We all yearn to explore space, not only with unmanned probes, but with human pioneers. Meanwhile, we are quite busy creating a **debris shield** that could imprison us on our home world, **Let's reverse course!**

INDEX

TTSIQ Sponsor Organizations

National Space Society

The Moon Society
www.moonsociety.org

Space Renaissance Initiative

Mars Foundation
To Arrive, Survive, & Thrive! ™

OpenLuna.org
"Your Moon, Your Mission, Get Involved!"

bout The National Space Society - http://www.nss.org/

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

About The Moon Society - http://www.moonsociety.org

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

About Space Renaissance Initiative - http://www.spacerenaissance.org/

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

About The Mars Foundation - http://marsfoundation.org/ - http://marshome.org/

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

About Open Luna Foundation - http://openluna.org/missions

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

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

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

About Moon Miners' Manifesto - http:www.MMM-MoonMinersManifesto.com

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

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

Most of the "editor's summaries" of news articles will be in the form of bullet points of the contents.
We welcome your comments - Peter Kokh, Editor, kokhmmm@aol.com

SPACEPORT & ROCKET NEWS

Work completed on Chinese satellite launch center on Hainan Island

http://www.spacedaily.com/reports/**Work_completed_on_satellite_launch_center_in_Hainan**_999.html

OCT. 21, 2014 - Construction of the **Wenchang Satellite Launch Center** in Hainan province, China's fourth and most advanced space launch center, has been completed and it will soon become operational.

- The center will handle next-generation rockets and space station modules.
- Building work began in 2009.
- Situated on the northeast coast of Hainan, about 60 km from Haikou, the provincial capital, the center is the country's first coastal satellite launch base.
- At, about 19 degrees north of the equator, it is suitable for launching **geosynchronous satellites, heavy satellites, large space station components and lunar and interplanetary missions.**
- To date, the nation's most widely used space facility is the Jiuquan Satellite Launch Center in the Gobi Desert. The other two centers are in Taiyuan, Shanxi province, and in Xichang, Sichuan province.
- The location will give Wenchang an unparalleled advantage compared with the other three centers.
- A satellite launched from Wenchang will have fuel savings of about 15% compared with launches from the Xichang, as its latitude makes for a shorter time from transitory orbit to geosynchronous orbit
- Another significant advantage is that rockets' payloads can be increased, to carry heavier satellites.
- As the new center faces the sea to the south and east, there is also no danger of debris from launch vehicles falling into residential areas.

- It is an ideal site for the launch of the Long March 5 rocket, China's most powerful, under development and expected to be ready to launch in 2015.
- The Long March 5 can be transported to the center by sea, while the other launch centers are in inland areas, requiring transportation by rail.
- Chang'e 5, China's fifth lunar probe, expected to return lunar samples,will be launched here in 2017.
- The opening of the center may increase tourism in Wenchang, the country's fourth "space city"
- The launch center's facilities include a space theme park and tram tours of the launch pads. ##

India Successfully Launches its Largest Rocket To Date

www.asianscientist.com/2014/12/topnews/**india-successfully-launches-largest-rocket-date**/

DEC. 16, 2014 - The Indian Space Research Organisation (ISRO) launched the first test flight of its newest rocket—the GSLV Mk.III—on December 18, conducting a suborbital flight that also demonstrated a prototype crew capsule (CARE) for India's proposed manned missions. Liftoff was from the Satish Dhawan Space Center.

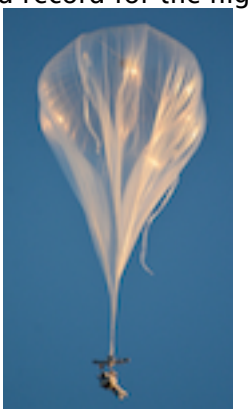
The GSLV Mk.III rocket is a completely new 3rd generation vehicle. The two-stage rocket is designed to place around 10 tonnes (11 US tons) of payload into low earth orbit or four tonnes (US tons) to a geosynchronous transfer orbit. ##

ANALOG FACILITY TRAINING

TO THE EDGE OF SPACE

Skydiver Goes Supersonic in Record-Breaking 'Near-Space Dive'

OCT. 24, 2014 - http://www.space.com/27536-**supersonic-near-space-dive-video**.html www.space.com/27534-**baumgartner-s-near-space-skydive-record-broken-highlight-video**.html http://www.space.com/27537-**supersonic-near-space-dive-photos**.htmlIn a harrowing plunge from the stratosphere, a Google executive broke the world record for the highest



From an altitude of more than 135,000 feet (41,148 meters),
Alan Eustace had a view of the curvature of Earth against the blackness of space.

Alan Eustace, a senior vice president at Google, hit supersonic speeds as he fell from more than 40 km (25 mi) above New Mexico, smashing the altitude record that Austrian daredevil Felix Baumgartner set two years ago with his famous Red Bull Stratos "space jump." Red Bull Stratos "space jump." http://www.space.com/17961-supersonic-skydive-worlds-highest-space-jump.html (Oct. 14, 2012)

- Eustace's feat was via the Stratospheric Explorer (StratEx) team at Paragon Space Development Corp.
- Eustace, wearing a custom-made pressurized spacesuit, was lifted into the air t by a high-altitude, helium-filled scientific balloon.
- After an upwards trip of 2 hours and 9 minutes, he cut himself loose at an unprecedented altitude of 135,890 feet (41,419 meters).
- He reached a speed of 1,322 km/h (822 mph).
- He reached Mach 1.23 at his fastest speed and his body set off a sonic boom that could be heard by the recovery team on the ground
- Eustace remained in free fall for approximately 4.5 minutes before deploying his parachute
- Baumgartner set the previous record on Oct. 14, 2012, when he stepped out of a specially built capsule that was lifted by a balloon 39,000 m (128,000 ft) above Earth.
- Eustace didn't ride inside any kind of pod, but was instead attached to the balloon directly.
- His 181 kg (400 lb.) spacesuit was made by ILC Dover.
- Eustace, 57, was already an experienced skydiver and pilot but he required extra training and had to complete a series of increasingly difficult test dives.
- He also had to learn how to move around in his high-tech pressure suit, which weighs some 400 lbs. (181 kilograms)
- The dive from the stratosphere required 34 months of preparation by Paragon and its StratEx team, which developed the balloon, spacesuit and accompanying support systems.
- One of Paragon's co-founders, Jane Poynter, is CEO of World View, a company that hopes to take paying customers on balloon rides to near space inside of a sealed capsule. http://www.space.com/25221-**world-view-space-tourism-balloons**.html ##

ORBITAL SPACE DEBRIS PROBLEM

See the Comprehensive Article on Space Debris in the **Articles Section** Below

Meeting the Threat of Orbital Debris

Authors: Al Anzaldua and David Dunlop

LOW EARTH ORBIT COMMERCE

MANNED SPACECRAFT

How NASA's 1st Orion Spaceship Test Flight Will Work (Video)

www.space.com/27387-**orion-test-flight-liftoff-to-splashdown-elaborately-explained-video**.html

NASA's Orion Capsule Makes first Flight - What comes next?

DEC 5, 2014 - www.space.com/27940-**nasa-orion-spacecraft-future**.html

NASA's Orion capsule is back on Earth after its 1st-ever test flight. for a while

- Orion got its first taste of space Friday morning (Dec. 5), zooming 5,800 km)3,600 mi) above Earth, then barreling back into the planet's atmosphere and splashing down safely in the Pacific Ocean.
- The unmanned, 4.5-hr mission, "Exploration Flight Test-1 (EFT-1)", was to test out Orion's heat shield, avionics and other systems in the space environment.

The capsule will one day get astronauts to an asteroid, Mars and perhaps other destinations in deep space. But the first of those manned missions is at least seven years away, and an unmanned Orion won't take flight again until 2017 at the earliest.

To the Moon, and an asteroid

- The data gathered during EFT-1 will help engineers tweak and refine Orion in the lead-up to the capsule's next space test, which will take place in late 2017 or 2018.
- On that unmanned flight, Exploration Mission-1 (EM-1), a different Orion capsule — being built by contractor Lockheed Martin — will cruise around the Moon and come back to Earth after spending about a week in deep space, after being launched by the new Space launch System megarocket (SLS)
- The Orion that just flew will be refurbished for a 2018 test of Orion's launch-abort system, which is designed to get astronauts out of danger in the event of a launch emergency.)
- Then, if all goes according to plan, SLS and Orion will fly together again on Exploration Mission-2 (EM-2), **the first crewed flight for both the capsule and the rocket**, to take astronauts out to visit a captured near-Earth asteroid dragged into lunar orbit by a robotic probe.

On to Mars

- SLS will blast a crewed Orion toward Mars, ideally by the mid-2030s - a flyby mission only.
- Orion is designed to support astronauts for up to 21 days at a time, and the trip to Mars will likely take about six months. So, any manned Red Planet mission will also feature a habitat module, which will house the astronauts for most of the journey, Orion's main job on such long-term trips is to get astronauts into space and safely back to Earth. ##

ORION test sets stage for ESA Service Module

www.esa.int/Our_Activities/Human_**Spaceflight/Orion_test_sets_stage_for_ESA_service_module**

DEC 5 2014 - Today's flight and splashdown of NASA's first Orion spacecraft paves the way for future human exploration beyond low orbit powered by **ESA's European Service Module**.

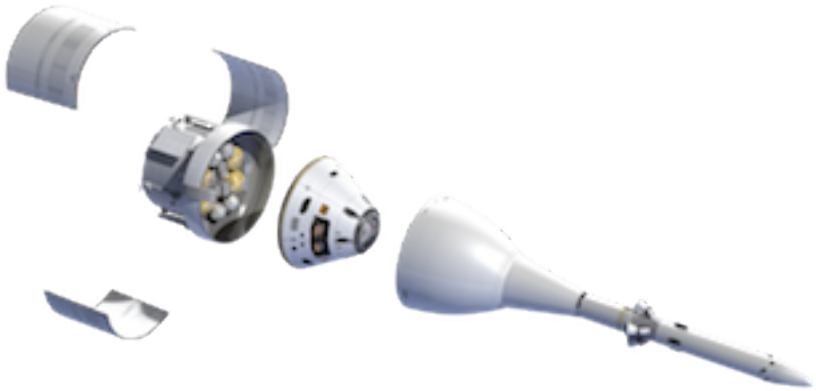
Flight Test-1, Orion **tested systems critical for crew safety, such as the parachutes, avionics and attitude control**, and demonstrated major events such as j**ettisoning the launch abort system and separating the service module fairing**.

ESA to provide critical component

- Future Orion spacecraft will be equipped with a **European Service Module**
- Thai will be the first time that Europe has provided a system-critical element for a US crewed vehicle.
- For this first flight, Orion used only an engineering structural model
- ESA's full service module is scheduled for the next uncrewed test.
- The service module will be the powerhouse that **fuels and propels the Orion spacecraft in space.** It will provide essential functions such as

√ **propulsion**, √ **power**, √ **thermal control** √ **life-support consumables storage and distribution**.

- On 17 November, ESA signed a contract in Berlin with Airbus Defence and Space to develop and build the module **as part of Europe's contributions to the International Space Station**.
- The design passed its preliminary design review earlier this year.
- The next major milestone is the critical design review, set for the end of 2015.



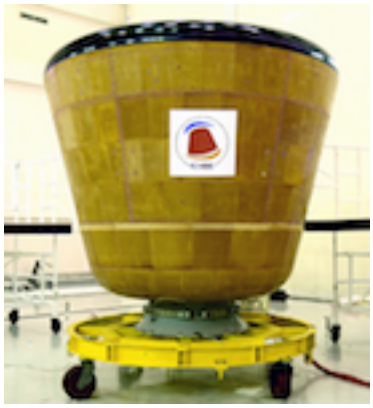
This is the first European development of a human spacecraft operating beyond Earth orbit.

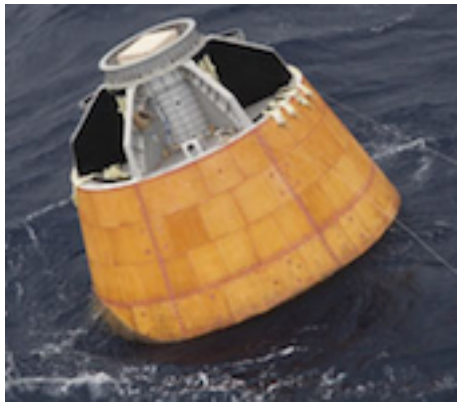
- ESA is developing the module as a contribution to the International Space Station common operation costs, drawing on expertise gained with ESA's hugely successful Automated Transfer Vehicle series of cargo vessels, the European supply craft for the orbital complex.
- Located directly below the Orion crew module, it will carry the propulsion capability for orbital transfer, attitude control and high-altitude ascent aborts.
- It will also generate power using solar wings and store it, and provide thermal control, water, oxygen and nitrogen for the astronauts until just before their return to Earth, when it will separate from the crew module. ##

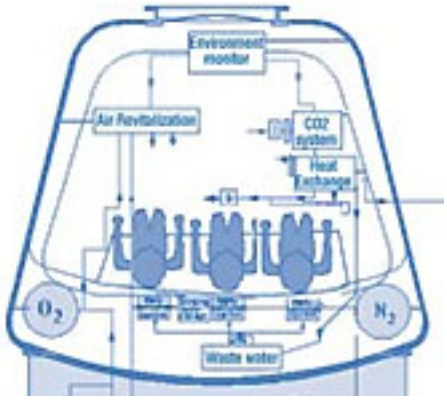
India's Prototype Space Capsule Passes Big Test

DEC. 28, 2014 - http://www.space.com/28114-**india-space-capsule-test-flight**.html

BANGALORE, India — the Indian Space Research Organisation (ISRO) successfully conducted the first experimental flight of its next-generation launch vehicle and demonstrated the re-entry and recovery of a prototype crew capsule.







Full image of partial diagram at right:
www.asianscientist.com/wp-content/uploads/2011/06/**space-capsule-rocket**.jpg

- The rocket carried a 3,775-kg (8,332 lb.) unmanned 3-man crew module built in India and separated from the rocket at an altitude of 127 km (79 mi) and, afyer being slowed by parachutes, splashed down in the Bay of Bengal.
- The flight validated the re-entry technologies envisaged for crew module and enhance the understanding of **blunt body re-entry aerodynamics** and **parachute deployment** in cluster configuration.
- The performance of the unmanned crew module was as expected.
- ISRO has sought about 125 billion rupees ($1.9 billion) for its human spaceflight endeavor but India's government has yet to approve the funding.
- Radhakrishnan has said that ISRO could send astronauts to space within seven to eight years of getting a government nod. ##

COMMERCIAL SPACEFLIGHT

NASA Commercial Crew Partners Continue System Advancements

http://www.nasa.gov/press/2014/november/**nasa-commercial-crew-partners-continue-system-advancements/** - NOV. 14, 2014 - **RELEASE 14-317**

NASA's industry partners continue to complete development milestones under agreements with the agency's Commercial Crew Program. Work performed by Blue Origin, Boeing, Sierra Nevada Corporation and SpaceX during partnership and contract initiatives is leading a new generation of safe, reliable and cost-effective crew space transportation systems to low-Earth orbit destinations.

- **Blue Origin** (partnership extended to 2016) conducted an interim design review of the subsystems in development for its Space Vehicle spacecraft designed to carry people into low-Earth orbit,. In October, NASA and Blue Origin agreed to add three additional unfunded milestones to the agreement: further testing of Blue Origin's propellant tank, BE-3 engine and pusher escape system.
- **Boeing** successfully closed out its Commercial Crew Integrated Capability (CCiCap) agreement with NASA, which significantly matured the company's crew transportation system, including the CST-100 spacecraft and Atlas V rocket.
- **Both Boeing and SpaceX** began work on the Commercial Crew Transportation Capability (CCtCap) contracts the agency awarded them Sept. 16 to develop systems to transport astronauts to and from the International Space Station
- **Sierra Nevada** Corporation (SNC) continued to perform incremental tests of its reaction control system as it prepares for a CCiCap milestone review for NASA that details the system, which would help maneuver the Dream Chaser spacecraft in space. SNC also is preparing for the CCiCap free-flight milestone test of its Dream Chaser test vehicle at NASA's Armstrong Flight Research Center.
- **SpaceX** held several CCiCap meetings with NASA, including one in August that covered the company's launch and mission operations plans and the associated ground systems at Kennedy Space Center's Launch Complex 39A. It also held a series of technical interchange sessions with NASA experts to discuss the intricacies of the progress, testing and plans associated with the Crew Dragon spacecraft and the Falcon 9 v 1.1 rocket.

More information about NASA's Commercial Crew Program:http://www.nasa.gov/commercialcrew

NASA Selects Commercial Space Partners for Collaborative Partnerships

www.nasa.gov/press/2014/december/**nasa-selects-commercial-space-partners-for-collaborative-partnerships/**

DEC. 23, 2014 - NASA has selected four U.S. companies to collaborate through unfunded partnerships to develop new space capabilities available to the government and other customers.

- The partnerships build on the success of NASA's commercial spaceflight initiatives to leverage NASA experience and expertise into new capabilities.
- The Collaborations for Commercial Space Capabilities (CCSC) initiative is designed to advance private sector development of integrated space capabilities through access to NASA's spaceflight resources and ensure emerging products or services are commercially available to government and non-government customers within approximately the next five years.

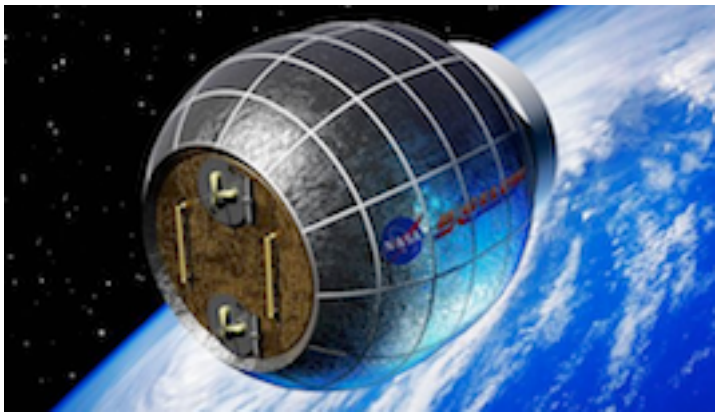
The Companies selected and their projects are:

- **ATK Space Systems**, in Beltsville, Maryland, is developing space logistics, hosted payload and other space transportation capabilities.
- **Final Frontier Design**, in Brooklyn, New York, is developing intra-vehicular activity space suits.
- **Space Exploration Technologies (Space-X)**, in Hawthorne, California, is developing space transportation capabilities that could be used to support missions into deep space.
- **United Launch Alliance**, in Centennial, Colorado, is developing new launch vehicle capabilities to reduce cost and enhance performance. ##

INTERNATIONAL SPACE STATION

Private Inflatable Room Launching to Space Station Next Year

OCT. 6 2014 - http://www.space.com/27356-**bigelow-inflatable-room-space-station**.html
http://www.space.com/19296-**how-nasa-will-add-inflatable-room-to-space-station-video**.html
TORONTO — A privately built inflatable room on the Space Station is on track to launch next year.




http://en.wikipedia.org/wiki/**Bigelow_Expandable_Activity_Module**
Mass: 3,000 lb (1,360 kg) – Length: 13 ft (4 m)[1]
Diameter: 10.5 ft (3.2 m) – Living volume: 565 cu ft (16 m^3)
in early 2010, various options were considered, such a a torus-shaped storage module. One application of which was a centrifuge demo. The simpler design was chosen.

- The **Bigelow Expandable Activity Module** (**BEAM**) is expected to head to space inside SpaceX's Dragon cargo spacecraft in 2015
- Once BEAM gets to the space station, the robotic Canadarm 2 will install it on the Tranquility node's aft port to test out expandable-habitat technology.
- NASA is paying Bigelow $17.8 million to send the demonstration module to the station
- BEAM will be in place at ISS for at least a couple of years.

The post-BEAM Future of Low Earth Orbit: "LEO will become a commercial domain"

- There was a time when every communications satellite was owned by the government
- Private companies are now responsible for this space domain which includes cellphones.
- Commercializaton will happen for crew operations as well

Pushing for change

- The BEAM mission will collect even more data about how expandable habitat modules perform on orbit. The company put two other modules to orbit as stand-alone missions in 2006 and 2007
- Bigelow and to launch private space stations someday
- Private work in space is hampered by International Traffic in Arms Regulations (ITAR), which restrict the sharing of technology with other countries, particularly China.
- After gravity, ITAR is the second-greatest barrier to getting something off Earth.

International standards

- NASA's chief of human exploration and operations says commercial operations are needed on the Station because NASA "owes the taxpayers some return."
- NASA is starting to put together voluntary international standards that could be used for future orbiting facilities, such as methods of choosing radio frequencies that do not interfere with one another
- For example, astronauts could not eat any of the lettuce grown onboard the space station during a recent experiment because it had to be sent back to Earth for a health and safety check first.
- BEAM will help evaluate **radiation levels inside compared to those on other parts of the station**
- The mission is part of NASA's larger push to make low-Earth orbit a place where commercial entities will operate, whether through launching CubeSats or ferrying cargo to and from the Station. ##

ISS-bound Cygnus Cargo Capsule & Antares rocket explode on liftoff
Student-built Cubesats and other experiments lost

http://news.yahoo.com/**commercial-supply-rocket-explodes-liftoff**-224100998.html
http://www.space.com/27594-**private-antares-rocket-explosion-full-coverage**.html
http://www.space.com/27597-a**ntares-rocket-explosion-astronaut-reactions**.html
http://www.space.com/27595-a**ntares-rocket-explosion-science**.html
http://www.space.com/27598-**antares-rocket-explosion-soviet-engines**.html

ATLANTIC, Va. (AP) -- An Antares rocket and an unmanned commercial Cygnus cargo capsule bound for the International Space Station exploded 20 seconds after liftoff Tuesday evening, October 28th with debris falling in flames over the Wallops Island launch site in SE Virginia.

This newest Cygnus cargo ship — named for the swan constellation — had held 2270 kg (5,000 lbs) of space station experiments and equipment for NASA, as well as prepackaged meals and eagerly awaited crab cakes, freeze-dried for safe eating. It had been due to arrive at the orbiting lab Sunday.

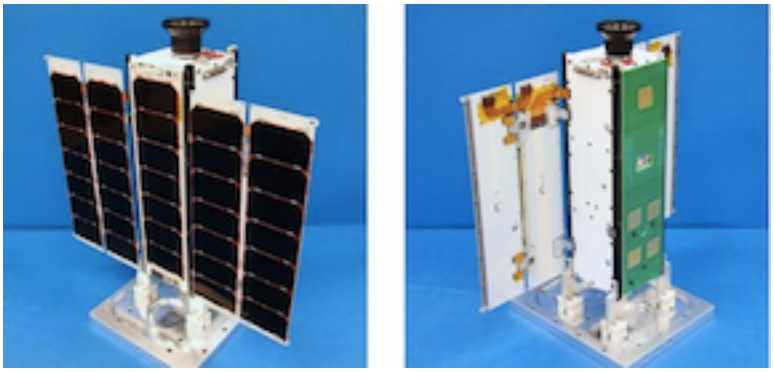
- Things began to go wrong 10 to 12 seconds into the flight and it was all over in 20 seconds when what was left of the rocket came crashing down.
- This was the first catastrophic launch in NASA's commercial spaceflight effort
- This was the fourth flight by Orbital Sciences to the orbiting lab.
- No injuries were reported.
- This was the 2nd launch attempt for the mission. The first try was thwarted by a stray sailboat in the rocket's danger zone. The restrictions are in case of just such an accident that occurred Tuesday.
- The Russian engines that powered the Antares rocket were “refurbished” variants of the NK-33 built by the Soviet Union for its ill-fated N-1 moon rocket during the height of the space race in the 1960s.
- NASA is paying billions of dollars to Orbital Sciences and the SpaceX company to make station deliveries, and it's counting on SpaceX and Boeing to start flying U.S. astronauts to the ISS in 2017.
- The accident was sure to draw criticism over the space agency's growing reliance on private U.S. companies in this post-shuttle era.
- The top priority will be to repair the launch pad as quickly and safely as possible. T
- There has been no estimate of how long it will take to determine the cause of the accident and to make repairs.
- The launch was insured at more than $200 million, not counting repair costs.
- Until Tuesday, all of the supply missions by the Virginia-based Orbital Sciences and California-based SpaceX had been near-flawless.
- Cygnus was carrying about 2,215 kg (4,883 lbs) of cargo, with about 727 kg (1,603 lbs.) of that devoted to science.



Left: Antares rocket **Center:** The Explosion Right: Cygnus cargo module

Lost Payload: science experiments by students, professional researchers and private companies.

