind speed, subtle changes in weight and precise angles into account. If the payload was damaged, it would be instant disqualification — and that payload was a single egg.

NASA Wants Your Help to Classify Weird Mars Terrain

30 July, 2015 – www.space.com/30094-nasa-mars-features-citizen-science.html

Science enthusiasts around the world have a unique opportunity to help NASA learn more about Mars.



Members of NASA's Mars Reconnaissance Orbiter (MRO) science team are asking the public to help them categorize **strange features near the Red Planet's south pole** for further study and analysis.

Those who join the effort will review photos of the region captured by MRO's Context Camera (CTX), identifying areas that deserve more detailed scrutiny by the orbiter's High Resolution Imaging Science Experiment (HiRISE) camera. HiRISE has a resolution of about 50 cm (20 in) per pixel, compared to 6 m (20 ft) per pixel for CTX,

16-Year-Old's DNA Experiment Will Fly in Space

31 July, 2015 – www.space.com/30123-genes-in-space-student-dna-experiment.html

The experiment, designed by Anna-Sophia Boguraev of Bedford, New York just north of NYC, aims to see how microgravity and radiation affect the immune systems of astronauts in space.

Your Vote Wanted to Help Name 32 Alien Worlds

12 August, 2015 – www.space.com/30232-exoplanet-naming-contest-iau.html

A global contest to name 32 alien planets is underway. The public can now vote on a list of proposed common names for the 32 exoplanets, as well as most of their host stars, in the International Astronomical Union's "NameExoWorlds" competition.

Voting is open through Oct. 31, and the winning names will be announced in mid-November,

NASA Grants to Expand STEM Education at Minority Serving Institutions

www.nasa.gov/press-release/nasa-awards-grants-to-expand-stem-education-at-minority-serving-institutions

18 August, 2015 – Awards totaling \$6 million to provide educator training and expand course offerings in science, technology, engineering and math (STEM). Four universities were selected to receive MUREP Community College Curriculum Improvement (MC3I) grants, which provide up to \$250,000 per year for a maximum of three years. The schools will work to increase the number of STEM classes available at minority serving community colleges.

The universities selected for MC3I grants are:

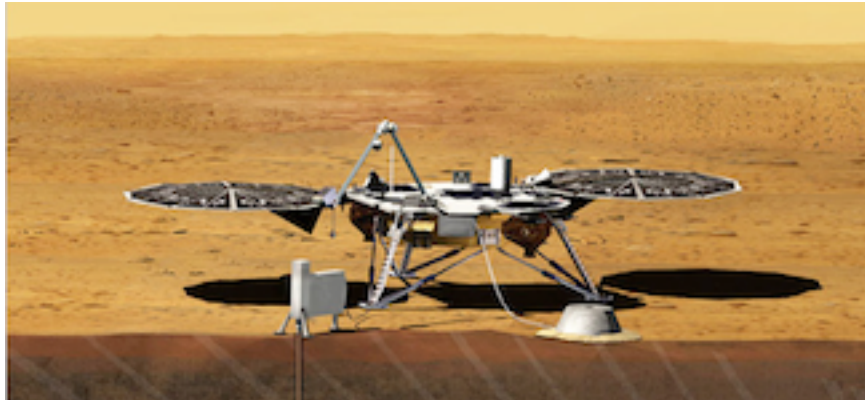
- Baltimore City Community College, Baltimore
- Napa Valley College, Napa, California

- Queensborough Community College, Bayside, New York
- Santa Monica College, Santa Monica, California

Texas State University in San Marcos was selected to serve as a MUREP Educator Institute and may receive up to \$1 million per year for three years. As an educator institute, the university will create learning opportunities at NASA's ten field centers for future teachers. ##

Send Your Name to Mars on NASA's Next Red Planet Mission

www.nasa.gov/press-release/send-your-name-to-mars-on-nasas-next-red-planet-mission



18 August, 2015b – Add your name to a silicon microchip headed to the Red Planet aboard NASA's InSight Mars lander, to launch next year. www.nasa.gov/mission_pages/insight/main/index.html

Astronaut Chris Hadfield New “Space Sessions” Album Recorded in Orbit

13 August, 2015 – www.space.com/30241-astronaut-chris-hadfield-space-sessions-album.html



Canadian Astronaut Chris Hadfield playing “Space Oddity” while aboard ISS
<https://www.youtube.com/watch?v=apemYk2oz7M>

If you've ever watched Hadfield's “Space Oddity” (editor has countless times) you will want this album.