- Planetary Resources first test payload, Arkyd 3 - designed as a precursor to the Arkyd 100 Series — a group of space probes that could be used to hunt for asteroids that might be mined for resources.
- 26 tiny Earth-observing cubesats from San Francisco-based Planet Labs that were to be deployed and used to observe Earth from space.



Planetary Resources' Arkyd 3 technology-demonstration spacecraft

- a spacecraft built to test technologies that could be used for asteroid mining

In the aftermath

- People in the vicinity were advised not to touch any potentially hazardous rocket or spacecraft debris that came down on their property or that might wash ashore.
- Immediately after the explosion, the launch team was ordered to maintain all computer data for the ensuing investigation.
- Meanwhile, the Russian Space Agency was proceeding with its own supply run the next day, planned well before the U.S. mishap.
- SpaceX is scheduled to launch another Dragon supply ship from Cape Canaveral in December; and some items on its list may be changed out to replace what was lost on the Cygnus.

No hardships for ISS

- The station and its crew have plenty of supplies on board — about five months' worth — even without the upcoming launches.

Only a temporary disappointment for students

- Among the science instruments that were lost: **a meteor tracker and 32 cubesat research satellites**
- Along with **numerous experiments compiled by schoolchildren**. They have been promised that **their experimenters would get a chance to refly their wor**k.

www.space.com/27584-**antares-rocket-explosion-students-lose-science-experiment-video**
www.space.com/27669-**orbital-sciences-rocket-explosion-soviet-engines.**html ##0

Space Station's 3D Printer makes 1st Part

NOV. 25, 2014 - http://www.space.com/27861-**3d-printer-space-station-first-part**.html

Space Station commander Barry "Butch" Wilmore holds up the first 3D printed part made in space. The part, an extruder plate (a piece of the printer itself), was made on Nov. 24, 2014.

The Space Station's 3D printer, designed and built by California-based **Made In Space**, has produced its first part, ushering in a new age of off-Earth manufacturing when voyaging spaceships print out their own spare parts on the go and colonists on other worlds make what they need from the dirt "beneath their boots"

- 3D printing creates products layer by layer out of plastic, metal or other feedstock material.
- The 3D printer created **an extruder plate — a duplicate piece of itself** — an hour-long task.
- The extruder plate measures roughly 3 in. by 1.5 by 0.25 in (7.6 by 3.8 by 0.6 cm)
- The part features logos of both Made In Space and NASA
- The plate holds in the printer's electronic board and wiring.
- "If something goes wrong on the space station, the crew can now build a solution."
- The machine arrived in September in SpaceX's Dragon Cargo capsule, and installed in the station's Microgravity Science Glovebox.
- Calibration activities quickly followed.
- The chief goal of the first phase of **the 3D Print project** is to make sure that it works in orbit as well as it does on the ground.
- Test items printed in space will be compared with identical samples produced by the same machine before it left Earth.

The second phase

- Focus on actual utilization of parts printed out on the space station.
- The technology could reduce the cost of spaceflight and enable more ambitions manned missions by ensuring availability of replacement parts
- "We're actually able to email our our hardware to space (emailing the specs of the needed part) instead of launching it."
- Sometime next year, Made in Space plans to launch a production printer to the space station, to replace the current "demonstrator" model.
- Also in the works is a "recycler" project to turn station trashinto 3D-printed objects in 2015 or 201.
- The company's long-term vision extends far beyond Earth orbit, on the Moon and on Mars - shipping the specs and using on location materials, for an enormous drop in costs. ##
- (Editor: alas, we cannot email the specs of pioneers and print them on location! Not yet anyway. LOL)

For more on this topic:.

http://www.space.com/27787-**space-station-3d-printer-readied-for-test-prints-video**.html
http://www.space.com/25706-**3d-printing-transforming-space-travel**.html (10 ways)
http://www.space.com/topics/**3d-printing**/
http://www.space.com/19600-**moon-base-concept-3d-printing-photos**.html
http://www.space.com/28095-**3d-printer-space-station-ratchet-wrench**.html

(Ed: But will it ratchet? - a static tool is not a usable tool)

http://www.space.com/27870-**3d-printer-made-in-space-op-ed**.html - excerpt below:

"The print took slightly more than an hour, and once it finished, the world changed. At the Made In Space Operations Center in Moffett Field, California, we had the ability to command the printer and see inside it as the machine received and executed our commands."

"For the first time, humans demonstrated the ability to manufacture while in space. At this moment, if the space station absolutely needs a part that the 3D printer can build, I can start producing the part onboard the ISS within minutes, from my chair in California." - Mike Snyder of Made in Space

Editor: Truly a monumental threshold moment! **Maintaining** outposts on Moon and Mars will be **vastly less expensive** than we had thought, making them a near term reality. This may be a godsend to **the Mars One project,** making it vastly more feasible, **cutting imports to Moon and Mars** needed to keep an outpost in operation, and watch it grow swiftly - **at minimum expense** - this is it.

If one were to pick the **most significant space-related event of 2014**, this would be our pick, hands down.

The Promises and Perils of Space-based Additive Manufacturing

DEC .1, 2014 - http://www.**thespacereview.com/article/2654/1**

[**Editor:** Minimally Condensed below, given its significance.)

NASA and the US Air Force commissioned the NRC to conduct a study. The NRC report **3D Printing in Space**, released in July 2014,evaluated the prospects of in-space additive manufacturing, examining the various technologies available and currently in development.

Additive manufacturing presents potential opportunities:

- As a tool in a broad toolkit of options for space-based activities
- and as a potential paradigm-changing approach to designing hardware for in-space activities.

A number of technical challenges that must be overcome:
Specific recommendations for future research.

"Because components, systems, and subsystems do not have to be completely manufactured on Earth before transported to space, additive manufacturing enables development of structures entirely unlike those made in the high-gravity environment of Earth.

The vision of space-based additive manufacturing: "Not just a different way to manufacture traditional components; in addition, it offers a new way to re-conceptualize space architectures, or made to survive the rigors of space launch."

Seven specific applications of additive manufacturing in space.

1. Creating replacement components in space

On ISS, the most immediate application of additive manufacturing in space involves the creation of replacement parts and components. **A significant percentage of hardware failures on the ISS involve plastics and composites,** suitable for repair using additive manufacturing techniques. Instead of carrying additional, redundant components, or waiting for them to arrive from Earth, parts can be manufactured in space as needed.

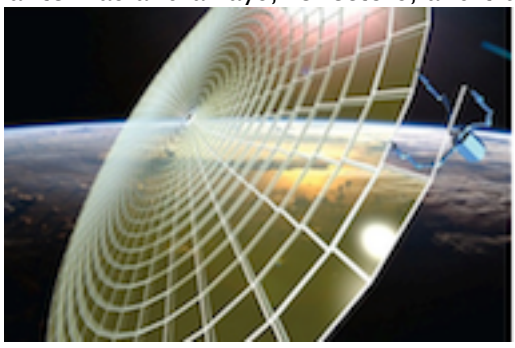
2. Recycling in space

Additive manufacturing could use recycled materials to reduce the time and cost of waste removal.

3. Creating structures difficult to produce on or transport from Earth

Currently, large components and systems such as antennas, booms, and panels are "designed for launch." Additive manufacturing enables users to design parts for ultimate use rather than machining, manufacturing, and transporting.

On-orbit construction and "erectables" technologies can enable deployment of systems that do not conform to weight and volumetric constraints posed by launch fairings and shrouds. Some of the structures envisioned and supported by NASA programs include ultra-thin mirrors, gossamer structures like ribbons, large antennas and arrays, reflectors, and trusses, among others.



Concept of a 3D printed solar array in space. (credit: Tethers Unlimited)

4. Creating sensors, sensor systems, and satellites

In a few years, additive manufacturing in space could potentially enable in-space production of not just components, but also entire multi-material subsystems and systems.

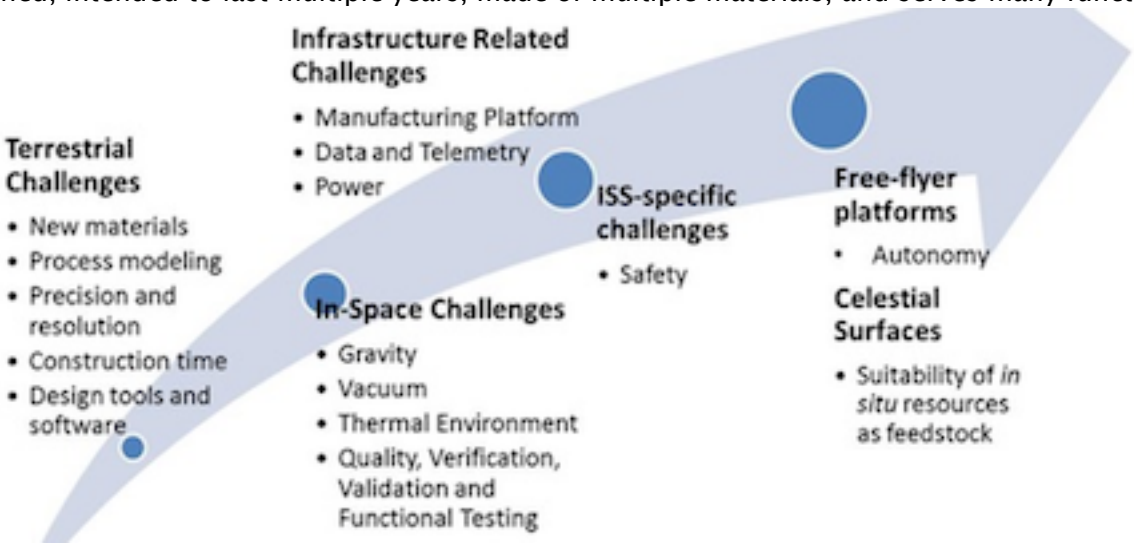
5. Freeflying "Fablab"

A typical Fablab is equipped with an array of flexible computer-controlled tools, often including 3D printers, with the aim to make "almost anything. " Users—human or robotic—would be able to access tools in space to manufacture what is needed without bringing it from Earth. There are several free-

flying spacecraft that could become available within the next decade and serve as free-flying fablabs for additive manufacturing in space.

6. Fully printed spacecraft

Additive manufacturing in space could create an entire spacecraft, built as a single unit with a single machine, or assembled by humans or even autonomously. How long it would take to realize this vision depends not only on technical advancements made but also on how a spacecraft is defined. A single-function spacecraft (e.g. one that only measures solar radiation during a space weather event and then degrades) is feasible on a shorter timeline than a multiple function spacecraft radiation-hardened, intended to last multiple years, made of multiple materials, and serves many functions.



7. Use of resources on planetary surfaces

Availability of construction materials like metal and water on the surfaces of the Moon, asteroids, and other celestial bodies could enable manufacturing of settlements and other facilities without having to take expensive and bulky pre-fabricated materials out of Earth's gravitational field.

Lunar regolith, for example, could be used to construct **pressurized habitats** for human shelter, as well as other infrastructure (e.g., **landing pads, roads, blast walls, shade walls, and hangars** for protection against thermal radiation and micrometeorites) on the Moon.

Technical challenges to the use of additive manufacturing in space

There are number of technical challenges, let alone legal and regulatory ones, that must be overcome before the technology is even close to meeting its promise. Space-based challenges are more complex than terrestrial ones, which themselves require considerable investment. In space, there will be new challenges relating to infrastructure, platforms, and the overall manufacturing approach.

Overall findings and recommendations

Space system configurations dominated by the need to survive ground manufacturing, assembly, test, transport, and launch could be fundamentally transformed as additive manufacturing advances.

Additive manufacturing is far more of a systems engineering and industrial logistics problem compared to additive manufacturing on the ground, and much needs to be done for the technology to deliver on its potential. The committee made a total of 15 recommendations that fall in five general categories:

1. **Analysis.** cost-benefit analyses related to its value in space. Focus on how additive space manufacturing can enable entirely new functionalities that were not possible before,e.g. the manufacture of smaller satellites.
2. **Investment.** Targeted investment is needed in areas such as standardization, certification, and space-based infrastructure. Joint workshops and other information-sharing forums to develop roadmaps with short- and long-term targets.
3. **Platforms.** NASA and other agencies should leverage the ISS to the extent feasible to test additive manufacturing parts and processes in the remaining lifetime of the station.
4. **Coordination and collaboration.** Coordination and collaboration within and across agencies, with the private sector, and with international partners. Leverage existing efforts such as America Makes, a

network of companies, non-profit organizations, academic institutions and government agencies that promotes additive manufacturing.

5. **Education and training.** Develop capabilities in relevant fields such as material science that are important for the development of additive manufacturing.

"If near-term efforts are carefully designed and executed, the application of additive manufacturing in the space environment could lead to more Earth-independent operation in space." ##

Plans to Create Russian National Orbital Station Confirmed

www.spacedaily.com/reports/**Plans_to_Create_Russian_National_Orbital_Station_Confirmed**_999.html

DEC. 16, 2014 - Russia's space agency Roscosmos is looking at plans to create a national space station that may be included in the new Federal Space Program.

- The high-altitude station is also being considered as a base for Russia's full-scale Moon exploration program in the 2016-2025 period.
- The new orbital station will also be used to test manned spacecraft for the lunar mission.
- Spacecraft will first be delivered to the station, and then continue to the Moon.
- Russia has been considering considering dropping out of the ISS program, and re-direct its funding into more promising space projects.
- Set to begin in 2017., the station will use modules constructed for the International Space Station.
- **Roscosmos Will Decide on New Super-Heavy Rocket Design in January 2015**
  Russia's space agency Roscosmos will decide on the design of the country's new super-heavy rocket in January 2015, Roscosmos chief Oleg Ostapenko said Monday.
- Blueprints have been received from three leading space rocket enterprises, the winning proposal to be announced in January.
- A New Station and a super-heavy carrier rocket able to lift up to 80 tons of cargo into space.
- A rocket capable of carrying 130 to 160 tons might be developed. (Russia's largest existing rocket, the Proton, can launch payloads of up to 20 tons.
- The modular Angara rocket will come in several versions, the largest able to 35 tons into orbit.
- **Russian Space Agency's 2015 Budget Unchanged Despite Economic Downturn**
  Russia will not cut Roscosmons 2015 and will implement all programs planned for 2015.
- The 2014 budget for Roscosmos stands at 165.8 billion rubles (US $2.8 billion). In comparison
- US space agency NASA's budget for 2014 totals $17.6 billion.
- The Russian economy has been showing signs of a slowdown following a steady decline in global oil prices. Exports of crude make up a large portion of the Russian budget's revenues.
- **Vostochny Space Center to Be Ready in Time Despite Current Delays**.
- The project, initially estimated to cost 400 billion rubles ($7.4 billion at the current exchange rate), is scheduled for completion in July 2015.
- "In some areas, [the construction] has been seriously behind schedule. But I'm sure that the deadlines set by the president and the government will eventually be met," Oleg Ostapenko told reporters.
- The project has been plagued by missed deadlines and a corruption scandal involving the former head of one of the project's main contractors, who was arrested earlier this year on charges of embezzling 1.8 billion rubles ($35 million at the current exchange rate).
- Russian Prime Minister Dmitry Medvedev has replaced the project's most senior manager.
- The Vostochny space center in thefar eastern Amur region, is expected to reduce Russia's dependency on the Baikonur cosmodrome in Kazakhstan which in on lease from the Kazakh government to Russia until 2050.
- The Russian government also hopes that the Vostochny will benefit the economy of Russia's Far East, and will enable the country to conduct more launches.
- The construction of the space center began in 2012. The first launch of a carrier rocket from Vostochny is scheduled to take in 2015. ##

ASTRONAUTS

BioSuit: A Skintight Spacesuit for Astronauts (Photos)

OCT. 1, 2014 - http://www.space.com/27210-**biosuit-skintight-spacesuit-concept-images**.html
http://www.space.com/27214-**skintight-spacesuit-biosuit-photos**.html

Since the dawn of human spaceflight, one of the biggest challenges has been how to protect astronauts in the harsh environment of space.

- Conventional spacesuits are essentially a balloon of gas that provides the 1/3rd atmospheric pressure necessary to keep one alive in the vacuum of space.
- To date, spacesuits heavy been bulky and hard-to-wear
- The "Biosuit" concept at MIT aims to launch spacesuit into a new frontier.
- MIT's pressurized but skintight "shrink-wrap" "Biosuit" would allow a much better range of motion.
- The goal is the same pressurization through mechanical counterpressure — applying the pressure directly to the skin, thus avoiding the gas pressure altogether,
- The new lightweight suit would combine passive elastics with active materials.for greater mobility.
- The suits might use coils to respond to heat, contracting to a "remembered" state when exposed to the right temperatures.

MIT skinsuit: a new kind of skintight spacesuit that could help astronauts leave the bulky suits of today behind for more mobility with exploration.

- Incorporated into a "tourniquet-like cuff," the coils produce the same amount of pressure needed for astronauts to safely work in space.
- The question is how to incorporate the coils into a spacesuit's design.
- The suit needs to be skintight in order to produce enough pressure, but how does an astronaut get in and out of an extremely tight garment?
- Scientists can "train" the coils to move into a certain shape when exposed to a specific temperature. When they are not exposed to the temperature, however, the coils can move into a more relaxed state, potentially allowing astronauts to remove the skintight suit.
- Once you put the suit on, you can run a current through all these little features, and the suit will shrink-wrap you, and pull closed.
- Research is needed to find out how to keep the coils at the proper heat t stay contracted.
- One option is to run a constant current through the suit to keep the coils contracted. But constantly heating the suit would use too much energy and also overheat the astronauts inside of it.
- Researchers want to find a way to lock the coils in place once they create the right pressure and release them once the astronaut's work is done.
- This applied work could also have implications for other technologies on the ground.
- Such suits could serve as a body-tourniquet for someone bleeding out on the battlefield. ##

Editor: On the Moon or Mars, persons self-conscious about their weight or other body imperfections could wear an outer gown or robe of some kind. This might keep the inner skinsuit from getting to dusty or "dirty."

Read "**Skinsuit Outerwear**" MMM 225 May 2009 www.nss.org/settlement/moon/library/mmm2009.pdf
or www.moonsociety.org/mmm_classics/mmc23_Jan2013.pdf

ining Co. Picks Spacesuits for Spacewalk Simulator

OCT. 24, 2014 - http://www.space.com/27525-**private-astronaut-training-spacesuits**.html
http://www.space.com/26981-**how-to-try-on-a-real-spacesuit-in-brooklyn-video**.html
(http://www.space.com/27269-spacewalk-simulator-crowdfunding-project-mets.html }
(http://www.space.com/24469-commercial-space-travel-faa-approval.html)

A "more spacelike" experience.

At the moment, most spacewalking training is limited to professional astronauts who have access to facilities such as NASA's Neutral Buoyancy Laboratory, which is a giant pool in Houston with a mock space station inside.

But s private spacesuit company and an astronaut-training organization are teaming up to give private astronauts on simulated spacewalks a more spacelike experience.

With a Kickstarter campaign underway to simulate spacewalks on Earth, Houston's **Waypoint 2 Space** announced a new partnership to integrate spacesuit design ideas with the simulator. The company plans to work with Brooklyn-based **Final Frontier Design** to integrate life support systems into the spacewalk simulator and other training systems.

Final Frontier Design's spacesuit during initial pressurization.

- Waypoint 2 Space looked at several excellent space suit designs, seeking ways to incorporate the best features of their life support systems into innovative solutions for its core suborbital program
- Final Frontier Design, founded after winning the NASA 2009 Astronaut Glove Challenge, offers a "spacesuit experience" that allows anyone to don the pressurized garment and move around.
- The completed simulator will sit inside a dark room and able to move horizontally and vertically.
- Trainees will use their spacesuit lights to figure out where to move.
- Star fields will be projected on the walls of the room to enhance the sensation that the amateur astronauts are in space.
- The simulator would be available to amateur space walkers in March 2015. ##

How Zero Gravity Affects Men and Women Differently

http://abcnews.go.com/**Health/gravity-affects-men-women-differently/story**?id=27026408

NOV. 19, 2014 - With an upcoming mission to Mars, NASA is studying the ways that living in space affects both men and women.

In a study published this month in Journal of Women's Health, researchers from NASA and National Space Biomedical Research Institute (NSBRI) went through decades of data to understand how living in zero gravity takes a toll on both men and women.

The team reviewed data on the 534 people to have flown in space at the time of the study, including 57 women, and studied cardiovascular, reproductive, musculoskeletal, immunological and behavioral health.

Changes in zero gravity included

- **Some men had worse vision**
- **Calcium loss** for **both sexes**,

- **Some women experienced Inability to stand for long period**s without fainting after landing on Earth
- E**ye and even eyeball** can be **affected by zero gravity**.
- **82 % of male** astronauts, (14 of 17), suffered from changes to their vision called **"visual impairment** intracranial pressure (VIIP), one of the most serious spaceflight-related health risks."
- **A large majority of the male astronaut**s had a problem
- Statistically **fewer women** were struck with the same symptoms.
- Only 62 %, (5 out of 8) female astronauts reported the same symptoms and none had as severe symptoms as some of the male astronauts.
- Researchers were examining if the women's age, hormones or vascular health helped them fare better in space.
- While male astronauts battled to keep their eyesight
- Female astronauts were more likely to faint while standing when they initially come back to Earth.
- Causes for fainting could range from a loss of plasma volume in space to the different ways men and women's cardiovascular systems react to stress,.
- Some female have fainted, some feel like they're going to faint.Both men and women have faced similar problems, including "space motion sickness."
- Women in space tend to report more motion sickness as they leave Earth and enter the Station.
- Men report feeling queasy more often as they return to Earth.
- NASA scientists are hoping to develop devices or medication for specific problems faced by both men and women as they travel into space or even to Mars
- It's not a question of who is better equipped but rather designing specific measures to protect men and women alike.

TECHNOLOGIES

NASA Partners with Leading Technology Innovators to Enable Future Exploration

http://www.nasa.gov/press/2014/october/**nasa-partners-with-leading-technology-innovators-to-enable-future-exploration/**

OCT. 17, 2014 - **Teams selected for the ECI pilot program and their topic areas are:**

- **High-Speed Video Imaging** with Disruptive Computational Photography Enabling Technology, by NASA's Stennis Space Center, Mississippi, with partner, Innovative Imaging and Research (I2F) of Mississippi. The team will develop and demonstrate **a system for high-speed, 3-D, High Dynamic Range (HDR) imaging**. Video imaging will be performed at the chip level using computational photography, providing NASA with advanced visualization technologies to meet future needs.
- **Lightweight Integrated Solar Array and Transceiver (LISA-T)**, by NASA's Marshall Space Flight Center in Huntsville, AL with partner, Huntsville's NeXolve, to build and demonstrate a **deployable solar array and integrated transceiver system**. The technology represents a novel approach to developing a lighter weight, higher power technology solution for future spacecraft energy needs.
- **On-Orbit Autonomous Assembly of Nanosatellites**, by NASA's Langley Research Center, Hampton, Virginia with external partner Cornell University, Ithaca, New York. The team will develop **advanced autonomous docking hardware based on Halbach magnetic array technology.** Reliable autonomous rendezvous and docking techniques provide enabling technologies for future mission needs.
- **Integrated Display and Environmental Awareness System (IDEAS)**, by NASA's Kennedy Space Center, Florida, with Orlando area partners Abacus Technology and Purple Rock Scissors, and the Florida Institute of Technology of Melbourne. The team will develop **a wearable computer with an optical heads-up display providing augmented reality data and communications, enhancing real-time operations on the ground and in space.** ##

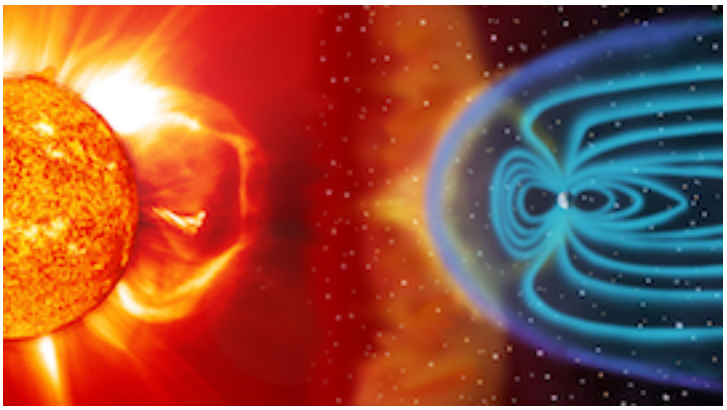
NASA Selects Nine Space Radiobiology Research Proposals

www.nasa.gov/press/2014/october/**nasa-selects-nine-space-radiobiology-research-proposals/**

OCT. 3, 2014 RELEASE 14-271 - NASA's Human Research Program will fund nine proposals for ground-based research that will help enable extended and safer human exploration of space by quantifying and, ultimately, reducing the risks posed by space radiation.

Using beams of high-energy, heavy ions that simulate space radiation, the research will employ new experimental approaches **to understand better the role of space radiation in the development of cancer, heart and circulatory disease, and long-term cognitive function problems.**

- These studies will be conducted at NASA's Space Radiation Laboratory at Brookhaven National Lab
- The proposals were in response to the research, "Ground-Based Studies in Space Radiobiology."
- Astronaut health and safety is problematic beyond low-Earth orbit as we plan to explore deeper into our solar system, to an asteroid and/or Mars.
- High radiation exposure levels in interplanetary space is a major challenge for a journey to Mars.
- The research goal is to help reduce the uncertainties and risks associated with the effects of human radiation exposure on deep space missions.
- Proposals submitted by 7 institutions will receive a total of c. $12.5 million over a 1-4 year period.



NASA's space radiobiology research aims to mitigate harmful effects of the space radiation on astronaut health outside of the relative protection of the Van Allen belts (pictured in blue)

- The Human Research Program is managed by the Space Life and Physical Sciences Division of NASA's Human Exploration and Operations Mission Directorate at NASA Headquarters in Washington.
- List of the selected proposals, principal investigators,organizations: http://go.nasa.gov/1tls8cj

NASA Selects 3 Proposals to Support Behavioral Health and Performance on Deep Space Missions

http://www.nasa.gov/press/2014/october/**nasa-selects-three-proposals-to-support-behavioral-health-and-performance-on-deep**

OCT. 8, 2014 RELEASE 14-279 - NASA's **Human Research Program** (HRP) will fund three proposals to help investigate questions about behavioral health and performance on future deep space exploration missions. This type of research may help astronauts as they venture farther than ever before to explore asteroids and Mars.

- HRP research provides knowledge and technologies to reduce crew health and performance risks during space exploration.
- It also develops potential countermeasures for problems experienced during space travel.
- Mission planners and system developers can use these potential countermeasures to monitor and mitigate the risks to crew health and performance.
- The selected proposals will receive a total of about $3.2 million over a 3-year period.
- Three projects were selected from 11 proposals received in response to the research announcement "Human Exploration Research Opportunities - Behavioral Health and Performance." \
- Science and technology experts from academia and government reviewed the proposals.
- Two proposals will investigate neurobehavioral conditions and standardized behavioral measures relevant to exploration class missions.

- One proposal will evaluate neurobehavioral effects of a dynamic lighting system on the Space Station.
- These same research studies can lead to advancements in human health understanding and treatments on Earth.

Astronaut Mike Fincke holds a light fixture inside of ISS. The fluorescent-based lights on ISS will soon be replaced by a customized, dynamic LED system, which NASA-funded Behavioral Health and Performance researchers will evaluate in an upcoming experiment.

For a complete list of the selected principal investigators, organizations and proposals, visit:

http://go.nasa.gov/1rX1Qzr

For information about NASA's Human Research Program, visit:

http://www.nasa.gov/exploration/humanresearch

Powering Space Travel With Astronaut Poo

DEC. 10, 2014 - www.asianscientist.com/2014/12/features/**powering-space-travel-astronaut-poo**/

Human waste generated at a lunar base can produce enough **biogas** (**mixture of methane and carbon dioxide**) to power the rocket that will help get the astronauts back to Earth, says a study by researchers at the University of Florida (UF)

- By optimizing waste digester technologies—stirring, temperature control, organic loading rate and reactor design—methane production can be improved substantially.
- The method improves on an earlier design for an anaerobic (oxygen-free) digester to manage waste at a planned base on Mars.

  "Anaerobic digestion is a biochemical process mediated by a mixed group of naturally occurring microorganisms that convert organic matter to biogas (typically 50-60 per cent methane and rest carbon dioxide) at near ambient conditions in an anaerobic environment,"
- The digester for a Mars mission would process biomass from plants grown on the red planet for food and to generate oxygen.

  "Since the physical characteristics of waste from the lunar mission are different, the engineering design incorporated into the fermentation vessel (anaerobic digester) was also different,"
- NASA's Moon stationwould have four crew members. Scientists used chemically-simulated food waste and packaging expected to be produced by the crew.
- A year's worth of the crew's solid waste could provide about 23 % of the 1,000 kg of methane required for ascent engines, using anaerobic digestion.
- Additionally, 59 % of methane would be available from carbon dioxide produced by the digester and life-support systems so that a total of 82 % of fuel needed for lunar ascent could be produced from waste products,
- Converting waste generated at the lunar station into fuel would also save on extra weight for the lift off from Earth.
- A spinoff would be efficient recycling of a variety of organic waste to produce methane on Earth.
- As a biofuel, processed anaerobic digestion has a highly positive net energy outcome compared to production of ethanol or butanol through fermentation.

  "Using human feces is more of a mindset issue. If human feces could be used in anaerobic digesters, it would solve many problems—such as the increasing load on sewage treatment plants,"

- Even though beneficial, the uptake of this technology has not been as widespread as expected. "One of the reasons is the lack of appropriate digester vessel designs for certain types of wastes." ##

ROBOTICS

Flexible 'Tentacle Robots' Could Aid Planetary Exploration

http://www.space.com/27399-**tentacle-robots-planetary-exploration**.html

OCT 10, 2014 - Space robots will soon look sleeker and slinkier, with new types of robotic systems **inspired by elephant trunks, octopus arms and giraffe tongues** coming online. These flexible, maneuverable "**tentacle robots**" will have a variety of space applications, from inspecting hard-to-reach gear on the Space Station to exploring crevices on Mars - all things that would be difficult for a conventional robot to do.

A new kind of robot

"Conventional assembly line robots" made around the world are usually "anthropomorphic, with a human-like arm, designed to do one thing and do it well, over and over again. They perform precision tasks in highly structured environments, with limited flexibility and adaptability.

Left: Flexible 'tentacle robots' can stack cones and perform other complex tasks

Right: Robotic systems inspired by elephant trunks, octopus arms and other structures found in nature could have a variety of space applications.

A Different paradigm

The new goal is "something that can adapt its shape and be able to adapt to environments not seen before. These one-of-a-kind robots are a non-factory product, at least at first in the highly experimental stage.

- "Snakelike robots" could aid spaceflight and exploration in "difficult areas" like rock cracks on the Moon, Mars and other alien worlds, gathering intriguing data about environments that would otherwise be inaccessible or dangerous to explore.
- Relatively stout tentacle robots could help rovers anchor themselves if needed.
- They could reach out and grab things to use it as a tunable hook for stability, as some monkeys do with their tails \
- Lithe, flexible robots could check the outside of the Space Station for damage caused by micrometeoroid strikes, serving as useful general-purpose tools wielded by astronauts or by NASA's humanoid robot Robonaut 2, to help the human crew perform menial tasks.
- They could have a robot lasso, or robot rope, as part of their toolkit to use in some situations.

Making progress

- Serious work started on tentacle robots about 15 years ago, making a lot of progress since then
- And machines inspired by elephant trunks, climbing vines and octopus arms, and other structures found in nature.
- The "Octarm" project, 2003-07, produced a pneumatically actuated "octopus-arm" that could grab and stack cones of varying sizes, explore tunnel-like environments and manipulate objects it had never encountered before even while submerged in water.

- Such machines are inexpensive and easy to build, if the designers know what they're doing. Octarm-cost just a few thousand dollars all told.
- Mechanically, these things are cheap and very versatile in what they can do, but the trick is "to extract that performance from it - "How much does it need to know?"
- "Tentacle robot researchers know an incredible amount more now than we did five years ago"
- We might soon see things that look intelligent and intelligent in a decade. ##

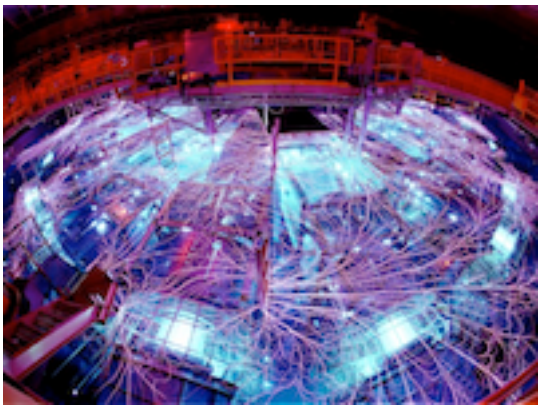
ENERGY PRODUCTION & ROCKET TECHNOLOGY

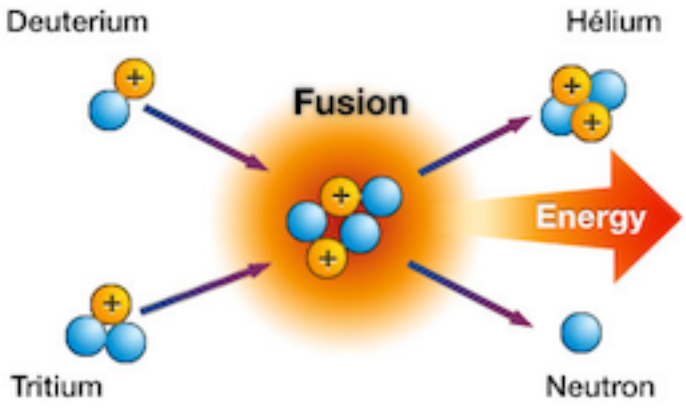
Z machine makes progress toward nuclear fusion

http://news.sciencemag.org/physics/2014/10/z-**machine-makes-progress-toward-nuclear-fusion**

OCT. 10, 2014 - Scientists are reporting a significant advance in the quest to develop an alternative approach to nuclear fusion.

Researchers at Sandia National Lab in Albuquerque, New Mexico are using the lab's Z machine, a colossal electric pulse generator capable of producing currents of tens of millions of amperes, andhave detected significant numbers of neutrons—byproducts of fusion reactions—coming from the experiment. This demonstrates the viability of their approach and marks progress toward the ultimate goal: **producing more energy than the fusion device takes in.**





Sandia Labs' multimillion-amp pulse generator "Z machine", is being used in the race to achieve fusion.

Fusion is a nuclear reaction that releases energy -- not by splitting heavy atomic nuclei apart—as in nuclear fission power stations—but by fusing light nuclei together. The approach is appealing as an energy source because

- The fuel (**hydrogen**) i**s plentiful and cheap**, and
- The **fusion process does not generate any pollution or long-lived nuclear waste.**

Atomic nuclei are positively charged and thus repel each other, so it is hard to get them close enough together to fuse. For enough reactions to take place, the hydrogen nuclei must collide at velocities of up to 1000 km/s, and that requires heating them to more than 50 million °C. At such temperatures, gas becomes plasma—nuclei and electrons knocking around separately—and **containing it becomes a problem**, because if it touches the side of its container it will instantly melt it.

Fusion scientists have been laboring for more than 60 years to find a way to contain super hot plasma and heat it till it fuses. Most efforts are now focused on one of two approaches:

- **Tokamak reactors**, like the international ITER fusion project in France, hold a diffuse plasma steady for seconds or minutes at a time while heating it to fusion temperature.
- **Laser fusion devices**, such as the National Ignition Facility in California, take a tiny quantity of frozen hydrogen and crush it with an intense laser pulse lasting a few tens of billionths of a second to heat and compress it.
- Neither technique has yet reached "breakeven," the point at which the amount of energy produced by fusion reactions exceeds that needed to heat and contain the plasma in the first place.

The middle ground

- Sandia's technique "**magnetized liner inertial fusion (MagLIF)"**involves putting some fusion fuel, the hydrogen isotope **deuterium**, inside a tiny metal can 5 mm across and 7.5 mm tall. Researchers then use the Z machine to pass a huge current pulse of 19 million amps, lasting just 100 nanoseconds, through the can from top to bottom. This creates a powerful magnetic field that crushes the can inward at a speed of 70 km/s.

Meanwhile, the researchers do two other things:

- Preheat the fuel with a short laser pulse
- Apply a steady magnetic field, which acts as a straitjacket to hold the fusion fuel in place. Crushing the plasma also boosts the constraining magnetic field, from about 10 tesla to 10,000 tesla. This constraining field is key, because without it there is nothing to hold the superheated plasma in place other than its own inward inertia. Once the compression stops, it would fly apart before it has time to react.

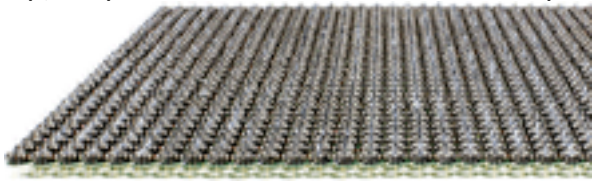
A major achievement

- Sandia researchers had heated the plasma to about 35 million °C and ~2 trillion neutrons coming from each shot. (One reaction of fusing two deuteriums produces helium-3 and a neutron.)
- Although the result shows that a substantial number of reactions is taking place—100 times as many as the team achieved a year ago—the group will need to produce 10,000 times as many to achieve breakeven. "It is good progress but just a beginning"
- Also detected were neutrons coming from the fusion of deuterium and tritium, another hydrogen isotope. The intense constraining magnetic field forces the tritium to follow a tight helical path in which it is much more likely to collide with a deuterium and fuse again.
- Researchers detected 10 billion neutrons from deuterium-tritium (D-T) fusions. "highly suggestive that the original [10 tesla] field was frozen in the plasma, reaching values of [c. 9000 tesla] at stagnation"
- Simulations suggest that the Z machine's maximum current of 27 million amps should be enough to reach "**breakeven**."
- Researchers have set their sights on a hoped-for upgrade to 60 million amps to boost the power output into a "high gain" realm of 1000 times input—a giant step toward commercial viability. ##

Cooperative 'bots' don't need a boss

DEC. 19, 2014 - http://www.sciencemag.org/content/346/6216/1444.full

- Robots are getting better all the time at working with humans
- But this year several teams demonstrated that these machines can also work together, without human supervision.
- Researchers have come up with new software and interactive robots capable of cooperating on rudimentary tasks.
- In one study, a thousand robots the size of U.S. quarter coins came together like a marching band to form squares, letters, and other 2D formations.
- The sheer scale required cheap, easy-to-run robots that can efficiently sense where other robots were.



Small, disk-shaped robots that maneuver in formation are
just one example of the year's progress in self-organizing machines

- In another project, 10 quadcopters radioed their locations to one another and adjusted their paths to avoid collisions and fly in formation, creating a rotating circle.
- A third group of robots, inspired by termites, was programmed to build simple structures cooperatively by sensing progress and inferring what the next step needed to be.
- In yet another experiment, a fleet of robotic boats performed relatively sophisticated group maneuvers, albeit under the command of a central computer that tracked them with a special camera system.
- So far, all the collaborative robots rely on relatively crude, local information about their environment and one another, but both they and their sensors are improving rapidly.
- More, and increasingly impressive, cooperative feats undoubtedly lie ahead. ##

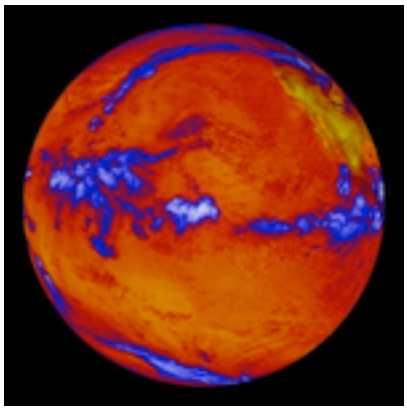
MISSION TO PLANET EARTH

NASA Study Finds Earth's Ocean Abyss Has Not Warmed

www.nasa.gov/press/2014/october/**nasa-study-finds-earth-s-ocean-abyss-has-not-warmed**/

OCT. 6, 2014 RELEASE 14-272 - The cold waters of Earth's deep ocean have not warmed measurably since 2005, according to a new NASA study, leaving unsolved the mystery of why global warming appears to have slowed in recent years.

- Scientists at NASA's Jet Propulsion Laboratory (JPL) analyzed satellite and direct ocean temperature data from 2005 to 2013 and found the ocean abyss below 1.24 miles (6,570 ft.=1,995 meters) has not warmed measurably.
- But the sea level is still rising.
- In the 21st century, greenhouse gases have continued to accumulate in the atmosphere, just as they did in the 20th century, but global average surface air temperatures have stopped rising in tandem with the gases.



Left: While the upper part of the world's oceans continue to absorb heat from global warming, ocean depths have not warmed measurably in the last decade. This image shows heat radiating from the Pacific Ocean as imaged by the NASA's Clouds and the Earth's Radiant Energy System instrument on the Terra satellite. (Blue regions indicate thick cloud cover.)

Right: Deep sea creatures, like these anemones at a hydrothermal vent, are not yet feeling the heat from global climate change. Although the top half of the ocean continues to warm, the bottom half has not increased measurably in temperature in the last decade.

- The temperature of the top half of the world's oceans -- above the 1.24-mile mark -- is still climbing, but not fast enough to account for the stalled air temperatures.
- Many processes on land, air and sea have been invoked to explain what is happening to the "missing" heat. One of the most prominent ideas is that the bottom half of the ocean is taking up the slack, but supporting evidence is slim.
- This latest study tests the idea using satellite observations, as well as direct temperature measurements of the upper ocean, with a network of 3,000 floating temperature probes called the Argo array.
- Water expands as it gets warmer. The sea level is rising because of this expansion and the water added by glacier and ice sheet melt.
- To arrive at their conclusion, the JPL scientists did a straightforward subtraction calculation, using data for 2005-2013 from the Argo buoys, NASA's Jason-1 and Jason-2 satellites, and the agency's Gravity Recovery and Climate Experiment (GRACE) satellites.
- From the total amount of sea level rise, they subtracted the amount of rise from the expansion in the upper ocean, and the amount of rise that came from added meltwater. The remainder would tell us the amount of sea level rise caused by warming in the deep ocean.
- The remainder was essentially zero. Deep ocean warming contributes virtually nothing to sea level rise during this period.
- During the same period warming in the top half of the ocean continued unabated, an unequivocal sign that our planet is heating up.

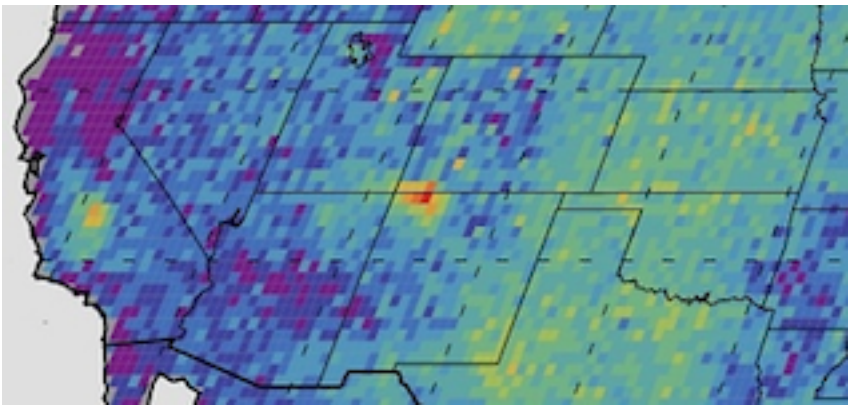
- Some recent studies reporting deep-ocean warming were, in fact, referring to the warming in the upper half of the ocean but below the topmost layer, which ends about 0.4 mile (700 meters) down.
- Before Argo floats were deployed, temperature measurements in the Southern Ocean were spotty.
- Using satellite measurements and climate simulations of sea level changes around the world, the new study found the global ocean absorbed in those 35 years was 24-58 % more than early estimates.
- Both papers from the newly formed NASA Sea Level Change Team, used NASA satellite data to improve the accuracy and scale of current and future estimates of sea level change. ##

Satellite Data Shows U.S. Methane 'Hot Spot' Bigger than Expected

www.nasa.gov/press/2014/october/satellite-data-shows-us-methane-hot-spot-bigger-than-expected/

OCT. 9, 2014 - RELEASE 14-280 - One small "hot spot" in the U.S. Southwest is responsible for producing the largest concentration of the greenhouse gas methane seen over the United States - **more than triple the standard ground-based estimate** -- according to a new study of satellite data by scientists at NASA and the University of Michigan.

- Methane is very efficient at trapping heat in the atmosphere and, like carbon dioxide, it contributes to global warming.
- The hot spot, near the Four Corners intersection of Arizona, Colorado, New Mexico and Utah, covers only about 2,500 square miles (6,500 square kilometers), or half the size of Connecticut.
- In each of the seven years 2003-2009, the area released about 0.59 million metric tons of methane into the atmosphere, almost 3.5 times the estimate for the same area in the European Union's widely used Emissions Database for Global Atmospheric Research.



Full image: http://www.nasa.gov/sites/default/files/thumbnails/image/14-280.jpg
(**dark colors** are lower than average; **lighter colors** are higher)

The Four Corners area (red) is the major U.S. hot spot for methane emissions in this map showing how much emissions varied from average background concentrations 2003-9

- Researchers used observations made by the European Space Agency's Scanning Imaging Absorption Spectrometer for Atmospheric Chartography (SCIAMACHY) instrument, which measured greenhouse gases from 2002 to 2012.
- The atmospheric hot spot persisted throughout the study period.
- To calculate the emissions rate required to produce the observed concentration of methane in the air, the authors performed high-resolution regional simulations using a chemical transport model, which simulates how weather moves and changes airborne chemical compounds.
- The study period predates the widespread use of hydraulic fracturing, known as fracking, near the hot spot. This indicates the methane emissions should not be attributed to fracking but instead to leaks in natural gas production and processing equipment in New Mexico's San Juan Basin, the most active coal bed methane production area in the country.
- Natural gas is 95-98 percent methane. Methane is colorless and odorless, making leaks hard to detect without scientific instruments.
- The results indicate that emissions from established fossil fuel harvesting techniques are greater than inventoried.

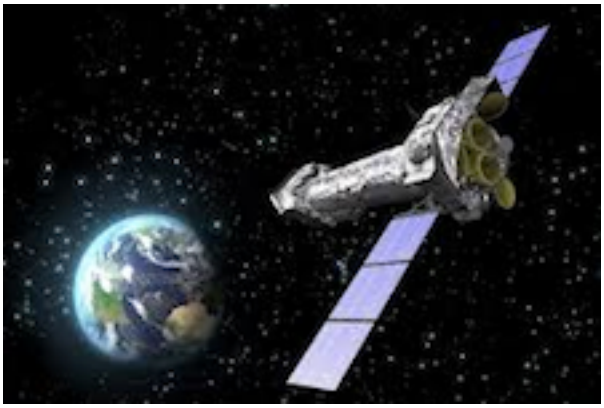
- **Coalbed methane** is gas that lines pores and cracks within coal.
- After the U.S. energy crisis of the 1970s, techniques were invented to extract the methane from the coal and use it for fuel.
- By 2012, coalbed methane supplied about 8 percent of all natural gas in the United States.
- The study demonstrates the unique role space-based measurements can play in monitoring greenhouse gases.
- "Satellite data cannot be as accurate as ground-based estimates, but from space, there are no hiding places,"
- NASA monitors Earth's vital signs from land, air and space with a fleet of satellites and airborne and ground-based observation campaigns.
- NASA develops new ways to observe and study Earth's interconnected natural systems with long-term data records and computer analysis tools to better see how our planet is changing.
- NASA shares this unique knowledge with the global community and works with institutions in the US and around the world that contribute to understanding and protecting our home planet. ##

Venezuela to build satellite "Sucre" in 36 months with China's help

http://www.spacedaily.com/reports/**Venezuela_to_build_satellite_Sucre_in_36_months_with_Chinas_help**_999.html

OCT. 8, 2014 - The manufacture and launching of Venezuela's third satellite will take some 36 months with the help of Chinese technology.

- The Sucre satellite, named after the independence hero Antonio Jose de Sucre, will have remote sensing capacities and support such strategic areas as **health, energy, food security, border surveillance and agricultural planning**



- The satellite will expand the nation's capacity for planning and research.
- Sucre's camera will take higher definition images up to one meter from the surface.
- It will have greater transmission capacity, memory storage and new generation batteries
- Part of the satellite's production will be finished inside Venezuela, at a design center in the central region in January 2015.
- Over 200 Venezuelan technicians, rained in China and are now qualified in satellite operation.
- Venezuela's first satellite, a telecom satellite named after independence leader Simon Bolivar, was launched from China in 2008.
- Venezuela's second satellite, a remote sensing satellite named after independence hero Francisco de Miranda, was launched into space also from China in 2012.
- The second satellite is mainly used for the country's land resource inspections, environmental protection, disaster detection and management, crop yield estimation and city planning.
- China has aided Venezuela in building and launching all its satellites with its mature technology. ##

[Most of the "editor's summaries" of news articles are in the form of bullet points of the contents.
For the full text, see the links cited. - Peter Kokh kokhmmm@aol.com]

NEAR SPACE & SPACE TOURISM

Dream Chaser Teams with Stratolaunch to Carry People into Space

www.space-travel.com/reports/**Dream_Chaser_Teams_with_Stratolaunch_to_Carry_People_into_Space_999.html** http://www.space.com/27349-**dream-chaser-space-plane-stratolaunch**.html

OCT. 3, 2014 - The Dream Chaser, a reusable crewed space shuttle currently under development by Sierra Nevada Corporation, may one day carry people into space with the help of Stratolaunch's massive carrier plane, the brainchild of aviation legend Burt Rutan and Microsoft co-founder Paul Allen.