NASA Awards Grants to Expand STEM Education

1 September, 2015 – www.nasa.gov/press-release/nasa-awards-grants-to-expand-stem-education

NASA's Minority University Research and Education Project (MUREP) has selected nine universities for cooperative agreement awards totaling \$3.6 million to create and operate a NASA MUREP Aerospace Academy.

The universities will receive as much as \$160,000 per year for two years and up to \$100,000 for a third year. The Aerospace Academies will engage historically underserved and underrepresented students in grades K–12 through hands-on activities that reflect each of NASA's four mission directorates: Science, Aeronautics, Space Technology and Human Exploration and Operations. The academies

Past **TTSIQ** issues are online at: www.moonsociety.org/international/ttsiq/ and at: www.nss.org/tothestarsOO

will also provide access to NASA technology through an Aerospace Education Laboratory, and encourage families and communities to get involved through the Family Café, an interactive forum with activities, workshops and guest speakers.

The universities selected for Aerospace Academy grants are:

- California State University, Fresno
- Cuyahoga Community College, Cleveland
- Elizabeth City State University, North Carolina
- Hartnell College, Salinas, California
- Morgan State University, Baltimore
- Tennessee State University, Nashville
- Texas State University, San Marcos
- The University of Texas at El Paso
- York College, City University of New York

Launching 'The Mars Generation': Teen on Mission to Get People to Mars

15 September 2015 - www.space.com/30544-astronaut-abby-launches-mars-generation.html



The Mars Generation, launched Sept. 15, 2015, aims to prepare the next generation of space buffs by getting youth excited about space and science education.

Abigail Harrison, as a college freshman, is launching "Astronaut Abby" on a large mission — getting people of all ages excited and educated about what it means to be a member of the generation that will land humans on Mars. 33 ##

NASA, U.S. Senate Welcome Robot Challenge Winners to Washington

www.nasa.gov/press-release/nasa-us-senate-welcome-robot-challenge-winners-to-washington



14 September, 2015 - West Virginia University robotics team, **The Mountaineers**, was the only team to complete level two of NASA's 2015 Sample Return Robot Challenge. During this phase of the competition, teams were required to demonstrate autonomous robots that can locate and collect samples from a wide and varied terrain, operating without human control. ##

NASA Seeks Big Ideas from Students for Inflatable Heat Shield Technology

www.spacedaily.com/reports/NASA_Seeks_Big_Ideas_from_Students_for_Inflatable_Heat_Shield_Technology_999.html – 22 September, 2015



Artist rendering of a hypersonic inflatable aerodynamic decelerator

NASA is giving university and college students an opportunity to be part of the agency's journey to Mars with the Breakthrough, Innovative, and Game-changing (BIG) Idea Challenge.

NASA is currently developing and flight testing HIADs – a new class of relatively lightweight deployable aeroshells that could safely deliver more than 22 tons to the surface of Mars. A crewed spacecraft landing on Mars would weigh between 15 and 30 tons. NASA's Mars Curiosity rover is the heaviest payload ever landed on the Red Planet – weighing in at only one ton. To slow a vehicle carrying a significantly heavier payload through Mars' thin atmosphere and safely land it on the surface is a significant challenge.

NASA is addressing this challenge through the development of large aeroshells that can provide enough aerodynamic drag to decelerate and deliver larger payloads. HIAD technology is a leading idea because these kinds of aeroshells can also generate lift, which would allow the agency to potentially do different kinds of missions.

Interested teams of three to five undergraduate and/or graduate students are asked to submit white papers describing their concepts by Nov. 15. Concepts may employ new approaches such as shape morphing and pneumatic actuation to dynamically alter the HIAD inflatable structure.