Left Stratolauncher **Right:** Dream Chaser piloted mini-shuttle

The Stratolaunch carrier plane with six Boeing 747 engines will be "the largest aircraft ever constructed," has been in the works since its first announcement at the end of 2011 and is designed to carry a 222 metric ton (245 US ton) rocket - or now the scaled Dream Chaser - to high altitude for a launch into orbit.

The news comes on the heels of Sierra Nevada Corporation's announcement that it will legally challenge NASA's decision to snub the company's bid for a Commercial Crew Transportation contract in favor of the competition's two other proposals, submitted by Boeing and SpaceX.

Despite that setback, the company plans to build a scaled version of the Dream Chaser that can be used with the Startolaunch plane to

- Carry three people into space
- Serve a variety of unmanned cargo or research missions.
- Provide a highly responsive capability with the potential to reach a variety of LEO destinations and return astronauts or payloads to a U.S. runway within 24 hours,.
- The original Dream Chaser, which has been undergoing development and flight testing for the past four years, has seating for up to seven and is designed to launch from an Atlas V rocket.
- The Stratolaunch carrier plane powered by six Boeing 747 engines will be "the largest aircraft ever constructed, It ##

Virgin Galactic SpaceShipTwo Spacecraft Crashes During Test Flight One pilot dead, other injured

OCT. 31, 2013 - www.space.com/27617-**virgin-galactic-spaceshiptwo-test-flight-anomaly**.html
www.space.com/27618-**virgin-galactic-spaceshiptwo-crash-kills-pilot**.html
www.space.com/27624-**virgin-galactic-spaceshiptwo-crash-space-tourism**.html
www.space.com/27629-**virgin-galactic-spaceshiptwo-crash-full-coverage**.html

www.space.com/27621-**virgin-galactic-crash-commercial-spaceflight**.html

Virgin Galactic's suborbital space plane SpaceShipTwo crashed today (Oct. 31) in California during a rocket-powered test flight that resulted in the death of one pilot and injuries to the other one.

The ship "suffered **a serious anomaly" just after its rocket motor ignited for the test fligh**l. The pilots were with the Mojave, California-based aerospace company Scaled Composites, which built and is testing SpaceShipTwo for Virgin Galactic.

Envisioned at the threshold of Space

vs. Wreckage on the desert floor

Investigate, fix, move on - Virgin Galactic CEO George Whitesides said during a news conference today. "We are going to be supporting the investigation as we figure out what happened today, and we're going to get through it. The future rests, in many ways, on hard days like this. But we believe we owe it to the folks who were flying these vehicles as well as the folks who have been working so hard on them to understand this and to move forward, which is what we'll do."

Strong Interest in rides to the threshold of space

Virgin Galactic's SpaceShipTwo will carry six passengers up past 100 km (328,000 ft altitude, the point where astronaut wings are awarded. The new craft is launched from an airplane, fires a rocket to gain altitude, then re-enters the atmosphere and glides to a landing.A ticket to ride SpaceShipTwo currently sells for **$250,000**; to date, **more than 700 people have put down deposits to reserve a seat**.

More on SSII **www.space.com/17994-how-virgin-galactic-spaceshiptwo-works.html**

Virgin Galactic Spaceship Broke Apart in Flight Before Crash: NTSB

NOV. 1, 2014 - www.space.com/27635-virgin-galactic-spaceship-broke-apart-ntsb.html

www.space.com/27632-**spaceshiptwo-crash-ntsb-holds-first-press-briefing-video**.html

http://www.space.com/27630-**virgin-galactic-spaceshiptwo-crash-reactions**.html

The debris field measures about 8 km (5 mi) from end to end — so large that the suborbital space plane could not have come down in one piece. "That spread of the debris field tells us that **it was an in-flight separation**, Why did that happen? That's what investigators are examining."

Co-pilot Michael Ashbury died in the crash, while Flight Operations Peter Seibold survived.

Early NTSB SpaceShip2 Crash Report: "Pilot Error": SpaceShipTwo Feather Mechanism Deployed Prematurely

Email Source: Doug Messier – November 2, 2014, at 10:14 pm – Text follows

At a news conference Sunday in Mojave, National Transportation Safety Board Acting Director Christopher Hart said that SpaceShipTwo's feathering system deployed in flight prematurely on Friday, causing the spacecraft to break apart 11 seconds into a powered flight.

"... cockpit video showed co-pilot Mike Alsbury, who died in the crash, moved one of the two levers needed to deploy the system nine seconds into the engine burn when the ship was traveling at Mach 1. He pulled the lever to unlock the feather system.

"The system is designed to be deployed at Mach 1.4 when it is in a safer attitude and in thinner air. The slipstream tore off the tail booms, and SpaceShipTwo disintegrated in two seconds.

"The mystery is why the tail booms moved. The pilots must move two levers in the cockpit for the feathering system to be deployed. The video shows the other lever, which is used to deploy the booms, was never moved. This was a statement of fact – Alsbury unlocked the feather system and the booms deployed – and not a conclusion about what caused the deployment.

"The ship's engine, fuel and oxidizer tanks were all recovered intact as part of a large piece of debris. They showed no sign of malfunctioning; all indications are that the engine burn went as planned. It was the first in-flight test of a new nitrous oxide/methane/plastic hybrid motor.

"Months of investigation are still required to determine a root cause. Investigators will review pilot training, safety procedures and other issues. The full investigation is expected to take a year." ##

Roscosmos Disavows Plan to Send Space Tourists to Moon

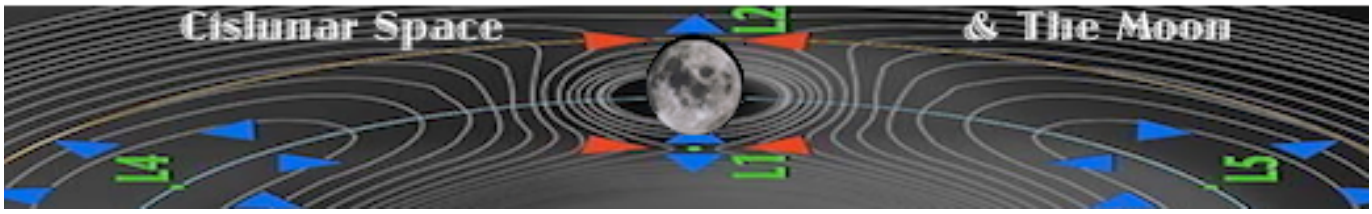
http://www.themoscowtimes.com/business/article/**roscosmos-disavows-plan-to-send-space-tourists-to-moon**/502381.html – Published in June, but overlooked by the editor, so printed now.

Russia's Energiya Space Company and U.S.-based space tourism firm Space Adventures expect to ferry two tourists around the Moon and Back in the 2017-18 time frame. Space Adventures claims that it has already found two people who are willing to splurge on the $150 million tickets.

But Roscosmos, the Russian government space agency, wants nothing to do with this plan, says it would cost a billion dollars plus – a lot more than the $300 million tourist fares to be collected, and would require a whole new habitation module yet to be designed and built.

If the first flight were followed by several others, a profit might be possible. As to the target date, Roscosmos points out "everything needs to be tested first, you cannot send out a tourist right away." ##

Xcor's Lynx Space Plane Taking Shape



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For the full text, see the links cited. - Peter Kokh kokhmmm@aol.com]

CISLUNAR SPACE & THE MOON'S "MINI-MOONS"

Mystery Mini Moons: How Many Does Earth Have?

http://news.discovery.com/space/asteroids-meteors-meteorites/**asteroid-capture-earth-gravity-satellite-mini-moon**-130207.htm

Small asteroids pass close to Earth fairly often,
But how many of small space rocks are captured by Earth's gravity?

The "mini-moons" don't stay for long.

- Within a year or so they resume their looping, twisting paths around the sun.
- But others arrive to take their place.
- Simulations show that two asteroids the size of dishwashers and a dozen half-meter (1.6 feet) in diameter are orbiting Earth at any given time.
- Every 50 years or so something the size of a dump truck arrives.
- Mini-moons are difficult to find - they only hang around for a relatively short time, 6-18 months.
- So far, there's been just one confirmed sighting.

Proposals to visit a "mini-moon"

- "We'd eventually like to see a mission to a mini-moon," astronomer Robert Jedicke, U, Hawaii, at a workshop in Huntsville, AL, to discuss proposals for two spare Hubble-class spy telescopes donated to NASA by the National Reconnaissance Office.
- One of these two telescopes could hunt for near-Earth objects, such as mini-moons, which could then be captured whole and brought to the ground for study.

Such a "mini-moon" could prove to be "the Rosetta stone of the solar system. You bring back a chunk of material that's never been processed through the atmosphere, that's not been sitting on the ground. It's going to be a tremendous wealth of information about how the solar system formed -- even more so if you can bring back more than one and get different types of material."

"The great thing is you don't have to go very far. These things are sitting there right in geocentric orbit and are relatively easy to get to."- astronomer Robert Jedicke, U. Hawaii

Hard to find.

- In theory, a cloud of temporarily captured asteroids circles Earth at all times
- But generally, the largest object is just about a meter (3 feet) in diameter
- Really difficult to detect with current technology.
- For a short time easily accessible for both scientific study and possibly eventually, resource utilization.
- So far the only **confirmed** captured asteroid orbiting Earth was **2006 RH120**, most recently visited from September 2006 to June 2007. Follow-up observations by ground-based radars determined the object was not metallic. - http://en.wikipedia.org/wiki/**2006_RH120**

[grainy photo of this 2006 RH120: diameter c. 5 meters (5.5 yards) - rotating every 2.75 minutes, ordinarily orbiting the Sun but makes close approaches to the Earth-Moon system every twenty years or so,[5] when it can temporarily enter Earth orbit - most recently Sept 2006 - June 2007.]

Potential Value of "Temporarily Captured Objects" (TCOs)

- Easily accessible for both scientific study
- Possibly, eventually, resource utilization. "We would want to discover one of these as soon after capture (by Earth's gravity) as possible to have enough time to get a spacecraft out there, and then still have time to study the object before it escapes back into heliocentric orbit"
- Two U.S. firms, **Planetary Resources** and **Deep Space Industries**, announced plans last year to mine asteroids for raw materials. Both companies are developing precursor missions to scout good targets.
- It might not pay to mine a half-meter diameter wide asteroid, but we could test out your techniques on one ##

THE MOON

We insist on capitalizing "Moon" when it refers to Earth's satellite. Read why:
http://www.moonsociety.org/info/capiltal-M-for-Moon.html

ANALOG STATION PROPOSALS

www.LunarCOTS.com – read about it – sign the petition! – donate if you can.

Commercial development of cis-lunar space including:

- Cis-lunar transportation
- Lunar surface equipment
- Harvesting of lunar polar ice
- Orbital propellant and servicing depots
- An initial crewed lunar base to support ice harvesting and processing operations.

Lunar COTS (LCOTS) is a term to describe

- A public-private funding approach for the development of
- An infrastructure based upon the use of lunar polar ice
- To facilitate transportation throughout cis-lunar space.
- It would be the logical follow-on approach to NASA's current commercial partnership programs.
- By helping to establish such a commercial infrastructure, the sustainable, permanent opening and settlement of the solar system can be achieved.

The Four Components of Lunar COTS

1) Commercial Cis-lunar Transportation Service
2) Commercial Lunar Surface Infrastructure
3) Commercial Cis-lunar Supply
4) Commercial Lunar Crew

The Petition "We, the undersigned, urge the establishment of NASA programs for the commercial development of cis-lunar space including:"

- Cis-lunar transportation
- Lunar surface equipment
- Harvesting of lunar polar ice
- Orbital propellant and servicing depot
- An initial crewed lunar base to support ice harvesting and processing operations

Specifically we urge the establishment of the following programs:

- Commercial Cis-lunar Transportation Service
- Commercial Lunar Surface Operations

- Commercial Cis-lunar Supply Service (lunar and orbital)
- Commercial Lunar Crew

We believe that these programs will

- Serve the needs of NASA
- Serve and expand commercial markets
- Permanently and economically open the Solar System to human settlement

Note: This item was sent to the editor by Doug Plata, MD, MPH, **dougspace007@gmail.com** who writes:

"I am looking into the possibility of **establishing a rudimentary, inflatable lunar habitat analogue in the Tucson area** for the purposes of:

- S**imulating the establishment of a lunar base** in conjunction with scenarios for Return to the Moon Conferences in Arizona starting in 2015 and
- **A facility to help develop a variety of operations associated with progressively making a small, initial, permanent base increasingly mass independent from Earth**.

We have **a basic design** which I call a "**UniHab**" which is **a single, inflatable complex including**;

- **Bedrooms**
- **Large greenhouse**
- **Living areas** (living room and kitchen),
- **Laboratory**
- **Sanitation** and life-support facilities,
- **Garage**,
- **Dirty room** for cleaning dust.

I think that such a UniHab could be easily constructed on an illustration basis fairly easily and for a modest amount of money." Doug Plata dougspace007@gmail.com

EDITOR: The above functions include all those provided at the Mars Society's two analog facilities in Utah and on Devon Island in Canada.: The structural design, however, promises to be quite different. Our own concepts of a lunar analog facility are much more elaborate: see:

http://www.moonsociety.org/presentations/pdf/AnalogMoonbaseProposal.pdf ##

LUNAR SCIENCE

Moons Can Help Planets Remain Stable Long Enough for Life to Form

http://www.spacedaily.com/reports/**Moons_Can_Help_Planets_Remain_Stable_Long_Enough_for_Life_to_Form**_999.html - OCT. 14, 2014

Editor: This article builds on the Moon's role in keeping Earth in a stable orbit and so belongs here. But the article also explains how moons can stabilize other extra-solar Earth-like planets so that life has a chance to form on them also. Bullet version of the article, with same title in the STARBOUND section below.

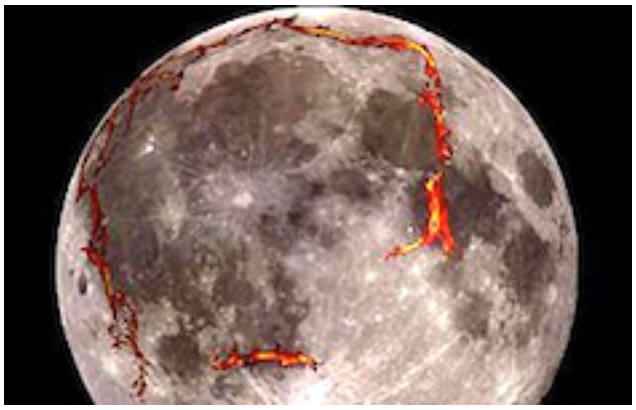
Origin of Moon's 'Ocean of Storms' uncovered

OCT. 3, 2013 - www.space-travel.com/reports/**Origin_of_moons_ocean_of_storms_revealed**_999.html

Oceanus Procellarum, a vast dark patch visible on the western edge of the Moon's near side, has long been a source of mystery for planetary scientists. Some have suggested that the "ocean of storms" is part of a giant basin formed by an asteroid impact early in the Moon's history. But **new research published in Nature deals a pretty big blow to the impact theory.**

Based on data from NASA's GRAIL mission, a new study found a series of linear gravitational anomalies forming **a giant rectangle, nearly 1,600 miles across, running beneath the Procellarum region**. Those anomalies appear to be the **remnants of ancient rifts in the Moon's crust**.

- The rifts provided a vast "magma plumbing system" that flooded the region with volcanic lava between 3 and 4 billion years ago. That lava solidified to form the dark basalts seen from Earth.
- The shape of the underlying gravity anomalies cast doubt on impact hypothesis.



Full Moon as seen from Earth. Gravitational anomalies surround the Procellarum region are superimposed in red. New research suggests these anomalies were once the source of a massive lava flow on the Moon.

- Instead of a central circular gravity anomaly like all other impact basins, at Procellarum we see these linear features forming a huge rectangle, indicating an internal origin and suggests internal forces.
- This process may have been driven by geochemical composition of the lunar crust in Procellarum.
- Early in its history, the Moon was entirely covered in molten magma, which slowly cooled to form the crust. However, the Procellarum region is known to have a high concentration of uranium, thorium, and potassium, radioactive elements that produce heat that may have caused Procellarum to cool and solidify after the rest of the crust had already cooled.
- When Procellarum did finally cool, shrink and pull away from the surrounding crust, it formed giant rifts seen in the new data, and magma flowed into those rifts and flooded the region.

"We think this is a really good, testable alternative to the impact basin theory. Everything we see suggests that internal forces were critical in the formation of Procellarum."

- **New mission, old debate**
  The familiar face of the Moon's near side is dominated by the lunar maria, the dark mostly circular patches etched across the surface- like Mare Serenitatis (Sea of Serenity), Mare Imbrium (Sea of Rains), and Mare Crisium (Sea of Crises) have been shown to be impact basins that later filled with volcanic lava, which eventually cooled to form the dark basalts. Samples gathered during the Apollo missions, and data gathered by subsequent unmanned missions, helped to confirm that idea.
- Oceanus Procellarum is shaped like a horseshoe, while other basins are round. Procellarum also lacks the telltale signs of an impact basin: surrounding mountains and radial grooves scoured by ejecta,
- The idea that Procellarum was indeed formed by an impact surfaced in the mid-1970s. “Procellarum looked different simply because it was much older than the other basins.” The telltale mountains and grooves had been eroded away, and debris had partially filled the basin's midsection, giving it the horseshoe shape.
- Signatures at the surface become degraded over time. Settling the debate required a mission like GRAIL, the twin GRAIL spacecraft orbiting the Moon in 2012, made detailed maps of the Moon's gravity, revealing important details about the Moon's subsurface crust.
- Apollo 15 Commander David R. Scott, explored the Hadley-Apennine region at the edge of the Imbrium basin in 1971 and noted,”it was very clear that Oceanus Procellarum differed in many ways from the circular maria in terms of its volcanic and tectonic activity.
- After so many years of puzzling, GRAIL has provided the data to show why it is so distinctly different."
- The results from this study show the remarkable extent to which internal processes can alter the surface of a planetary body. The data generated here will be helpful in understanding the evolution of other planets and moons, and aid in the continuing exploration of our own Moon. ##

Moon's Long-Ago Magnetic Field May Have Trumped Earth's

DEC 4, 2014 - www.space.com/27927-**moon-magnetic-field-mystery**.html

The Moon today does not have a global magnetic field. But moon rocks collected by Apollo astronauts suggest that it once had a magnetic field billions of years ago, one stronger than Earth's is now.

- Many mysteries remain, such as what powered it and when it died out.
- Scientists have been uncertain whether the Moon generated a magnetic field the same way Earth does, or if the magnetic fields seen on the Moon were instead produced by outside forces.
- The lunar magnetic field did not disappear completely after 3.5 billion years ago, but persisted, albeit at least 10 times weaker, until at least about 3.2 billion years ago.
- Cosmic impacts on the Moon could have sparked super-heated plasma that generated strong, brief magnetic fields, explaining the magnetized rocks the astronauts found.
- In the past few years, a new generation of scientific techniques and computer simulations has made a strong case that the Moon may have had a magnetic core like Earth's, generated by electric currents.
- Flowing metal in Earth's core makes the heart of the planet a dynamo — a generator of electrical current — and this dynamo generates Earth's magnetic field.
- If the Moon had a dynamo generating a magnetic field, that could yield clues to its inner structure.
- The defining question of lunar science even before the Apollo missions, is to what extent is the Moon an unmelted primordial body like many asteroids, as opposed to a melted evolved body with a multilayered structure, which can have a metallic core with a magnetic field.
- The Moon is intermediate between a planet and an asteroid, so establishing whether the Moon had an ancient dynamo could help show that it was a highly evolved body differentiated into layers like Earth.
- This would tell you about the origin of the Moon — some models say the Moon started off cold and unmelted, while others suggest it was created from a giant impact and predict it should have been hot.
- Recent scans of magnetized lunar rocks show no evidence of effects from cosmic impacts, now provide strong evidence that the Moon had a magnetic field to at least 1 billion years after the Moon formed.
- Earth’s magnetic field is currently 50 microteslas in strength, but the early Moon may have had a magnetic field that was bigger, maybe up to more than 70 microteslas.
- It's hard to understand how the Moon's magnetic field could be as strong as it seemed given its very small core, one-fifth to one-seventh the radius of the Moon, while Earth's core half Earth’s radius.
- This means the surface of the Moon is proportionately much farther away from its core than Earth is.
- Since magnetic fields fall rapidly in strength with distance, it's hard to understand how the Moon could have had a magnetic field that was that strong all the way to its surface."
- All known dynamos of planets are generally thought to be powered by convection, the roiling of fluids due to heat. Given the size of the Moon — only about a quarter of Earth's diameter — the Moon should have cooled relatively quickly. So a lunar dynamo powered solely by convection should have persisted only for a few hundred million years at most, until about 4.1 billion years ago.
- But new models suggest that that radioactive material inside the Moon could have kept it warmer.
- A convection-powered lunar dynamo could have lasted until 3.5 billion or 3.4 billion years ago.

Other more exotic mechanisms could have powered the lunar dynamo.

- "Smacking the Moon obliquely with large impacts from asteroids maybe a bunch of times"
- The Moon's spin wobbles over time, called precession, and it wobbled a lot more intensely in the past when it was closer to Earth, and that could also instill motion to power a dynamo.
- Neither of these mechanisms have been found in any planetary body today, and either would represent a new way of generating magnetic fields.

Much remains unknown about the Moon's magnetic field. "We still don't know when the lunar dynamo turned off. There's evidence it lasted until at least 3.3 billion years ago, and perhaps as long as 1.3 billion years ago, really pushing the limits of what we know can power the lunar dynamo. ##

Turning the Moon into a Cosmic Ray Detector

http://www.space-travel.com/reports/T**urning_the_Moon_into_a_cosmic_ray_detector**_999.html

SEP. 29, 2014 - Scientists from the University of Southampton, England, want to turn the Moon into a giant particle detector to help understand the origin of **Ultra-High-Energy** (**UHE**) cosmic rays - the most energetic particles in the Universe.

Dr Justin Bray, a Research Fellow in Cosmic Magnetism at the University of Southampton, is lead author of a proposal to use the Square Kilometre Array (SKA), set to become the largest and most sensitive radio telescope in the world, to detect vastly more UHE cosmic rays by using the Moon as a giant cosmic ray detector.

- The origin of UHE cosmic rays is one of the great mysteries in astrophysics. Nobody knows where these extremely rare cosmic rays come from or how they get their enormous energies. We detect them on Earth at **a rate of less than one particle per square kilometer per century.**
- Dr Justin Bray, is lead author of a proposal to **use the Square Kilometre Array (SKA)**, set **to become the largest and most sensitive radio telescope in the world,** to detect vastly more UHE cosmic rays **by using the Moon as a giant cosmic ray detector.**
- Physicists detect high-energy particles when they hit the upper atmosphere triggering a cascade of secondary particles that generate a short and faint burst of radio waves only a few nanoseconds long.
- These signals are so short and faint no radio telescope on Earth is can currently pick them up.
- The large collecting area and high sensitivity of the SKA will detect these signals using the visible lunar surface - millions of square kilometres -more data about UHE cosmic rays than ever before.
- The current largest detector on Earth is the Pierre Auger Observatory in Argentina that covers an area of 3,000 square kilometres. The SKA will be more than 10 times larger (33,0000 square kilometres)
- Researchers hope to detect around 165 UHE cosmic rays a year from the Moon vs 15-a-year currently
- Cosmic rays at these energies are so rare that you need an enormous detector to collect a significant number of them - The Moon dwarfs any particle detector that has been built so far. If we can make this work, it should give us our best chance yet to figure out where they're coming from."
- Defining science goals for the SKA telescope is crucial for ensuring that the appropriate technical capabilities are considered during the design phase

What the SKA will do

- With a network of radio antennas across Australia and Africa, the SKA will advance our understanding of how the Universe evolved and challenge Einstein's theory of relativity. Its widespread dishes and antennas will provide detailed information on **the large scale 3D structure of the Universe**.
- When operational in the early 2020's, the SKA radio telescope will produce more than 10 times the current global traffic of the Internet in its internal telecommunications system.
- **To play back a single day's worth of SKA data on an MP3 player would take 2 million years.** ##

The Water On the Moon Came from the Solar Wind not from comets

OCT. 8, 204 - http://www.space.com/27377-**moon-water-origin-solar-wind**.html
http://cms.space.com/16219-**moon-water-lunar-ice-photos**.html

- Water trapped in rocks on the Moon's surface probably originated mostly from streams of energetic particles blasted from the sun and not from cosmic impacts from comets.
- For years, scientists argued over whether the Moon harbored water or not. Recent findings confirmed that water does exist on the Moon, although its surface remains drier than any desert on Earth.

- This water could one day help support colonies on the Moon and missions to Mars and beyond.
- Where did all of this water came from?
- One possibility is that it was delivered by impacts from carbonaceous chondrites — meteorites rich in water — and from comets.
- Another is that water formed on the Moon after exposure to the solar wind — streams of high-energy particles from the Sun reacting with oxygen trapped in moon rocks to form water
- Scientists analyzed 45 microscopic grains of dust returned by NASA's Apollo 16 and 17 crew.
- They focused on levels of different isotopes of elements within these dust grains. Isotopes differ from each other in how many neutrons there are in their atoms — normal hydrogen atoms do not have any neutrons, while atoms of deuterium, an isotope of hydrogen, each possess one neutron. Water can be made with deuterium as well as with normal hydrogen.
- The sun is naturally low in deuterium because its nuclear reactions quickly consume the isotope. All other bodies in the solar system possess relatively high levels of deuterium, remnants that existed in the nebula of gas and dust that gave birth to the solar system.
- By analyzing the ratio of deuterium to hydrogen in the water in Moon dust, the researchers could deduce whether the water originated from the sun or elsewhere, such as chondrites.
- One complicating factor in this analysisis that cosmic rays — high-energy particles from deep space — can generate deuterium when they slam into the Moon.
- To account for how cosmic rays can influence deuterium levels on the Moon, the scientists also looked at levels of lithium-6, an isotope of lithium that cosmic rays would also generate when they hit the moon. By examining the ratio of lithium-6 to normal lithium, the researchers deduced how often cosmic rays struck the Moon and generated deuterium as well as lithium-6.on rocks to form water.
- The water in interiors and exteriors of these dust grains apparently came mainly from the solar wind.
- There was no chondritic signature, suggesting that any water that cosmic impacts bring to the Moon is not retained well. At most, an average of 15 % of the hydrogen in lunar soil may come from chondritic water, leaving 85% at least from the solar wind. ##

NASA Is Studying How to Mine the Moon for Water

OCT. 9, 2014 - http://www.space.com/27388-**nasa-moon-mining-missions-water**.html

- There's a lot of water on the Moon, and NASA wants to learnl how to mine it.
- It is not all in the form of ice in north and south polar craters “where the Sun never shines.”
- Scientists are developing two separate mission concepts to assess, and learn how to exploit, stores of water ice on the Moon and other lunar resources.
- “**Lunar Flashlight”** and the “**Resource Prospector”** mission are targeted for Dec 2017 and 2018
- We need to understand the **inventory** of volatiles across the whole Moon **as well as their purity, and accessibility**.

Solar sailing to the Moon

- Lunar Flashlight is **a CubeSat mission**, meaning the body of the spacecraft is tiny — about the size of a cereal box, Cohen said. But after it's deployed in space, the probe would get much bigger by unfurling an 860-square-foot (80 square meters) solar sail.
- The spacecraft would cruise toward the Moon on a circuitous route, propelled along by the photons streaming from the sun.
- Lunar Flashlight would start orbiting the Moon about six months after its launch, then spend another year spiraling down to get about 12 miles (20 kilometers) from the lunar surface.
- The probe would make about 80 passes around the Moon at this low altitude, measuring and mapping deposits of water ice in permanently shadowed craters near the lunar poles.
- It will work as a mirror - we take the sunlight, bounce it off the solar sail into the permanently shadowed regions, and we're going to use a passive infrared spectrometer to collect the light from the permanently shadowed regions in wavelengths that are indicative of water frost.
- The aim is to find water ice at the surface accessible to future explorers.

- Such deposits could provide drinking water for potential manned lunar outposts.
- Moon water could also be split into its constituent hydrogen and oxygen — components of rocket fuel, which could then spur and support exploration even farther afield,.

A water-mapping rover

- The Resource Prospector Mission (RPM) plans to send a rover onto the lunar surface to get an up-close look.
- It would land at a yet-to-be-determined polar site and map **surface and subsurface concentrations** of hydrogen **at two different locations**, ideally separated by at least 0.6 miles (1 km). RPM
- It would use a neutron spectrometer to measure water concentrations up to 3.3 feet (1 m) underground and a near-infrared spectrometer to make its surface measurements.
- The solar-powered rover would roll into permanently shadowed regions, relying on batteries to keep working in the dark.
- It would likely have an operational lifetime of about one week on the lunar surface
- Like Lunar Flashlight, RPM is geared to help enable future exploitation of water ice on the Moon.
- Resource Prospector is fundamentally about identifying, locating the 'ore' and understanding how to excavate it — how to get at it — and what does that cost in terms of energy."
- The rover would also be equipped with a drill to take samples from up to 3.3 feet (1 m) deep.
- Collected samples would be heated up in an oven, and the volatile materials such as water liberated by this process would be identified and quantified.
- RPM also plans to extract oxygen from lunar dirt to be combined with hydrogen to create water,
- A lot of technology demonstration here is not just applicable to the Moon, but to any surface where you want to manipulate materials.
- Mars is one such place. In July, NASA officials announced that its next Mars rover, to blast off in 2020, will carry an instrument that will generate oxygen from the carbon-dioxide-rich Martian atmosphere.

More missions coming?

- NASA isn't the only entity eyeing the Moon's resources. A number of private firms, including Moon Express and Shackleton Energy Co., also aim to mine and process lunar water.
- Both Lunar Flashlight and RPM are still in the concept phase, yet to be officially approved by NASA — They could bring such dreams closer to reality, by providing a better understanding of the quantity, distribution and composition of water on the Moon. ##

NASA finds Widespread Evidence of Young Lunar Volcanism

http://www.nasa.gov/press/2014/october/**nasa-mission-finds-widespread-evidence-of-young-lunar-volcanism/**

http://www.space.com/27424-**volcanoes-on-moon-dinosaur-age**.html

OCT. 12, 2014 - RELEASE 14-284 - NASA's Lunar Reconnaissance Orbiter has provided strong evidence that the Moon's volcanic activity slowed gradually instead of stopping abruptly a billion years ago.Scores of distinctive rock deposits observed by LRO are estimated to be less than 100 million years old which corresponds to Earth's Cretaceous period, the heyday of dinosaurs.

- Some areas may be less than 50 million years old.
- "This finding is the kind of science that will make geologists rewrite the textbooks about the Moon."
- The deposits are scattered across the Moon's dark volcanic plains ("maria") and are characterized by a mixture of smooth, rounded, shallow mounds next to patches of rough, blocky terrain, dubbed "irregular mare patches."
- They average less than a third of a mile (500 meters) across.
- One of the largest, a well-studied area called Ina, was imaged from lunar orbit from Apollo 15.
- A total of 70 irregular mare patches have now been identified on the Moon's nearside.
- Their large number and wide distribution strongly suggest that late-stage volcanic activity was not an anomaly but an important part of the Moon's geologic history.
- The numbers and sizes of the craters within these areas indicate the deposits are relatively recent.

The feature called Maskelyne is one of many newly discovered young volcanic deposits on the Moon. These "irregular mare patches{ are thought to be remnants of small basaltic eruptions much later than the commonly accepted end of lunar volcanism, 1-1.5 billion years ago.

- Based on a technique that links such crater measurements to the ages of Apollo and Luna samples, three of the irregular mare patches are thought to be less than 100 million years old, and perhaps less than 50 million years old in the case of Ina.
- The steep slopes leading down from the smooth rock layers to the rough terrain are consistent with the young age estimates.
- NASA's Lunar Reconnaissance Orbiter (LRO) has provided researchers strong evidence **the Moon's volcanic activity slowed gradually instead of stopping abruptly a billion years ago**.
- In contrast, the volcanic plains surrounding these distinctive regions are attributed to volcanic activity that started about 3 1/2 billion years ago and ended roughly 1 billion years ago. At that point, all volcanic activity on the Moon was thought to cease.
- The findings have major implications for how warm the Moon's interior is thought to be. The lunar mantle had to remain hot enough to provide magma for the small-volume eruptions that created these unusual young features
- The new information is hard to reconcile with what currently is thought about the temperature of the interior of the Moon.
- These young volcanic features are thus prime targets for future exploration, robotic and human ##

Tiny LunarCubes Could Explore Moon on the Cheap

AUG. 24, 2014 - http://www.space.com/17273-tiny-**lunarcubes-spacecraft-moon-exploration**.html

Low-cost CubeSat missions might help unravel some of the Moon's closely guarded secrets.

- Ultra-small and lightweight, they have demonstrated their agility to carry out space research in low-Earth orbit, typically using commercial off-the-shelf electronics.
- A move is on to consider using these miniaturized spacecraft to further Moon exploration— a new class of CubeSat dubbed LunarCubes.
- When CubeSats emerged onto the scene, and ideas began to materialize about their uses in Earth orbit, skepticism prevailed. But now that scads of CubeSat missions have been flown or are on the books, the idea of these diminutive spacecraft heading for the Moon has taken off.

More questions than answers

- Spacecraft have found the Moon to be a much more dynamic and complex place than anyone expected and have generated more questions than answers
- There are many scientific problems where one good, simple measurement could dramatically improve our understanding.
- Every mission in the last 5 years found startlingly new information. Clearly, there is a lot more to learn

Several things are happening that can advance a LunarCubes program into being.

- Numbers of boosters are already outfitted to deploy CubeSats into Earth orbit.
- Every geosynchronous Earth orbit (GEO) satellite placement is a potential lunar mission starting point, given the discovery of **weak stability boundary transfer orbits from GEO to lunar orbit.**

- There could be multiple lander opportunities in the coming years by Google Lunar X-Prize teams, each one looking for small and lightweight science payloads.

Dirt cheap

- A trio of science briefings on LunarCubes will be staged between October and April of 2015, to start building bridges between science and technical communities.

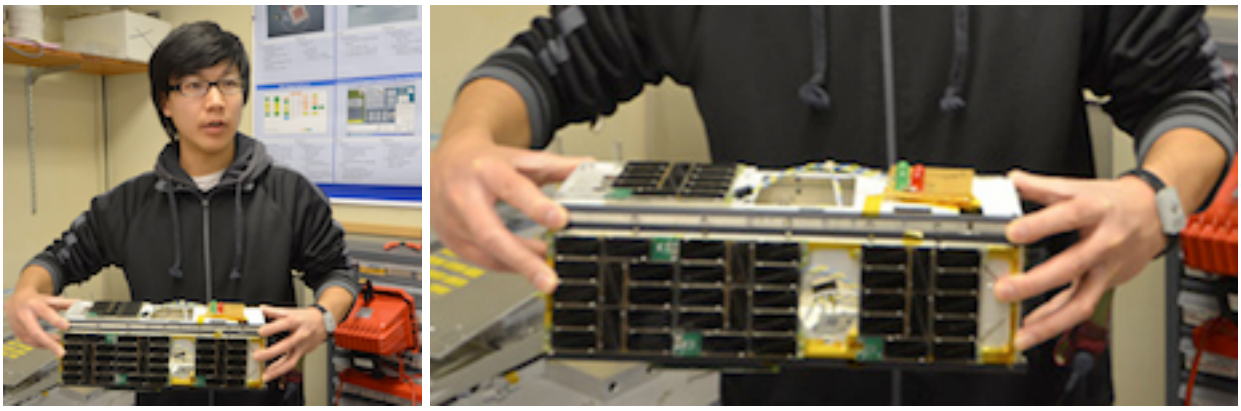
What's required for a CubeSat to operate in deep space

- The jump from CubeSats lingering in low-Earth orbit to working in deep space, means longer duration missions, taking on higher doses of radiation, and experiencing a more extreme thermal environment.
- The technology is very much there. You don't have to invent new technology to make this work.
- But this opportunity also means an increase in price to build and test a CubeSat capable of going the lunar distance.
- The dollar leap would be from an Earth-oriented CubeSat costing a few hundred thousand dollars to a Moon-bound version requiring a cash outlay of a few million dollars
- That's dirt cheap, he said, in contrast to any (regular) lunar mission that has an out-the-front-door price tag of hundreds of millions of dollars.

In a (lunar) swirl

Lunar swirls Lunar Swirls are one of the most enigmatic geologic features on the Moon. They appear as curlicues of pale Moon dust, twisting and turning across the lunar surface in some locations. Understanding their formation has implications for space weathering, lunar surface water phenomena and the history of the lunar dynamo.

- One early proposal for a CubeSat mission to the Moon is to use a mothership to release several CubeSat probes on impact trajectories into the heart of lunar swirls and measure the magnetic field, solar wind flux and dust flux, until the moment of impact.
- Ideal for this task is the National Science Foundation-funded **C**ubeSat for **I**ons, **N**eutrals, **E**lectrons & **MA**gnetic fields, or CINEMA for short, built by UC Berkeley and South Korea's Kyung Hee University and bound for Earth orbit on an Atlas V rocket now scheduled for a September takeoff from Vandenberg Air Force Base in California.

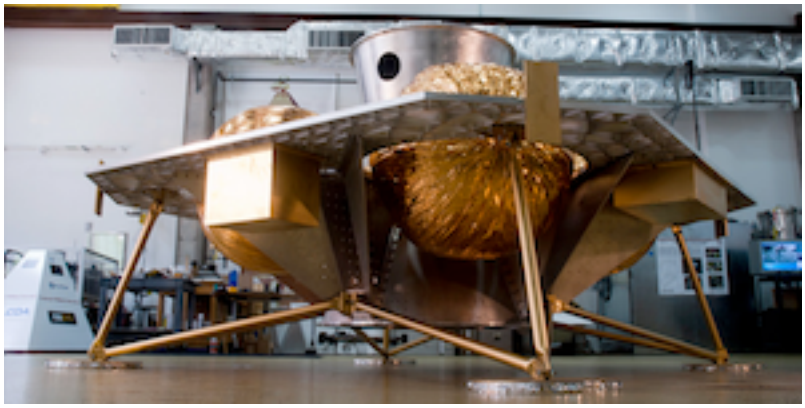


A student holds CINEMA, the CubeSat for Ions, Neutrals, Electrons & MAgnetic fields, an 8-pound, shoebox-size package. A similar type CubeSat could carry out lunar exploration in the future

Next generation lunar explorers - CubeSat Science has much potential

- Small satellites with single instruments can be targeted for specific goals, say, a neutron spectrometer to search for hydrogen in craters near the lunar poles,
- Such CubeSats may be the way in which we might continue to scientifically explore the Moon in the era of tight budgets.
- With new rockets under development that can travel to the Moon — like the SpaceX Falcon 9 and NASA's Space Launch System — and carry CubeSats as secondary payloads, there may also be numerous opportunities to deploy such small instruments in the next decade.
- **Surface science cubesat opportunities**
- Google Lunar X Prize landers could offer LunarCubes a ride down to the Moon's surface.
- They could then be catapulted off the lander,

- Or, bolted to the deck of a lander, they could look up into the sky or down at the surface
- Or drop them onto the surface – Just understanding how the exhaust plume from the lander interacted with the soil is an interesting science and engineering question.
- A deployed rover could also haul several LunarCubes to be scattered away from the exhaust plume onto a pristine lunar site.



The Griffin lander above would deploy one Google Lunar X Prize competitor's design, a mobile robot built by Astrobotic Technology Inc., a Pittsburgh, Pa.-based company. ##

Indian X-PRIZE Moon Lander To Be Launched In 2015

DEC. 17, 2014 – www.asianscientist.com/2014/12/topnews/**indian-xprize-launched-2015**/

India will be the first geographic region outside of the US to launch its own XPRIZE, tapping into the innovation potential of its 1.2 billion residents.

- XPRIZE, a global innovation competition, will give multiple prizes over the next few years, in the areas of water, energy, waste management and food & nutrition, with an anticipated first prize addressing water sustainability.
- The Indian entry hopes to launch in 2015 with the support of Coca-Cola India.
- An XPRIZE "Visioneering" event saw XPRIZE Trustees working together in brainstorming sessions to identify which of India's Grand Challenges can best be solved through incentivized prize competitions.
- Mr. Ratan Tata, chairman emeritus, Tata Sons and trustee at XPRIZE, along with Mr. Naveen Jain, founder & CEO of Inome, and Mr. Paresh Ghelani, chairman, BPG Motors have been great supporters of XPRIZE and active in bringing XPRIZE to India with the belief that the next big innovations to solve some of the world's Grand Challenges will come from India, directly impacting millions of people at the base of the pyramid. [India's population 1.25 billion (2013), will soon overtake China's 1.357 billion.]
- Through the XPRIZE effort, the team wants to tap into this potential and possibility." "**We chose India as the first geographic location outside ofern the US to launch our global development prizes because we believe India has a technological and entrepreneurial capacity like no other country in the world**." ##

Russian Luna 25 Mission to cost "Billions"

OCT. 14 2014 – www.space-travel.com/reports/**Russian_Luna_25_Mission_to_Cost_Billions**_999.html

- In September, Russian space agency Roscosmos said it was planning to launch a full-scale Moon exploration program, carried out as part of the Russian Federal Space Program for 2016-2025.
- The Luna-25 exploration mission will cost tens of billions of rubles: it will be a resource-heavy project, and complex in terms of technical feasibility.
- Russia will return to the Moon by the end of the 2020s with the Luna-Glob project: Luna-25, 26, 27, 28 and Luna-29, aimed at further exploring the Moon.
- Of these three lunar spacecraft – two will go to Moon's surface and one into orbit.
- Russia is also looking at developing space exploration plans for 2050 and beyond.
- Illustration below

##

Russians to deliver New Batch of Lunar Soil to Earth in 2023-2025

www.space-travel.com/reports/**New_Batch_of_Lunar_Soil_to_be_Delivered_to_Earth_in_2023_2025_**999.html

OCT. 14, 2014 - According to a Russian aerospace company, New samples of lunar soil will be delivered to Earth in 2023-2025, a goal of the Russian Lander Luna-27.

The soil is to be delivered in its initial state, without experiencing any temperature changes and while preserving all its particles.

Moon Exploration to be core of Russian Space Program

www.space-travel.com/reports/**Russia_to_take_Moon_exploration_as_core_of_space_program**_999.html

OCT 14, 2014 - Roscosmos has prepared a long-term program of deep space exploration, with exploration of the Moon as the core

- The new program is also aimed at exploring other planets in the Solar System.
- The program envisages building infrastructure for permanent lunar settlements near the Moon's south Pole, along with explorations using unmanned vehicles.
- Russian space industry is capable of solving technological problems met in the ambitious program.
- The first Russian manned expedition to the Moon could be launched in late 2020s.
- If conducted successfully, 40 years after the end of the U.S. Apollo program.
- Prior to any manned expedition, three probes, Luna-25, -26 and -27, would be sent.
- The last Russian (Soviet) lunar mission, Luna-24, was in August 1976, which found presence of water in samples brought back from the Moon.
- Luna-24 was also the last spacecraft to land on the Moon until China's Chang'e-3 in December 2013.

Russia Preparing Joint Moon Exploration Agreement With Europe

www.space-travel.com/reports/**Russia_Preparing_Joint_Moon_Exploration_Agreement_With_EU**_999.html - NOV. 25, 2014

Cooperation on missions to the Moon

- Russian and the European Union scientists are preparing agreement on joint exploration of the Moon.
- The exploration of the Moon and Mars is a priority for the Russian space program.
- A landing on the Moon is planned in 2030 with the subsequent deployment of a manned base
- Test sites for the accumulation and transfer of energy over large distances and new engines tests will be gradually deployed.
- Another heavy launch vehicle carrying up to 80 tons is being developed for this purpose.

Cooperation on missions to Mars

- In spring 2012, the ESA and Roscosmos agreed on the development of the so-called ExoMars program.
- The research program includes the launch of the Trace Gas Orbiter (TGO) in 2016, with the goal of collecting data on atmospheric gases present in low concentrations.
- The project also involves the exploration of ice found in the soil on Mars,
- As well as landing the ExoMars Entry, Descent and Landing Demonstrator Module (EDM).
- The Mars rover is expected to land in 2018 and perform geological analyses of the planet's soil and search for traces of life.
- Russia will create a landing deck and provide a range of unique scientific equipment for the Russian-European mission to Mars. ##

China's ailing Moon rover "Yutu" weakening

OCT. 14, 2014 - www.space-travel.com/reports/Chinas_ailing_moon_rover_weakening_999.html

China's ailing moon rover Yutu has entered its 11th dormancy as the lunar night falls, with its functions degrading. while the rover is otherwise currently in good condition and works normally, its control problem persist - it remains immobile after a short trek on its first day on the Moon.

- After going through several freezing lunar nights under abnormal status, its functions are gradually degrading.
- Immobility aside, the rover's designed lifetime was just three months, but it has survived for over nine.
- The Chang'e-3 probe was launched on Dec. 2 last year and landed on the Moon on Dec. 14.
- The rover, Yutu, named after the pet rabbit of the lunar goddess Chang'e in Chinese mythology, separated from the lander and touched down on the Moon's surface on December 15.
- Yutu's radar started working on December 15 when the lander and rover took photos of each other and beamed them back to Earth.
- The roverwas intended to roam the lunar surface, surveying the geological structure and substrate while looking for natural resources, but control problems emerged before the 2nd lunar night fell on January 25.
- Program authorities believe the problem was probably caused by the "complicated lunar surface," including stones and dust, but this has not been confirmed.
- Mission Control had hoped the rover would go farther, and they really want to find the true reason why it didn't-" Sofar, they can only try to deduce the cause via ground-based simulation.
- The follow-up Chang'e-4 mission is under further analysis.As the backup probe of Chang'e-3, Chang'e-4 will verify technology for the more sophisticated Chang'e-5/6 missions, whose tasks will include unmanned sampling and returning to Earth.
- China plans to launch an experimental recoverable moon orbiter before the end of this year to test technology vital for the success of Chang'e-5. ##

China Launches Its 1st Round-trip Mission to the Moon

OCT. 26, 2014 - http://www.space.com/27546-**china-roundtrip-moon-mission**.html
http://www.space.com/27667-**china-moon-roundtrip-mission-photos**.html

China has launched its first round-trip mission to the Moon with a robotic spacecraft, a mission that will pave the way for the country's planned lunar sample-return program.

- An advanced Long March 3C rocket launched Change'e 5 the from the Xichang Satellite Launch Center in southwest China's Sichuan Province.
- The mission is expected to last about eight days, during which the spacecraft will fly around the Moon and then return to Earth
- The goal is to test vital re-entry technologies needed for China's lunar return sample program.
- This mission will gather experimental data and confirm **re-entry technologies such as guidance.**
- **navigation and control, heat shield and trajectory design**.

- The actual sample return mission is now targeted for a 2017 flight to land on the lunar surface and snag samples for return to Earth.
- Also aboard theare the hitchiking payloads 4M, developed by LuxSpace in Luxembourg, and PS86X1 from Pocket Spacecraft — a virtual organization situated in the United Kingdom.
- The test spacecraft is expected to make a so-called "skip re-entry" to progressively slow down before landing in north China's Inner Mongolia Autonomous Region.
- The spacecraft's skip reentry must be well-controlled. "If it's too low, the probe may be burnt. If too high, it won't be able to land in the targeted area."
- This is actually China's 4th robotic flight to the Moon since the Chang'e 1 moon orbiter launch in 2007.
- Since then, China has launched Chang'e 2 in 2010, and its first Moon lander, Chang'e 3 in 2013.
- The Chang'e 3 delivered China's first lunar lander, called Yutu ("Jade Rabbit") to the Moon's surface.
- The missions are all named after the mythical goddess Chang'e, ##

China's Chang'e 5 Moon Probe Returns to Earth

NOV. 1, 2014 - http://www.space.com/27627-**china-moon-mission-earth-return**.html
http://www.spacedaily.com/reports/**China_completes_first_mission_to_moon_and_back**_999.html

China's latest Moon mission returned to Earth at around 6 a.m. Saturday local Chinese time), ending an 8-day unmanned flight designed to test technology for a future lunar sample-return project.