Selected teams will continue in the competition by submitting in the spring of 2016 full technical papers on the concept. Up to four teams will present their concepts to a panel of NASA judges at the BIG Idea Forum at Langley in April 2016. ##

NASA Selects Science Education Partners for STEM Agreements

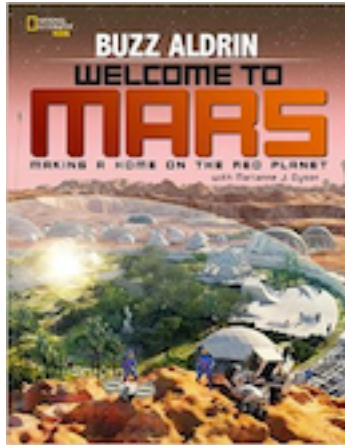
www.nasa.gov/press-release/nasa-selects-science-education-partners-for-stem-agreements

25 September, 2015 – NASA has selected 27 organizations from across the United States to **begin negotiations for cooperative agreement awards** totaling \$42 million to implement a **new strategic approach to more effectively engage learners of all ages** on NASA science education programs and activities.

- Agreement awards can run up to five years, with an additional five-year option.
- Selectee activities will support Earth science, astrophysics, planetary science and heliophysics.
- Negotiations for specific monetary awards now will begin and final awards are expected to be made by the end of this year. ##

Buzz Aldrin's 'Welcome to Mars' Charts Path to Red Planet for Kids

22 September, 2015 - www.space.com/30602-buzz-aldrin-welcome-to-mars-kids-book.html
www.amazon.com/Welcome-Mars-Making-Home-Planet/dp/1426322062



In "Welcome to Mars: Making a Home on the Red Planet" (National Geographic Children's Books, 2015), astronaut Buzz Aldrin invites kids to set a course for Mars as he delves into its history and environment as well as plans for a manned mission.

10 Surprising Facts About Lunar Eclipses

www.space.com/30669-10-surprising-lunar-eclipse-facts.html

ONLINE OP-ED ARTICLES FROM OTHER WRITERS WORTH READING

[Editor: this is the start of a new feature in TTSIQ. We will be on the lookout for more such articles, and we invite readers to call such articles to our attention: kokhmmm@aol.com]

Going Back to the Moon: Q&A with Planetary Scientist Paul Spudis

21 April, 2015 - www.space.com/29158-manned-moon-exploration-paul-spudis-interview.html

Google Lunar X-Prize meets Yoda

27 May, 2015 - www.space-travel.com/reports/Google_Lunar_X_Prize_meets_Yoda_999.html

Cutting the costs of a Human Return to the Moon

27 July, 2015 - www.thespacereview.com/article/2795/1

Will We Ever Colonize Mars? (Op-Ed)

26 September, 2015 - www.space.com/30679-will-humans-ever-colonize-mars.html

Moon Miners' Manifesto Resources

<http://www.moonsociety.org/chapters/milwaukee/mmm/>

MMM is published 10 times a year (exc. Jan July). The December 2014 issue begins year # 28.

Most issues deal with the **opening of the Lunar frontier**, suggesting how pioneers can make best use of **local resources** and learn to **make themselves at home**, through psychological, social, and physiological adjustment.

Some of the points made will relate specifically to **pioneer life** in the lunar environment. Much of what will hold for the Moon, will also hold true for **Mars and for space in general**. There is one Mars theme issue each year. **Other space destinations** are discussed: the asteroids, moons of Jupiter and Saturn), even the cloud tops of Venus.

Issues #145 (May 2001) forward through current are as pdf file downloads with a Moon Society username and password. Moon Society International memberships are \$35 US; \$20 students, seniors – join online at:

<http://www.moonsociety.org/register/>

MMM Classics: All the “non-time-sensitive editorials and articles from past issues of MMM have been re-edited and republished in pdf files, one per publication year. A 3-year plus lag is kept between the MMM Classic volumes and the current issue. **As of December 2011, the first twenty-two years of MMM, 200 issues, will be preserved in this directory**, These issues are freely accessible to all, no username or password needed, at:

www.moonsociety.org/publications/mmm_classics/

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

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