Chang'e 5 T1 launched on Oct. 23 atop a Long March 3C rocket, then completed a flyby of the Moon before swinging back toward home. A test capsule barreling through Earth's atmosphere Friday at 40,000 km/h (25,000 mph); the capsule survived intact and touched down as planned in north China's Inner Mongolia Autonomous Region

The future planned sample return which will involve landing on the Moon, and then launching from the Moon's surface a payload container with moondust inside. ##

U.K. group to crowd-source funding for Moon mission

www.space-travel.com/reports/**UK_group_to_crowd-source_funding_for_moon_mission_999.html**
www.bbc.com/news/science-environment-30102343

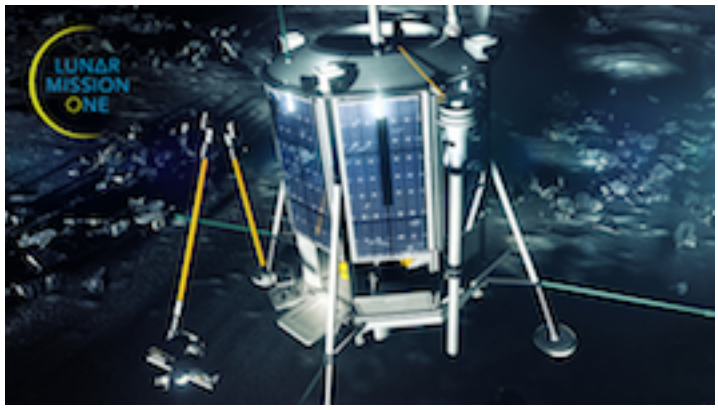
NOV. 18, 2014 - A group in the United Kingdom aims to launch a lunar probe and study the Moon using money raised on crowd-funding website Kickstarter. If this new form of funding works we'll have a legacy that shows it's possible to fund these missions very differently."

Lunar Mission One

The Moon's interior has never been sampled; The goal is to land a probe on the Moon that can **drill deep into lunar rock and collect samples.** Rocks several feet beneath the lunar could offer **new insight into the formation of the solar system.**

Getting Started:

- **The first Kickstarter goal is** to raise $1 million (637,000 **£**) on Kickstarter to earn the project some early momentum, with planning and additional fundraising set to ramp up in 2015.
- **Following through** –the group will likely have to raise s**everal hundred million more dollars**.



The Lunar Mission One lander deploys a robotic arm and drill on the Moon

Incentives

- The current incentive is the **opportunity to have one's digital and genetic likeness delivered to the Moon.** Donors who fork over $95 (60 **£**) will have their name, photos, text and even a DNA sample stored in a time capsule that will be buried on the Moon. Their Kickstarter page offers funders the **opportunity to pledge as little as $4.75 (3 £) and as much as $7,800 (5,000 £)**

Participation won't end with donation:

- "**Rather than just watching the mission, people can help make key decisions such as the selection of the landing site** or **what should be included in the public archive**."

Organizers will have to find inventive ways to keep their funders engaged, as real action isn't like to happen for at least another four years. ##

UK researchers set out goals for Lunar Mission One

DEC. 7, 2014 – http://www.bbc.com/news/science-environment-30344604
www.space-travel.com/reports/**UK_Plans_to_Drill_Into_Moon_Explore_Feasibility_of_Manned_Base_999.html**

Scientists have set out the detailed scientific goals of a proposed UK-led mission to the Moon.

Lunar Mission One: to deeply drill where no one has drilled before

- Its principal aim is to **survey the Lunar South pole** to learn more about the geology of the Moon and see if a human base can be set up in the future.
- It will also **drill 100 metres below the surface**
- And also **assess whether it is feasible to have observatories on the far side of the Moon**.
- Details of the **Lunar Mission One** programme were announced last month. [preceding story above

- Although there have been more than 50 expeditions to the Moon including six landings by Apollo astronauts there is still much to learn.
- Until recently the European Space Agency had plans for a a lunar lander (since scrapped)
- The science case for Lunar Mission One is quite similar.
- There have been no missions to the Moon's south pole.
- The South pole is a portal into the Moon's interior and its distant past as it is on the south rim the deepest known impact crater in our Solar System, around 12km deep – the "South Pole-Aitken Basin" which might contain rocks from tens of km below the surface and even part of the lunar mantle dug up by an impact more than four billion years ago.
- The deepest samples that have been obtained are from three metres below the surface, by Apollo 17 Astronauts Gene Cernan and Harrison Schmitt in 1972.
- Lunar mission One aims to drill up to 100 metres below the surface.
- The study of the rock by **the spacecraft's on board laboratory** should give a unique insight into what happened during the early days of the formation of the Moon.
- This data may shed light on what happened when the material now in the Moon was torn away from proto-Earth by a collision with anotherworld dubbed "Theia," early in the history of the Solar System.
- It will also give an indication of the depth to which water might be present. Current studies have suggested that it is in surface soils in permanently shaded polar craters.
- The depth of these deposits will determine if there is enough to support human settlement..
- The probe will also search for traces of organic (carbon) compounds which might have been reached the Moon by meteorite bombardment.
- The probe will also test the feasibility of using the site as a radio observatory as it sometimes faces away from the Earth and so is shielded from the hubbub of our planet's constant broadcast transmissions. ##

LUNAR MISSION ONE UPDATE DEC. 19, 2014 – OVER $1 MILLION RAISED VIA CROWDFUNDING

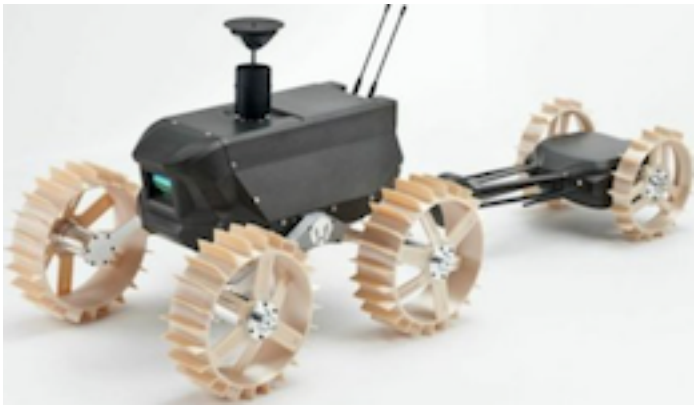
http://www.space.com/28064-**private-moon-drilling-mission-crowdfunding**.html

GOOGLE LUNAR X-PRIZE

Japan's Team Hakuto Unveils Its Rovers In The Google Space Race

OCT. 8, 2014 – www.asianscientist.com/2014/10/topnews/**hakuto-unveils-rovers-google-space-race/**

Hakuto, the Japanese team competing for the US $30 million Google Lunar XPrize, has announced new pre-flight models of its 2 moon exploration rovers: 4-wheeled "Moonraker" and 2-wheeled "Tetris." [The Google Lunar XPRIZE competition challenges privately funded teams to land a spacecraft on the Moon that, travel at least 500 m and transmits high-definition video and imagery back to Earth.]



- Hakuto has developed a small and lightweight dual rover system to fulfill the requirements of the Google Lunar XPRIZE **and, for the first time, explore caves beneath the lunar surface**.

- By conducting several experiments to prove the rovers' performance in the space environment, Hakuto is currently aiming to win one of the Google Lunar XPRIZE Milestone Prizes for mobility.
- As encouragements, Google Lunar XPRIZE introduced Milestone Prizes worth a total of US $6 million to recognize technological achievements and associated financial hurdles faced by the teams as they prepare their lunar spacecraft for the largest international incentive prize of all time.
- Hakuto, one of five teams selected to compete for the Milestone Prizes, will conduct thermal vacuum testing to prove that the rover can perform the mission in harsh conditions.
- Hakuto's rovers must be able to move more than 500 meters on the Moon's surface, which is covered in fine, abrasive sand known as regolith, while keeping away from craters and rocks.
- Hakuto has developed wheels that can run over this soft terrain and will demonstrate this capability
- Hakuto will send two rovers to the Moon to explore a lunar lava tube for the first time.

Down into a Lava Tube

- [In 2009, Japan's lunar exploration satellite, "Kaguya" (Selene), discovered holes that are thought to be caves or "skylights" into underlying lava tubes.]
- The two-wheeled "Tetris," connected by a tether to the four wheeled "Moonraker," will be lowered down through a hole on the surface to explore the caves underneath.
- Lava tubes could be very important scientifically as they could help explain the Moon's volcanic past.
- They could also become candidate sites for long-term habitats able to shield humans from the Moon's hostile environment [**cosmic rays**, micrometeorites, thermal extremes]

Construction

- The rovers' bodies are made of strong, lightweight, autoclave-molded carbon fiber reinforced plastic (CFRP) materials, commonly used in aircrafts and rockets.
- Design and production of the rover bodies were by RDS Inc., Hakuto's official partner.
- Since the launch cost increases according to mass, Hakuto has utilized Japanese expertise in down-sizing, while also incorporating many off-the-shelf commercial products to keep costs to a minimum.
- Hakuto has selected a hyperbolic mirror camera system to become the "eye" of Moonraker, which will capture high-definition, 360-degree images of the lunar surface and transmit them back to Earth as part of the Google Lunar XPRIZE "Mooncasts."
- Data from the panoramic camera and other sensors will also be used by the rover in Simultaneous Localization and Mapping (SLAM) to identify its surroundings and estimate its own position. ##

Carnegie Mellon Unveils Lunar Rover "Andy"

www.space-travel.com/reports/**Carnegie_Mellon_Unveils_Lunar_Rover_Andy**_999.html

NOV. 27, 2014 - Carnegie Mellon University has unveiled Andy, a four-wheeled robot designed to scramble up steep slopes and survive the temperature swings and high radiation encountered while exploring the Moon's pits, caves and polar ice.

Red Whittaker poses with "Andy"

"Every extraterrestrial robot carries some DNA from Carnegie Mellon," but Andy would be the first true CMU robot to make the leap from Earth," said William "Red" Whittaker, professor of robotics and

director of the Field Robotics Center."This is the culmination of lots of work by lots of people and is the next step toward Carnegie Mellon becoming a spacefaring university."

Andy, named after Andrew Carnegie and Andrew Mellon, was developed over the last nine months by a largely student workforce and drew on expertise and resources from across the university, including the School of Computer Science, the College of Engineering, the College of Fine Arts and the Mellon College of Science.

"If we're on the Moon anyway, we're going to do something while we're up there."

- A Carnegie Mellon contribution to an effort led by Pittsburgh's **Astrobotic Technology** to land a robot on the Moon and win the $20 million-plus **Google Lunar XPrize.**
- One possibility is to use Andy to explore lunar pits. These are giant, newly discovered, steep-sided holes created by the collapse of underground voids - **lava tubes**.

"You can't explore caves from a satellite; you've got to be there,
on the ground, so robots are the next big step."

- Andy's wide stance, low center-of-gravity and high belly clearance combine for unprecedented stability, slope-climbing and straddling of rocks.
- Andy achieves its superb mobility with very wide wheels and light weight.
- Andy's wheels are a foot in diameter, which is exceptional for a three-foot rover.
- Its weight on the moon will be less than 10 pounds.
- Andy has the **softest footprint** and **greatest strength-to-weight ratio** of any space rover to date.
- The rover has strong pulling power with a novel suspension for transferring that power to the ground.
- Andy uses high-reliability terrestrial parts, multiples of some critical components, and innovative software for detecting faults and switching between components as necessary.
- A spare component can take over operations permanently if its twin is fatally damaged, or temporarily if its twin can be recovered by rebooting following a failure.
- Andy also incorporates a new method for combining landing imagery with 3-D path reconstruction data to plan and document its exploration route.
- Andy will also accommodate a number of artistic payloads

More information about Andy and Carnegie Mellon's Lunar Exploration Initiative is available online at http://www.cmu.edu/google-lunar-x/.

- Carnegie Mellon's Robotics Institute has led the development of a number of planetary robotic technologies for NASA, including walking robots for exploring active volcanoes, robots designed for extraterrestrial drilling and advanced wheel development. Autonomous driving software originated at Carnegie Mellon is the basis of navigation and safeguarding for NASA's Mars rovers. ##

Private Moon Mail Project Will Launch Your Stuff to the Lunar Frontier

DEC. 11, 2014 - www.space.com/27987-**astrobotic-moon-mail-lunar-mementos**.html

X-Prize contender **Astrobiotic** is offering people the chance to fly their special item to the lunar surface with a new service called MoonMail. Anyone interested can buy a small capsule that they can fill with keepsakes that will then be transported to the Moon during the company's first lunar mission, sometime in the next two years.

Giving individuals a chance to send something to the Moon

- A precious family heirloom? A lock of hair? For a price, you could send a small object of your choosing on a one-way trip to the lunar surface, immortalizing it on the Moon forever.
- The Moon capsules don't exactly come cheap. The smallest container, which measures 0.5 in across (1.3 cm), costs $460, and a 0.75-inch-wide (1.9 cm) capsule costs $820. A 1-inch (2.5 cm) capsule costs $1,660. Prices increase depending on the height chosen for the container.
- Win a free capsule, thanks to an Astrobotic contest. Company representatives ask people to submit their best ideas for what they want to send to the Moon by Dec. 23 as entries into a contest to win a free container that will fly their item to the lunar surface.
- Representatives will select their favorite, most meaningful idea as the winner. [Regretably, this deadline arrives before this issue goes to press.]
- Astrobotic expects to load 100s to 1,000s of these purchased capsules onto its first Moon probe.

- The capsules will remain attached to Astrobotic's lander after it touches down in Lacus Mortis
- Items will be screened to make sure they aren't potentially harmful to the spacecraft and its mission.
- Cultural sensitivities will be taken into account before anything is sent to the lunar surface. Astrobotic's MoonMail continues the recent and growing trend of commercial opportunities inviting not just governments, companies and organizations to take part in spaceflight, but individuals, too.
- From 'space selfies' to flying names, DNA and now mementos, these projects point to a future where space exploration involves the public.

The main goal of Astrobotic's first mission will be to win the Google Lunar X Prize, worth up to $30 million. In order to win the grand prize, a team has to be the first to land a probe on the Moon, move 1,640 feet (500 meters) on the lunar surface and beam back various kinds of data, including images, from the natural satellite.

The multimillion-dollar prize is designed to create an economy around the commercial utilization of the Moon. https://www.astrobotic.com/moon-mail

The Lunar Initiatives

No date: http://www.**lunarinitiatives**.com

The Lunar Workshops:

The Lunar Workshops offer a collaborative environment where leaders of the Lunar Renaissance can present their latest results while discussing and creating the future of lunar & planetary exploration.

The Lunar SIGs: www.lunarsigs.com

For the leaders of the Lunar Renaissance annual meetings are not enough. We have created the Lunar SIGs (Special Interest Groups) to address the need to actively collaborate on a more regular basis. With the SIGs' monthly online seminars and discussions they (and you) can keep up with rapidly changing science and technology in the Lunar Renaissance.

Lunar Artwork: ww.lunarartwork.com

Before a problem can be solved it must be imagined. Art leads science and technology; our art competitions and promotions will dare artists to dream the impossible so we can create it.

Cubes to the Moon: www.cubestothemoon.com

It is one thing to talk about the future; it is quite another thing to lead. We intend to lead. We will get several LunarCubes built and flown sooner rather than later - through crowd funding, The Lunar Challenges and the other Lunar Initiatives.

Lunar Challenges: www.lunarchallenges.com

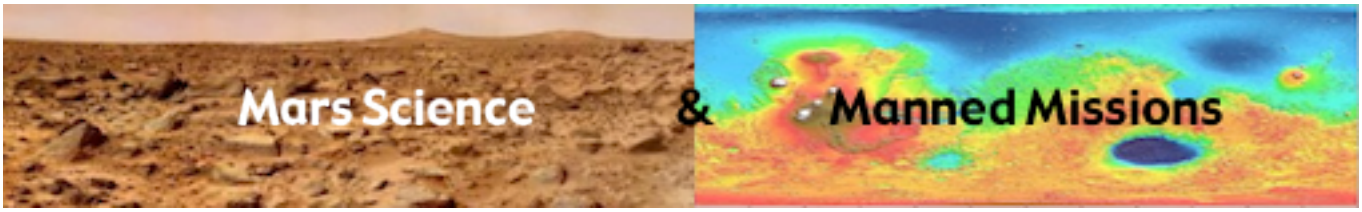
Cash prize challenges are the most powerful way to stimulate the creation and implementation of disruptive technologies. More importantly, challenges attract and train thousands of creative risk takers and problem solvers that we will need to open the Lunar Frontier.

The Lunar Incubator: www.thelunarincubator.com

To open the Lunar Frontier we will need not just transformative technologies but new business models and business leaders. The Lunar Incubators will encourage experimentation in the business of space as well as the science and technology of space.

The International Lunar Geophysical Year 2017-2018: www.ilgy-2017.com

The original IGY started the Space Age in 1957-58. We will be promoting The International Lunar Geophysical Year in 2017-18. We will support this collaborative global space initiative with three global Lunar Conferences here on Earth in 2016, 2018 and 2020.

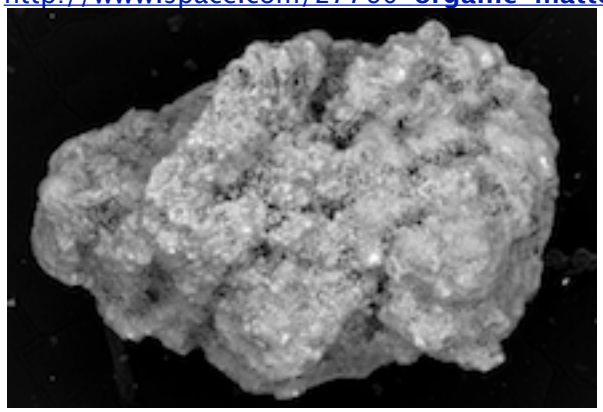


[Most of the "editor's summaries" of news articles are in the form of bullet points of the contents.
For the full text, see the links cited. - Peter Kokh kokhmmm@aol.com]

MARS SCIENCE

Could There Be Organic Matter on Mars?

NOV. 14, 2014 - http://www.space.com/27760-**organic-matter-on-mars**.html



A very small micrometeorite, some of the most abundant material to fall on Mars.
Some contain organic carbon that may form chloromethane when heated.

- The origins of organic matter found by Mars lander missions have long been debated,
- A new study suggests a way to find out whether these chemicals are indigenous or from elsewhere.
- Several Mars lander missions have detected chloromethane, a chemical produced by some organisms
- Most scientists think the findings were contamination from Earth.
- A team of researchers has replicated these experiments on a meteorite found on Earth, and found that it produced chloromethane from organic materials in the rock.
- This suggests that the chloromethane on Mars may have come from meteorite debris on its surface or from Martian soil itself, not from Earth.
- In 1976, the Viking 1 lander detected chloromethane in a soil sample baked in a small oven on board.
- Viking 2, did not detect chloromethane, but did find traces of **di**chloromethane, also organic.
- Scientists dismissed the findings, saying they were contamination from Earth.
- Recently, Curiosity rover found traces of chloromethane in soil heated in one of its instruments.
- Again, researchers claimed the chemicals were nothing more than terrestrial contamination.

Fresh evidence

Frank Keppler, a biogeochemist at the University of Heidelberg in Germany, led a study to analyze the Murchison meteorite that landed in Australia in 1969. If he could understand how chloromethanes formed from this meteorite, he might be able to shed some light on whether the ones found on Mars came from Earth, from other meteorites or from the Red Planet itself — and possibly from life.

- Mars is constantly pummeled by micrometeorites, about 50,000 tons a year, most carbonaceous - containing carbon, an essential building block for life.
- Heating up material from the Murchison meteorite to temperatures of up to 400°C (750° F) as in the Viking and Curiosity experiments, and they found chloromethane. It couldn't be contamination from Earth because it had a different chemical fingerprint.
- The isotope signatures of carbon and nitrogen in the meteorite's chloromethane didn't match those found on Earth. This suggests the same process may have occurred with micrometeorites on Mars.
- The presence of chloromethane is a "clear sign" that organic matter exists on Mars, but this doesn't necessarily suggest the organic matter came from life, but we cannot yet exclude it.

- To determine whether the chloromethane on Mars came from Earth, from meteorites, or from the Martian soil, scientists could measure its isotopic signature. But the landers on Mars (including Curiosity) do not have the tools to measure these isotopes, but perhaps future missions will. ##

Chinese find Meteorite From Mars with Alien Biomass

DEC. 4, 2014 - www.marsdaily.com/reports/**Meteorite_From_Mars_Contains_Alien_Biomass**_999.html

Chinese scientists have discovered that **a meteorite of Martian origin that hit Earth in Morocco in summer 2011**, contains signs of water and organic carbon combinations, which may be evidence of extraterrestrial life dating 700,000 years back in time.

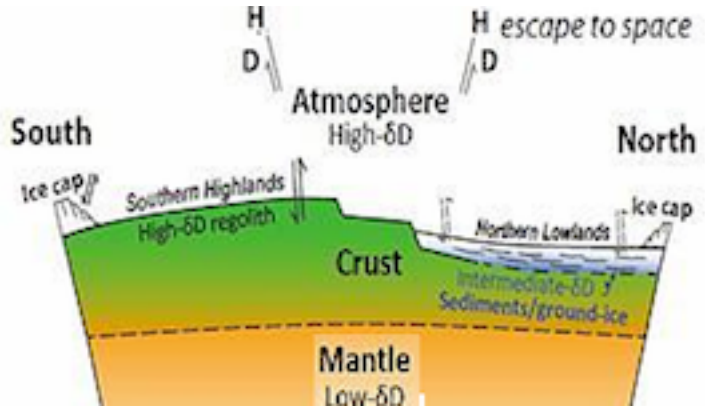
- Meteorite 'Tissint' landed in the midst of Moroccan desert of Guelmim-Es Semara on 18 July, 2011, roughly 700,000 years after it was chopped off the Martian surface by an asteroid from outer space.
- The 8-kg gray-coloured glassy boulder contained traces of water
- Recently researchers found previously unidentified matter in its carbon composition, biological and organic in nature.
- Recent tests have ultimately proven that this organic matter is extraterrestrial nature.
- The organic matter may still be physical, not biological, in origin. However, this is very unlikely.
- While the organic matter is extraterrestrial in origin, it has four unusual features.
    1. The meteorite did not spend a lot of time on Earth outside of the scientists' control.
    2. The organic matter was sealed inside the rock, under its glassy surface, created by the high temperatures only possible at atmospheric entry.
    3. Some of these carbon compositions hardened into diamond, which is also only possible in natural conditions outside of Earth.
    4. The carbon-containing matter also bears a lot of deuterium, found in Martian soil. ##

Scientists Find Meteoritic Evidence of Mars Water Reservoir

www.marsdaily.com/reports/**NASA_Planetary_Scientists_Find_Meteoritic_Evidence_of_Mars_Water_Reservoir**_999.html

DEC. 19, 2014 - Controversy still surrounds the origin, abundance and history of water on Mars, But an international team of planetary scientists have found evidence in meteorites on Earth that indicates Mars has a distinct and global reservoir of water or ice near its surface.

- This discovery helps resolve the question of where the "missing Martian water" may have gone.
- Scientists continue to study the planet's historical record, trying to understand the apparent shift from an early wet and warm climate to today's dry and cool surface conditions.
- The reservoir's existence may be a key to Mars" climate history and the potential for life on Mars.
- Until this study there was no direct evidence for this surface reservoir or interaction of it with rocks from Mars' surface that have landed on Earth.



- The samples revealed water whose hydrogen atoms have a ratio of isotopes distinct from that found in water in the Red Planet's mantle and current atmosphere. I

- Recent orbiter missions have confirmed subsurface ice, believed to have formed some geomorphologic features on Mars,
- But this study used meteorites of different ages to show that significant ground water-ice may have existed relatively intact over time.
- The distinct hydrogen isotopic signature of the water reservoir must be of sufficient size that it has not reached isotopic equilibrium with the atmosphere.
- The hydrogen isotopic composition of the current atmosphere could be fixed by a quasi-steady-state process that involves rapid loss of hydrogen to space through sublimation from a widespread ice layer.
- Curiosity's observations in a lakebed, in an area called Mount Sharp, indicate Mars lost its water in a gradual process over a significant period of time.
- We have no samples from Mars, so this study emphasizes the importance of finding more Martian meteorites and continuing to study the ones we have with the ever-improving analytical techniques.
- Scientists examined two possibilities, that the signature for the newly identified hydrogen reservoir either reflects near surface ice interbedded with sediment or that it reflects hydrated rock near the top of the Martian crust.. Both scenarios being possible.
- But the fact that the measurements with higher water concentrations appear uncorrelated with the concentrations of some of the other measured volatile elements, in particular chlorine, suggests the hydrogen reservoir likely existed as ice. ##

Mars was warm enough for flowing water, but only briefly

http://www.marsdaily.com/reports/**Mars_was_warm_enough_for_flowing_water_but_only_briefly**_999.html

NOV. 18, 2014 - With the growing variety of samples collected and measurements made by Mars rovers, the scientific evidence that water once flowed freely on the surface of the Red Planet has mounted.

Researchers have had trouble rectifying these liquid water signs with the fact that Mars is freezing cold. Even more confusing -- **the newest climate models suggest Mars was always icy cold.** So, the question remained: **when and how was ancient Mars ever warm enough to host liquid water?**

- New research suggests **Martian volcanoes may have helped warm the planet for a few dozen or few hundred years at a time**, long enough to allow water to exist in a liquid state.
- On Earth, major volcanic activity has a cooling effect. On Mars an influx of volcanic gases allowed Mars' atmosphere to better trap heat, not reflect it.
- Mars' early atmosphere being dusty, a lot of volcanic plume minerals like sulfur dioxide and sulfuric acid would adhere to the dust particles, reducing their ability to reflect the Sun's rays, delaying cooling.
- Some 30% of Mars was resurfaced by lava flows, and it can erupt over relatively short periods of time,
- Flood basalts and can have a huge affect on a planet's atmosphere."
- Summer afternoons were likely warm enough on early Mars to allow for short stints of liquid water.

An example from Earth

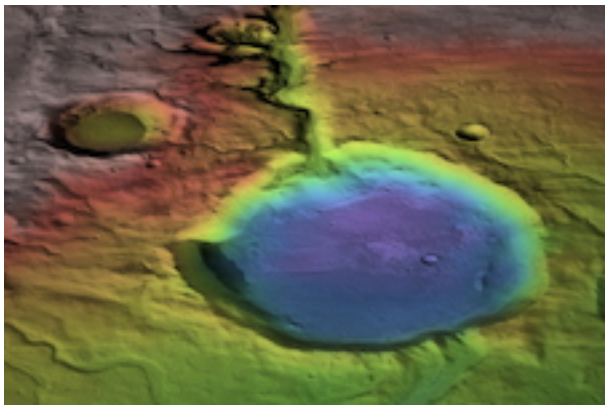
- The average yearly temperature in the Antarctic Dry Valleys is way below freezing, but peak summer daytime temperatures can exceed the melting point of water, forming streams, which then refreeze.
- In a similar manner,volcanism could have brought the temperature on early Mars above the melting point for decades to centuries, causing episodic periods of stream and lake formation.
- This research was published this week in the journal Nature Geoscience. ##

Volcanic Eruptions on Mars Could Have Caused Water to Flow

DEC. 3 2014 - www.space.com/27908-**mars-water-volcanic-eruptions.**html

Source: http://www.nature.com/ngeo/journal/v7/n12/full/ngeo2293.html

- Mars surface is now cold and dry, but there is ample evidence suggesting that rivers and lakes covered it billions of years ago.
- Volcanic eruptions could have warmed the planet, allowing water toi flow across its surface long ago.
- However, the latest generation of climate models for early Mars suggests its atmosphere was too thin to keep the planet warm enough for water to flow.



In Mars' early history, water formed an open-basin lake, filling the crater, forming a delta, and breaching the lower rim as water flowed to lower elevations shown in blue.
Full size: i.space.com/images/i/000/044/064/original/**ancient-water-mars-2.jpg**?1417634048

- Moreover, the Sun was much dimmer billions of years ago than it is now, suggesting Mars would have had less sunlight to heat it.
- Now, the researchers suggest intense volcanic activity could help solve this conundrum by regularly spewing tons of greenhouse gases into the Martian atmosphere that would have trapped heat.
- Each eruption would have kept Mars warm for decades or even centuries.
- Many of the geological features that suggest water once flowed on Mars date to about 3.7 billion years ago, when massive volcanos were active.
- On Earth, widespread volcanism often leads to cooling rather than warming, because ash and sulfuric acid particles can reflect the sun's rays.\
- The volcanoes would generate sulfur dioxide gas that would produce a significant greenhouse effect. The research team's computer models of the early Martian atmosphere suggest that, all in all, volcanic eruptions would heat the equatorial region of Mars enough for water to flow.
- No prior work has seen similar effects is that no prior simulation of Mars' early climate included both dust and sulfuric acid.
- This model of intermittent melting is consistent with previous evidence that channels and valley networks seen in ancient Martian terrain formed during temporary wet episodes.
- "For a few decades every several millennia, an eruption so large goes off that the atmosphere changes, the climate warms, the rivers flow and the lakes fill.:"
- Then, as the eruption dies off, things slowly relax back to their cold, icy, sleepy state for a few more millennia until the next biggie." ##

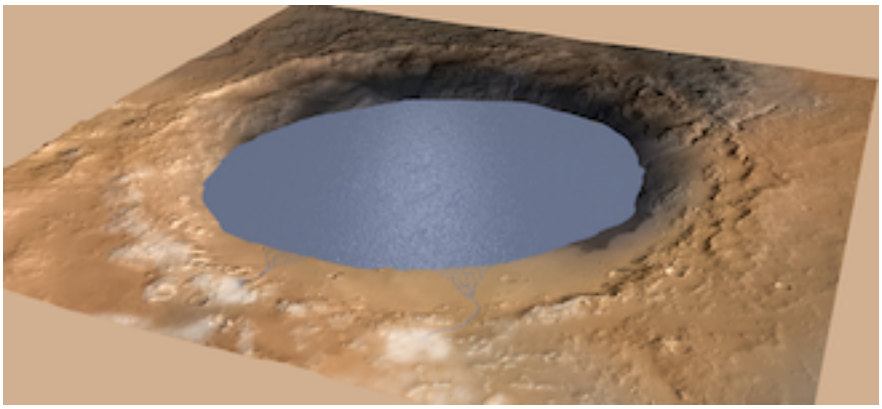
Editor: This sounds very much like something we see on Earth every some thousands years **the "supervolcano.."** The largest,. in northern Sumatra (Indonesia), all but wiped mankind off the planet some 55,000 years ago, And the one most ready to pop at any time now, being underneath Yellowstone National Park in NE Wyoming,. It could dump meters of ash over most of the western United States, making it unlivable for some time. PK

Curiosity Finds Clues to How Water Helped Shape Martian Landscape

www.nasa.gov/press/2014/december/**nasa-s-curiosity-rover-finds-clues-to-how-water-helped-shape-martian-landscape/**
www.space.com/27950-**mars-crater-lake-curiosity-rover.**html
http://www.space.com/27971-**mars-whale-rock-lake-curiosity-photo**.html

DEC. 8, 2014 -Observations by NASA's Curiosity Rover indicate Mars' Mount Sharp was built by sediments deposited in a large lake bed over tens of millions of years.

- Ancient Mars maintained a climate that could have produced long-lasting lakes at many locations.
- This hypothesis challenges the notion that warm and wet conditions were transient, local, or only underground on Mars
- A more radical explanation is that Mars' ancient, thicker atmosphere raised temperatures above freezing globally



This illustration depicts a lake of water partially filling Mars' Gale Crater,
receiving runoff from snow melting on the crater's northern rim.
Full image and detailed caption: www.nasa.gov/jpl/msl/pia19080/#.VblwQt6kL_c

- But so far we don't know how the atmosphere did that.

Why does this layered mountain sits in a crater?

- Mount Sharp stands about (5 km 3 mi) tall, its lower flanks exposing hundreds of rock layers.
- Rock layers alternating between lake, river and wind deposits indicate **repeated filling and evaporation** of a Martian lake much larger and longer-lasting than any previously examined close-up.
- Rivers carried sand and silt to the lake, depositing the sediments at the mouth of the river to form deltas similar to those on Earth.
- This cycle occurred over and over again.
- As Curiosity climbs higher on Mount Sharp, we will have a series of experiments to show patterns in how the atmosphere and the water and the sediments interact.
- We may see how the chemistry changed in the lakes over time.
- This hypothesis is supported by what we have observed so far, a framework for testing in 2014.
- After the crater filled to a height of at least a few hundred meters~yards and the sediments hardened into rock, accumulated sediment layers were sculpted over time into a mountainous shape by wind erosion that carved away material between the crater perimeter and the current edge of the mountain.
- On the 8-km (5-mi) journey from its 2012 landing site to its current work site at the base of Mount Sharp, the rover uncovered clues about the changing shape of the crater floor during the era of lakes.
- The rover found sedimentary rocks suggestive EUROPAof small, ancient deltas stacked on top of one another
- Curiosity crossed a boundary from an environment of rivers to an environment dominated by lakes.
- Modeling of Mars ancient climate has yet to identify the conditions that could have produced long periods warm enough for stable water on the surface.

"Knowledge we're gaining about Mars' environmental evolution by deciphering how Mount Sharp formed will also help guide plans for future missions to seek signs of Martian life," said Michael Meyer, lead scientist for NASA's Mars Exploration Program at the agency's headquarters in Washington. ##

Mars Has 'Macroweather,' Just Like Earth

DEC. 26, 2014 - www.space.com/28099-**mars-atmosphere-macroweather-discovery**.html
www.space.com/24932-mars-atmosphere-today-could-explain-planets-past-tragedy-**video**.html

Mars, like Earth, experiences macroweather" — atmospheric effects that lie in between short-term weather and long-term climate. This discovery might not only shed light on how Earth's atmosphere behaves. It could also yield insights on all planets and moons with atmospheres.

- Earth's weather daily basis due to constant fluctuations in the atmosphere.
- But Earth's climate varies over decades.
- Earth's atmosphere also experiences something between these two extremes called "macroweather."

Could other worlds also have macroweather?

- To see if other worlds might have macroweather, scientists investigated Mars because its atmosphere is relatively well studied: Data from Vikings 1 and 2 in the mid-1970s through early 1980s, as well as data collected from orbit by NASA's Mars Global Surveyor spacecraft.
- By accounting for the Sun warming the planet, as well as the thickness of the Martian atmosphere, investigators found that macroweather exists on Mars, but with a time scale isshorter than on Earth.
- On Mars, the shift from weather to macroweather takes place over 1.8 Martian sols, equivalent to about two Earth days, while that transition takes a week to 10 days on Earth.
- How Earth and Mars differ in size and how much sunlight they each receive are factors.\Mars is only slightly more than half as wide as Earth, about one-tenth of Earth's mass and orbits about 50 percent farther away from the sun than our home planet does.
- Weather on Mars can be predicted only two days in advance, compared to 10 days on Earth.
- The team is currently working on a global macroweather model that may be capable of making forecasts at the range of months to decades.
- Such research could increase our knowledge of the weather on Venus, Titan, Jupiter, Saturn, Uranus and Neptune, and exoplanets and exomoons orbiting distant stars.##

Robotic Rock Climbers Could Aid Hunt for Mars Life

NOV. 29, 2014 - http://www.space.com/27881-**mars-life-search-cliffbot-robot**.html

A 'Cliffbot' is lowered over some rocks during a field test in Morocco in 2013

http://www.astrobio.net/news-exclusive/**cliffbot-goes-climbing**/

A robot scaling the faces of steep cliffs on Mars might one day help find signs of life.

- "Cliffbot" could help examine places otherwise difficult or impossible for astronauts to safely reach
- Further improvements are needed for it to overcome expected obstacles.
- That gullies and canyons with steep cliffs are seen all over Mars suggest past water flows.
- That possibility raises hope that life might once have existed there, or could live there still, perhaps hidden in underground reservoirs.
- Liquid water is an essential ingredient for life as we know it
- There is life virtually everywhere there is liquid water on Earth.

Does the history of Mars includes life?

- Scientists need to learn more about the planet's past.
- Digging on Mars is difficult, requiring heavy equipment not easy to ship.
- We can take advantage of naturally occurring gullies and canyons that already slice into Mars, exposing layers of rock.
- A robot that can scale the cliffs of these valleys could uncover clues to Martian history.
- The further it descends, the further back in time it could travel.

Research by the French chapter of the Mars Society

- Since 2001, the Association Planète Mars, the French chapter of the Mars Society, has experimented with probes capable of being lowered down faces of steep cliffs using cables.
- The goal is for astronauts to manually operate a Cliff Reconnaissance Vehicle (CRV) or Cliffbot* instead of themselves dangling off rock faces.
- They could use cameras and other instruments on the robot to examine difficult-to-reach locations.
- The latest series of tests of the Cliffbot were conducted in February 2013 in the Moroccan desert, where the Saharan geology and topography is similar to that of Mars.
- Previously the robot was tested on cliffs less than 18 m (59 ft) high, in France and Utah
- They succeeded in lowering Cliffbot on a cable of up to 46 m (150 ft) long.
- The robot was lowered into a cave mouth difficult for an astronaut in a spacesuit to fit through.
- On Mars, the Cliffbot would weigh 38 % of what it weighs on Earth, making it easier for operators to lower it to look at items of interest
- A wide-view, high-definition camera on Cliffbot transmited pictures of numerous fossil seashells embedded in Moroccan cliffs, suggesting the robot could spot similarly anomalous features on Mars.

Difficulties encountered

- A boulder 40 cm (15.7 in) long got wedged between the wheel spokes suggesting that solid wheels without spokes might prevent such mishaps.
- "Hazcam," a camera with a rear-facing mirror on Cliffbot, helped operators see the robot's surroundings and better anticipate the hazards it faced.
- Operators propose to add cameras directed at its wheels to detect such problems.
- Hazcam did help operators understand what the robot was doing when it was hanging out of sight.
- Cliffbot might in the future carry instruments used on other Mars rovers, such as a detector of methane, whose existence on Mars might suggest the presence of life, or that could detect chlorophyll.
- Future experiments with Cliffbot are planned in Utah in 2015. ##

Could Ancient Mars Have Supported Life? Water Isn't the Only Key

DEC. 11, 2014 - www.space.com/27982-**mars-life-ancient-habitability-factors**.html

Ancient Mars featured flowing rivers and sizable lakes

- But that doesn't mean early Mars could definitely have supported life.
- The presence of liquid water is just one of many factors affecting past or present habitability of Mars
- Things that make a place livable are numerous
- Sometimes, there's a showstopper

Diverse attributes could contribute to making an environment livable.

- A global magnetic field could shield surface life from ionizing radiation
- A thick atmosphere would moderate temperatures and protect against solar ultraviolet radiation.
- Modern Mars lacks these characteristics, but it possessed both of them about 4 billion years ago.
- Did the magnetic field, thick atmosphere, and liquid water all occurred simultaneously
- The emergence and sustenance of both life and its habitat require a convergence of the right chemicals and physical conditions in the right place at the same time.
- **Assessing physical conditions prevailent in the distant past is challenging but not impossible**,
- NASA's MAVEN spacecraft (short for Mars Atmosphere and Volatile Evolution) is currently studying the rate at which gas is escaping from the Martian atmosphere, gathering data that should allow researchers to extrapolate this process backward in time.
- Curiosity's recent discoveries suggest that Mars could have supported microbial life billions of years ago, but only if the conditions above were in place.
- In this regard, Mars serves as a laboratory of sorts. "Everything we learn about Mars is a lesson in how to learn about other planets, and those lessons are key to enabling us to explore them." ##

NASA's MAVEN Orbiter's First Look at Martian Upper Atmosphere

http://www.nasa.gov/press/2014/october/**nasa-mission-provides-its-first-look-at-martian-upper-atmosphere/**

October 14, 2014 NASA's **M**ars **A**tmosphere and **V**olatile **E**volutio**n** (**MAVEN**) orbiter entered Mars orbit Sept. 21, lowered its orbit and tested its instruments. Its goal is to help solve the mystery of **how the Red Planet lost most of its atmosphere**.

"On Earth, ozone destruction by refrigerator CFCs is the cause of the polar ozone hole. On Mars, ozone is just as easily destroyed by the byproducts of water vapor breakdown by ultraviolet sunlight. Tracking the ozone lets us track the photochemical processes taking place in the Martian atmosphere. We'll be exploring this in more complete detail during MAVEN's primary science mission."

All the instruments showed data quality better than anticipated and provided a first look at

- **A storm of energetic solar particles** at Mars,
- Unprecedented ultraviolet images of the **tenuous oxygen, hydrogen, and carbon coronas** over Mars
- A comprehensive **map of highly-variable ozone** in the atmosphere underlying the coronas.

BACKGROUND

- Solar energetic particles (SEPs) are streams of high-speed particles blasted from the sun during explosive solar activity like flares or coronal mass ejections (CMEs).
- **Around Earth, SEP storms can damage the sensitive electronics on satellites**
- **At Mars, they are thought to be one possible mechanism for driving atmospheric loss.**

After traveling through interplanetary space, these energetic particles of mostly protons deposit their energy in the upper atmosphere of Mars. A SEP event like this typically occurs every couple weeks.

A solar flare on Sept. 26 produced a CME that was observed by NASA satellites on both sides of the Sun. Computer models of the CME propagation predicted the disturbance and the accompanying SEPs would reach Mars on Sept. 29. MAVEN's Solar Energetic Particle instrument was able to observe the onset of the event that day.

MAVEN Identifies Links in Chain Leading to Mars Atmospheric Loss

www.marsdaily.com/reports/**MAVEN_Identifies_Links_in_Chain_Leading_to_Mars_Atmospheric_Loss_999.html**

DEC. 16, 2014 - Since beginning its science phase on November 16th, MAVEN is observing the upper atmosphere of Mars to help understand climate change on the planet.

- Early MAVEN discoveries reveal key features about the Mars' loss of atmosphere to space over time.
- The observations reveal how the solar wind can penetrate deep into a planetary atmosphere.
- The first comprehensive measurements of the composition of Mars' upper atmosphere and electrically charged ionosphere offer an unprecedented view of ions as they gain the energy that will lead to their to escape from the atmosphere.
- Solar-driven processes acting on gas in the upper atmosphere leads to atmospheric loss.
- Over the course of MAVEN's mission, we'll be able to fill in this picture and really understand the processes by which the atmosphere changed over time.
- On each orbit, MAVEN dips into Mars' ionosphere - a layer of ions and electrons about 47-186 km (75-300 mi} above the surface, serving as a kind of shield around the planet, deflecting the solar wind, an intense stream of hot, high-energy particles from the sun.
- MAVEN's Solar Wind Ion Analyzer, however, has discovered a stream of solar-wind particles that are not deflected but penetrate deep into Mars' upper atmosphere and ionosphere.
- Interactions in the upper atmosphere appear to transform this stream of ions into a neutral form that can penetrate to surprisingly low altitudes. Deep in the ionosphere, the stream emerges, almost Houdini-like, in ion form again.

The reappearance of these ions, which retain characteristics of the pristine solar wind, provides a new way to track the properties of the solar wind and may make it easier to link drivers of atmospheric loss directly to activity in the upper atmosphere and ionosphere.

MAVEN is exploring the nature of the reservoir from which gases are escaping by conducting the first comprehensive analysis of the composition of the upper atmosphere and ionosphere.

- These studies will help researchers make connections between the lower atmosphere, which controls climate, and the upper atmosphere, where the loss is occurring.
- The instrument measures the abundances of many gases in ion and neutral forms, and a well-defined structure in the upper atmosphere and ionosphere
- In contrast, in the lower atmosphere, gases are well-mixed.
- Variations in these abundances over time provide evidence of significant upper-atmosphere weather not measured in detail before, and provide new insights into the physics and chemistry of this region.

New insight into how gases leave the atmosphere is being provided by the spacecraft's Suprathermal and Thermal Ion Composition (STATIC) instrument.

- Within hours after being turned on at Mars, STATIC detected a "polar plume" of ions escaping from Mars, important in determining the rate of atmospheric loss.
- As the satellite dips down into the atmosphere, STATIC identifies the cold ionosphere at closest Approach, then measures heating of this charged gas to escape velocities as MAVEN rises in altitude.
- Energized ions ultimately break free from Mars gravity along a plume that extends behind Mars. ##

Spike seen in Methane on Mars, but source unknown

www.marsdaily.com/reports/**Spike_seen_in_methane_on_Mars_but_source_unknown**_999.html

www.jpl.nasa.gov/news/news.php?feature=4413

DEC/ 16, 2014 - Methane, a gas that on Earth comes mainly from living organisms, has been measured for the first time making a sudden spike on Mars, leaving scientists puzzled about its origin.

"We now have full confidence that there is methane occasionally present in the atmosphere of Mars, And that there are organics preserved in ancient rocks on Mars in certain places."

- The latest findings from NASA's Curiosity rover raise the question, could microbes be the source of the methane? And what caused the levels to soar and dissipate again in a matter of weeks?
- Methane is the kind of material that you would look for if life ever originated on Mars. However, the findings do not mean that we have found evidence of life on Mars. More investigation is needed.\
- The methane and the organic molecules from a rock-powder sample collected by rover's drill can be consistent with both the former presence of life or the existing presence of life.

Mars is widely believed to have once been warm and wet, and potentially welcoming to some form of life in the distant past.

Curiosity is not equipped to find out whether life currently exists on Mars, but the mission aims to uncover whether life ever arose there by looking for chemical elements that are the building blocks of life, including carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur.

- After poring over 20 months of data collected Curiosity, scientists found that methane on the dusty planet is far lower than expected, about half of what they thought they would detect from processes like the solar breakdown of dust and organic materials delivered to the Martian surface by meteorites.
- But they discovered a ten-fold spike in methane in November, by using a tunable laser spectrometer,.averaging seven parts per billion, or about 10 times higher than the methane detected in prior months.
- The period of high methane lasted barely two months.
- One theory is that methane is "occasionally produced or vented near the Gale Crater -- and that the gas disperses quickly once these episodes of venting or production cease,.
- Methane can be generated by solar ultraviolet radiation of cosmic dust on the surface of Mars.
- If there is water in subsurface aquifers, the interaction of rocks and water could produce methane
- Another possibility is that microbes are producing methane in their metabolic process.
- We can't tell if the source of methane is "modern" or from a leakage in stored methane. But the source is "relatively well-localized and small," and likely north of the rover's current location in Gale Crater.
- "What this is telling us is that Mars is currently active, that the surface or the subsurface is communicating with the atmosphere." ##

ESA's Mars Express spots "frosty morning" in Mars' vast Hellas Basin

NOV. 27, 2014 - http://www.esa.int/spaceinimages/Images/2014/11/**Hellas_Chaos**

Hellas Chaos, in the southern central part of the giant Hellas basin, stretches roughly 200 km (124 mi) north-south and for about 500 km (311 mi) east-west. It shows a variety of landforms, from large impact craters containing wind-blown dunes or flat-topped mesas, to ridges and troughs with rough knobs of material protruding from the surface.

The image was acquired by the High Resolution Stereo Camera on ESA's Mars Express on 23 January 2014 during orbit 12 785. The image is centered on 46ºS / 69ºE. The ground resolution is about 18 m per pixel. [36 m per pixel in the 50% reduction of the image above]

North is to the right and west is at the top. For link to higher resolution images, see URL above

The region is also dusted with carbon dioxide frost. In the right-hand portion of the image, the curved outlines of large sublimation pits are interspersed with polygonal-patterned terrain. These features are typical of 'periglacial' terrain, and develop as a result of contraction and relaxation during freeze-thaw cycles as the seasons change.

Insight, next NASA Mars Mission. Reaches Milestone

NOV. 17, 2014 - www.marsdaily.com/reports/**Next_NASA_Mars_Mission_Reaches_Milestone**_999.html

Denver prepare **NASA's InSight Mars lander** for propulsion proof and leak testing on Oct. 31, 2014. Following the test, the lander was moved to another clean room for the start of the mission's assembly, test and launch operations (ATLO) phase. The assembly portion of ATLO will last about six months. The InSight mission (for Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) is scheduled to launch in March 2016 and land on Mars six months later. It will investigate processes that formed and shaped Mars and will help scientists better understand the evolution of our inner solar system's rocky planets, including Earth.

- The mission has begun the **A**ssembly, **T**est and **L**aunch **O**perations (ATLO) phase of its development, on track for a March 2016 launch to Mars.
- The lander, its aeroshell and cruise stage are assembled by Lockheed Martin Space Systems, Denver.
- The subsystems are coming from all over the globe, and the ATLO team works to integrate them into the flight vehicle. When the spacecraft has been assembled it will undergo rigorous testing.

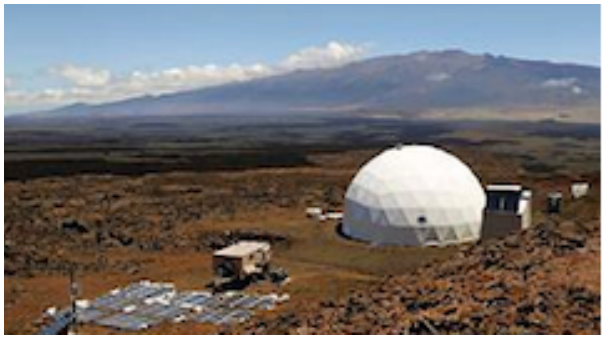
- Over the next six months, technicians will add avionics, power, telecomm, mechanisms, thermal systems and navigation systems.
- The propulsion system was installed earlier this year on the lander's main structure.
- Physically, InSight looks a lot like the Phoenix lander they built, but most of the electronic components are similar to what is currently flying on the MAVEN spacecraft.
- InSight stands for **IN**terior exploration using **S**eismic **I**nvestigations, **G**eodesy and **H**eat **T**ransport
- it is more than a Mars mission. This is a terrestrial planet explorer that will address one of the most fundamental issues of planetary and solar system science: understanding the processes that shaped the rocky planets of the inner solar system (including Earth) more than four billion years ago.
- To investigate the planet's interior, the stationary lander will carry a robotic arm that will deploy surface and burrowing instruments contributed by the national space agencies of France and Germany -- Centre National d'Etudes Spatiales (CNES) and Deutsches Zentrum fur Luft- und Raumfahrt (DLR), who are partnering with NASA by providing InSight's two main science instruments.
- The **S**eismic **E**xperiment for **I**nterior **S**tructure **(SEIS)** will be built by CNES in partnership with DLR and the space agencies of Switzerland and the United Kingdom. It will measure waves of ground motion carried through the interior of the planet, from "marsquakes" and meteor impacts.
- The Heat Flow and Physical Properties Package, from DLR, will measure heat coming toward the surface from the planet's interior.
- Guided by images of the surroundings, InSight's robotic arm will place the seismometer on the surface and a protective covering over it to minimize effects of wind and temperature on the instrument.
- The arm will also put the heat-flow probe in position to hammer itself into the ground to a depth of 3 to 5 yards, or meters.
- Another experiment will use the radio link between InSight and NASA's Deep Space Network antennas on Earth to measure precisely a wobble in Mars' rotation that c**ould reveal whether the planet has a molten or solid core**.
- Wind and temperature sensors from Spain's Centro de Astrobiologia and a pressure sensor will monitor weather at the landing site,
- A magnetometer will measure magnetic disturbances caused by the Martian ionosphere. ##

MARS ANALOG EXERCISES

U-Hawaii Manoa studies effects of long-term space travel to Mars

http://www.spacedaily.com/reports/**UH_Manoa_studies_effects_of_long_term_space_travel**_999.html
www.marsdaily.com/reports/**Eight_months_on_Hawaiian_Mars_tests_rigors_of_exploration**_999.html
http://www.space.com/27843-**gallery-of-life-in-hawaii-mars-simulation**.html
http://www.space.com/27838-**mars-sim-participants-share-life-on-the-inside**.html

OCT. 22-24, 2014 -The University of Hawai'i at Manoa is leading a study on the effects of long-term space travel to humans, such as on trips to and from Mars, which will take months.



Hawai'i Space Exploration Analog and Simulation (HI-SEAS).
The white vinyl dome measures 11 m (36 ft) in diameter, 6 m (20 ft) tall

- Six members of the Hawai'i Space Exploration Analog and Simulation (HI-SEAS) team are in isolation inside a simulated faux Mars habitat on the northern slope of Mauna Loa on Wednesday, Oct. 15.

- NASA is spending $1.2 million on a series of three such projects to determine **the potential pitfalls of sending people together to spend long periods in close quarters on a distant planet.**
- UH will investigate human factors that affect astronaut crew function and performance over time, hoping to learn more about how the mind works, how individuals contribute to a team, and how that team dynamic changes over time

Can humans withstand the radiation that the journey would involve?

- It could take eight months to reach Mars, plus many months spent on this world with a thin atmosphere and no known food source, followed by an simmularly long flight back to Earth.
- The NASA-funded project, the longest US Mars simulation yet, three men and three women with no access to fresh food, with limited Internet access
- A with 20-minute intervals between click and response, as enroute to Mars
- Allowed to venture outside their igloo-like enclosure only if wearing a spacesuit.
- The isolated site is on the basaltic lava slopes of Mauna Loa, with very sparse plant or animal life.

Both crew psychology and radiation are considered "red risks" for Mars, "which means essentially, until we solve these problems, we are not going,"

- One recent study indicated the risk of radiation-induced cancer would limit any trip to one year.
- It just as important to study whether crew mental states could hold up for the duration.
- The volunteers are healthy, educated people in their 20-39, with a keen interest in science and space.
- The crew was picked for ability to work and live together

Third-quarter syndrome

- One potential problem is "third-quarter syndrome" depression - the simulation is no longer fun, and the end is not quite near.
- Another issue is communication breakdown over time between the crew and ground control, "the crew basically comes to the conclusion that mission support doesn't understand what they are going through, is asking too much of them and isn't providing enough support."
- Meanwhile, mission support sees the crew as becoming uncooperative.

The IHI-SEAS Approach

- Using a technology that does not record the crew's every word, but keeps track of the volume of their voices and their proximity to others, to see if a person is self-isolating, or if there are arguments between certain people.

Other simulation experiments have taken place under the sea off the Florida coast, in Antarctica and in Russia, where a 520-day Mars experiment was carried out in 2011. "If we see problems arise in this environment, we can be confident that those problems are going to arise in space."

The Mars Society's 365 day crew mission is now underway at the Flashline Mars Arctic Research Station on Canada's far north Devon Island, inside the Haughton Crater.

Editor: On the radiation risk: Face it NASA, do it right or don't bother! Send the Mars Habitat first, with robots or robotic equipment needed to cover it with mars dust/soil shielding at least 2-3 meters thick (enough for short term stays) and you won't have to worry about radiation exposure except in transit to and from Earth, where a different solution will be needed. Again, if you aren't up to doing it right, why even talk about it. You impress only the ignorant. If the above scenario won't work because you are not sure that the crew could land within walking distance of the pre-shielded habitat, then you aren't quite ready on that score either. ##

"Mars Arctic 365" year-long exercise on Canada's Devon Island

http://ma365.marssociety.org

www.indiegogo.com/projects/**ma365-a-one-year-mars-simulation-in-the-canadian-arctic**

What will this project accomplish?

MA365 will build upon and go beyond all previous efforts conducted by The Mars Society at FMARS.

- Groundbreaking 1-year Mars simulation in the Canadian Arctic;
- Test equipment, technology, techniques, and crew psychological factors; and,
- Overcome challenges to survive the harsh isolated conditions by working as a team.

This will be the most realistic Mars simulation ever conducted!

Past Mars simulations have provided useful insight and data, but have not gone nearly as far in replicating the conditions to be faced by the first Mars explorers:

1. Extreme isolation with limited access & resupply;
2. Duration of simulation;
3. Cold temperatures;
4. Mars analog environment (limited vegetation, similar geology, etc.);
5. Realistic habitat;
6. Realistic science, procedures, equipment & technology;
7. Hard work in a harsh environment with schedule pressure; and,
8. High visibility and public interest / exposure (people will follow the story, identify with the crew, and want to participate in some way).

We need much more realistic Mars simulations so we can truly identify, assess & learn to mitigate the actual challenges of human Mars exploration. In this way, MA365 will be a major step forward.

When will the mission happen? MA365 will have two phases:

https://www.indiegogo.com/projects/**ma365-a-one-year-mars-simulation-in-the-canadian-arctic**

Phase 1 began in July of 2013, and included refit and resupply of the station, beginning the task of preparing it for the one-year Mars simulation. This phase concluded July 2014, with a second refit team delivering food, fuel, equipment and supplies, enabling FMARS to support an effective one-year mission.

Following the refit, in August 2014, three 6-man teams occupied the station for two weeks each, gaining familiarity with the habitat, terrain, and equipment while proving themselves in a team ompetition. The team which is judged to have performed the best during their two week trial will be selected as the prime crew for the one-year Mars simulation.

Phase 2 is the one-year mission itself, which is to begin the Arctic summer in July 2015. ##

MARS MISSIONS

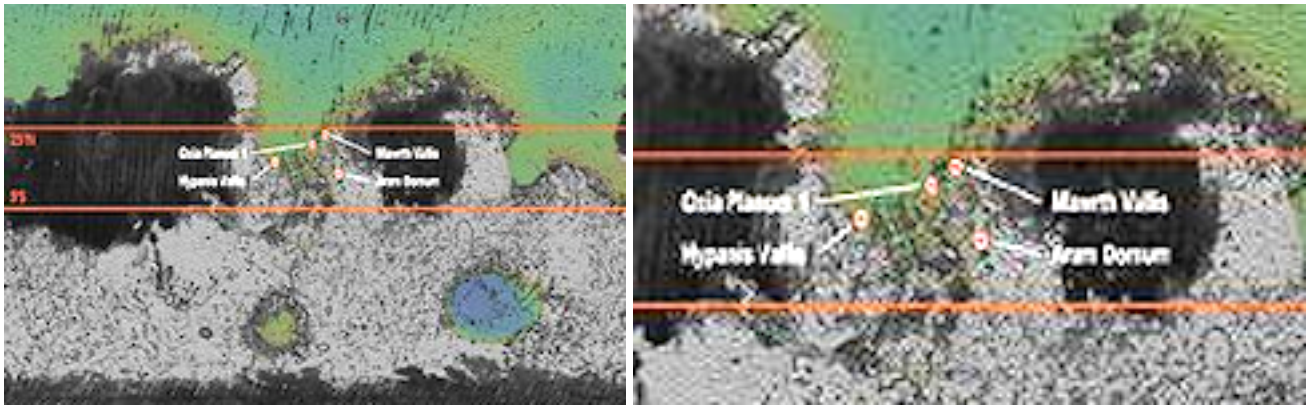
Four candidate landing sites for ExoMars 2018

OCT. 3, 2014 - www.marsdaily.com/reports/**Four_candidate_landing_sites_for_ExoMars_2018**_999.html

ExoMars is a joint two-mission endeavor between ESA and Russia's Roscosmos space agency.

- The **Trace Gas Orbiter** and an entry, descent and **landing demonstrator module, Schiaparelli**, will be launched in January 2016, arriving at Mars nine months later.
- The Rover and Surface Platform will depart in May 2018, with touchdown on Mars in January 2019.
- The present-day surface of Mars is a hostile place for living organisms, but primitive life may have gained a foothold when Mars was warmer and wetter, between 3.5 billion and 4 billion years ago.
- **Our landing site should be in an area with ancient rocks where liquid water was once abundant.** Our initial assessment identified four landing sites best suited to the mission's scientific goals."

- In Dec.2013, the science community propose eight candidates – all relatively close to the equator.



Four possible landing sites are being considered for the ExoMars 2018 mission. The sites – **Mawrth Vallis**, **Oxia Planum**, **Hypanis Vallis** and **Aram Dorsum** – all relatively close to the equator – are indicated in this context map. Following additional review by the Landing Site Selection Working Group, they have been formally recommended for further detailed analysis

Geological Arguments

- The area around **Mawrth Vallis** and nearby **Oxia Planum** contains one of the largest exposures of **rocks that are older than 3.8 billion years and clay-rich, indicating that water once played a role here.** Mawrth Vallis lies on the boundary between the highlands and lowlands and is one of the oldest outflow channels on Mars. The exposed rocks at both locations have varied compositions, indicating a variety of deposition and wetting environments. In addition, the material of interest has been exposed by erosion only within the last few hundred million years, meaning the rocks are still well preserved against damage from the planet's harsh radiation and oxidation environment.
- By contrast, **Hypanis Vallis** lies on an exhumed fluvial fan, thought to be the remnant of an ancient river delta at the end of a major valley network. Distinct layers of fine-grained sedimentary rocks provide access to material deposited about 3.45 billion years ago.
- Finally, the **Aram Dorsum** has an eponymous channel, curving from northeast to west across the location. The sedimentary rocks around the channel are thought to be alluvial sediments deposited much like those around Earth's River Nile. This region experienced both sustained water activity followed by burial, providing protection from radiation and oxidation for most of Mars' geological history, also making this a site with strong potential for finding preserved biosignatures.

Operational & Engineering Arguments

- All four sites are clearly interesting scientifically, but they must also allow for the operational and engineering requirements for safe landing and roving on the surface.
- Our preliminary evaluation indicates that Oxia Planum presents the fewest challenges
- Next come simulations to predict the probability of landing success based on the entry profile, atmospheric and terrain properties at each of the candidate sites.

Deadlines

- Certification of at least one site by the second half of 2016
- A final decision on the landing site for the ExoMars 2018 rover sometime in 2017. ##

Russia May Send Repeat Mission to Martian Moon Phobos in 2023

http://www.marsdaily.com/reports/**Russia_May_Send_Repeat_Mission_to_Martian_Moon_Phobos_in_2023**_999.html – OCT. 8, 2014

- Russia may attempt to repeat its Phobos-Grunt mission to Phobos in 2023.
- The prior probe, launched Nov. 9, 2011 failed to leave near-Earth orbit.
- The 2nd Phobos-Grunt is now in planning.
- Partnership with Europe (ESA) would be desirable.
- That the spacecraft will be manufactured by a Russian aerospace company s not ruled out

Phobos-Grunt probe at the Baikonur space center.

- The mission could be launched in 2023.
- It could become the first spacecraft to return a large sample from an extraterrestrial body since Luna 24 in 1976. ##

Russian Scientists Develop Mechanism for Rover's Descent to Mars

http://www.marsdaily.com/reports/**Russian_Scientists_Develop_Mechanism_for_Rovers_Descent_to_Mars**_999.html

OCT. 8, 2014 - Russian scientists have developed a unique mechanism for the rover's descent to the surface of Mars, designed specifically for the joint EU-Russia ExoMars research project.

- Their European colleagues want maximum safety for the rover, for it to be able to slide down, if necessary, to the surface of Mars in any direction.
- The solution presupposes the construction of two ramps upon which the rover will be able to drive off the landing deck.
- The joint ExoMars research program includes the launch of **the Trace Gas Orbiter (TGO) in 2016**, (land in 2018) with the goal of collecting data on atmospheric gases present in low concentrations.

The Exo-Mars Rover

- The project also involves **the exploration of ice found in Mars' soil**, as well as landing **the ExoMars Entry, Descent and Landing Demonstrator Module (EDM).**
- Its goals: perform a geological analysis of Mars soil and search for traces of life.
- Russia will create a landing deck and provide a range of unique scientific equipment for the Russian-European Mars mission.

NASA Mars Rover Laser Tech Adapted to Hunt Gas Leaks on Earth

OCT. 8, 2014 - http://www.space.com/27378-**mars-rover-laser-tech-gas-leaks**.html

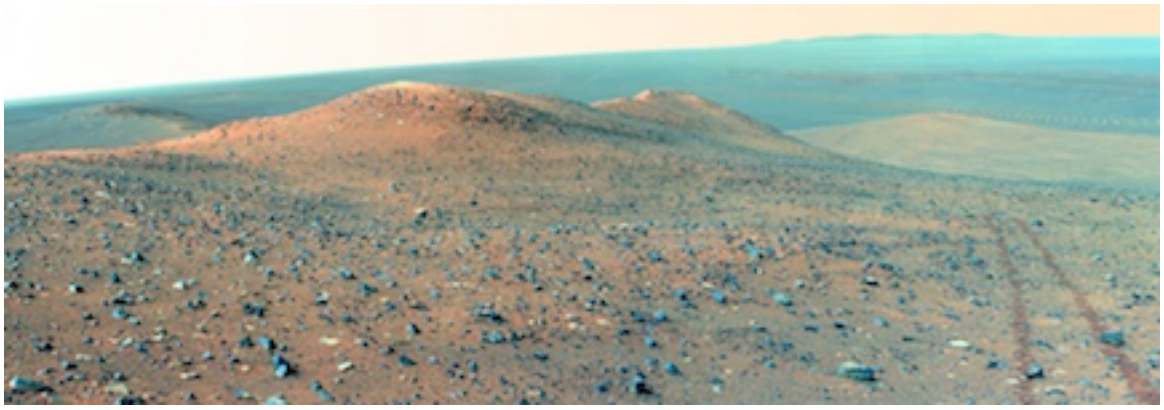
Engineers at JPL originally developed the laser technology to hunt for traces of methane on Mars, which could be a sign of possible Mars life.But methane is also one of the main components of natural gas on Earth, so the California-based Pacific Gas and Electric Company (PG&E) is incorporating

Curiosity's tech into a hand-held devices that could be used to quickly track down and repair potentially dangerous gas leaks. The technology is integrated into Curiosity's Tunable Laser Spectrometer.

- PG&E's adoption of this technology comes after a new law that requires the California Public Utilities Commission to start minimizing natural gas leaks from pipelines to curb greenhouse gas emissions.
- PG&E supplies electricity to nearly 40 percent of California.
- Many people consider natural gas a "bridge fuel" that could help wean humans off coal and push society toward greener, renewable energy sources. But natural gas comes with its own set of problems, including the environmental impact of fracking and concerns about pipeline safety.
- A variety of instruments in space and on the ground have detected methane in Mars' atmosphere over the years, but only in very low concentrations.
- The atmosphere around Mars is oxidizing, which means methane produced there should be converted into carbon dioxide relatively quickly.
- Any methane that found in Mars' atmosphere must have been produced recently, perhaps by comet strikes, water-rock interactions or, most intriguingly and controversially, by Martian lifeforms. ##

Opportunity's Northward View of 'Wdowiak Ridge' (False Color)

OCT. 18, 2014 - http://www.jpl.nasa.gov/spaceimages/details.php?id=pia18615



This vista from NASA's Mars Exploration Rover Opportunity shows "Wdowiak Ridge," from left foreground to center, as part of a northward look with the rover's tracks visible at right.

The ridge stands prominently on the western rim of Endeavour crater, about 200 yards~meters west of the rim's main crest line. Its informal name is a tribute to Opportunity science team member Thomas J. Wdowiak (1939-2013).

This panorama spans about 70° N-NW on the left to E-NE on the right. Wdowiak Ridge rises steeply about 12 m (40 ft) from base to top. It extends about 150 m (500 ft) in length. For scale, the distance between Opportunity's parallel wheel tracks is about 1 m (3.3 ft).

This version of the image is presented **in false color, which enhances visibility of the wheel tracks.**

Editor: Wish the colors were real! Future Martians could sure enjoy the dash of blue or aqua rocks against otherwise monotonously monotone landscapes. -- PK

Mars Express Flies over Becquerel Crater

DEC, 23, 2014 - www.marsdaily.com/reports/**Flying_over_Becquerel**_999.html (and Video movie)

This latest release from the camera on ESA's Mars Express is a simulated flight over the Becquerel crater, showing **large-scale deposits of sedimentary material**.

- The 167 km-diameter (104 mi) Becquerel crater isin the Arabia Terra region, straddling the transition between the rough southern highlands and the smoother northern lowlands on Mars.
- Its floor has a fine display of layered sedimentary deposits, studied in detail using images and spectral data from NASA's Mars Global Surveyor and Mars Reconnaissance Observatory missions.
- This new Mars Express movie provides an excellent overview of the wider context.

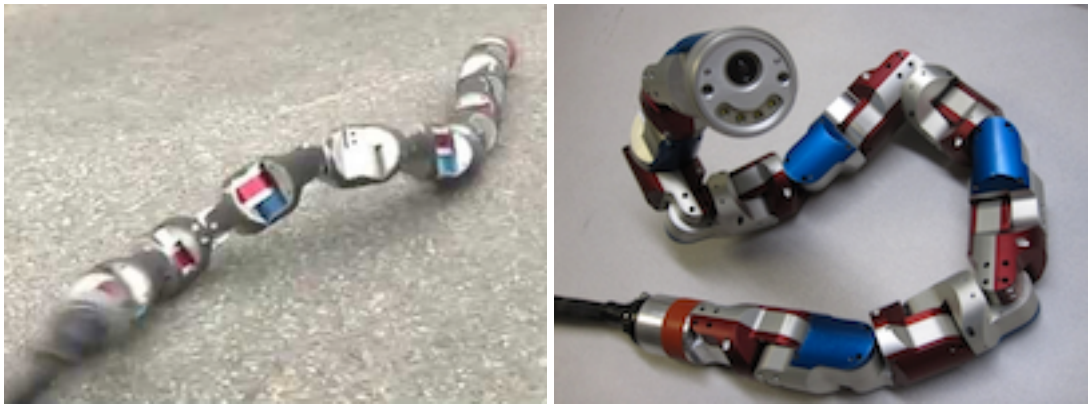
- The light-toned deposits are known to be composed of sulphate-bearing rocks. On Earth, sulphates such as gypsum result from the evaporation of water
- The common occurrence of layered sedimentary deposits in Arabia Terra points towards a key role having been played by water in laying down them down.
- Apparently, an initial impact crater was later filled by **wind-blown sediments** and/or volcanic ash, mixed with **upwelling ground water** in the low-lying crater floor.
- The sequence of layers could corm from seasonal variations or episodic oscillations in aMs' axis.
- Subsequent erosion by wind can leave a mound of sediments.
- Evidence for this is seen in the dark material surrounding the light-toned sedimentary deposits, thought to be wind-blown dust from a source somewhere to the northl.
- These theories are being hotly debated in the scientific community and additional ground-truth data is needed ito resolve the controversy.
- Gale crater being explored by Curiosity is also home to a large mound of sedimentary deposits known as Mount Sharp. ##

A Robot's Superior Ability to Climb "Sandy" Hills (on Moon and Mars)

http://www.sciencemag.org/content/346/6206/204.3.short

What's that coming over the hill—is it a robot?

[Not a free article. You must pay to read it - what follows is from an unnamed reader]



http://news.sciencemag.org/physics/2014/10/**sidewinder-robots-slither-snakes**

"Crossing a slope can be difficult, particularly if it is made of sand. Sidewinder rattlesnakes manage to climb sandy hills by adjusting the length of their body in contact with the sand. Marvi et al. designed robots based on this idea to determine what affects climbing ability on sandy slopes (see the Perspective by Socha). Based on the behavior of the robots, the authors performed further animal studies, and used an iterative approach to improve the robots' capabilities and to better understand animal motion." ##

How to design Sidewinder robots to slither like snakes

In 2011, archaeologists needed to find out whether parts of ancient Egyptian boats were hidden in dangerously unstable man-made caves by the Red Sea. The perfect solution? At robotic snake outfitted one with a camera and sent slithering through the cave's narrow opening. But inside, the robot snake couldn't make its way up the cave's sandy slope, and the exploration was a bust.

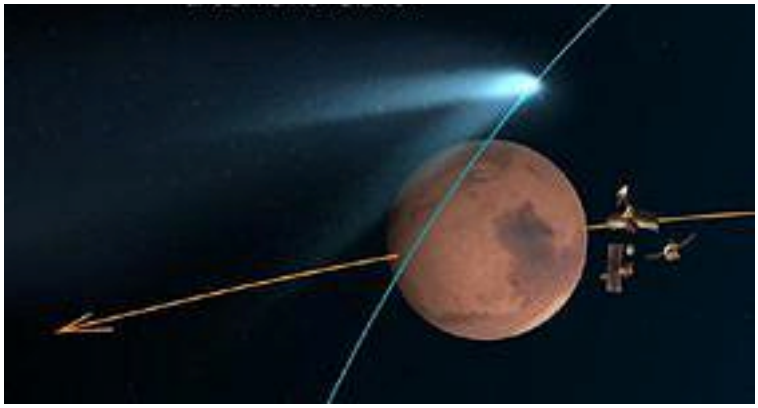
Now, by teaming up with researchers studying how live snakes move, a way to climb that mountain was found: what it takes to make snake robots go uphill, even on slippery, sandy slopes.

- First, these reptiles, real and robotic, are sidewinders—**they move forward not by slithering, but rather by wriggling their bodies perpendicular to the direction of travel in a undulating S-shaped wave.**
- That motion that enables a snake to go uphill. But to maintain a grip on an incline, the snake **modifies its motion to keep more of its body touching the ground as it moves**.
- These insights could lead to robots that do better on rough terrain than robots with wheels

- As it moves, a sidewinder sends a horizontal wave down its body. At the same time, it undulates up and down. As a result, the parts of the body on the ground push off while the airborne loops reach upslope, where they then make contact to push off.
- On flat ground, at any moment the rattlers have 25% of their body in contact with the ground. But the snakes tune their motion to the terrain. On a slope of 10°, 40% of the body remains in contact with the ground. That fraction increases to 45% on a 30° slope.
- In making the adjustment, a snake has to balance two factors. Too much contact and the reptile can't lift the other parts of the body high enough to reach up the slope. Too little contact, and the sand gives way under the snake's weight. These animals have found a sweet spot,
- They programmed the robot to move in a similar manner, then altered the waves to change how much of the robot's body was in contact with the sand at any one time. It, too, made it up through the sand.
- By tweaking the two waves, they made their snake robots do what the snake can't do, such as turn on a dime. These attributes may lead to robots that can snake their way through rubble in disaster zones to find trapped people or that can inspect nuclear power plants. ##

NASA Prepares its Science Fleet for Oct. 19 Mars Comet Encounter

www.spacedaily.com/reports/**NASA_Prepares_its_Science_Fleet_for_Oct__19_Mars_Comet_Encounter_**999.html http://www.space.com/27449-**mars-comet-close-encounter-infographic**.html
http://www.marsdaily.com/reports/**Comets_Close_Encounter_One_in_a_Million**_999.html



Left: Artist rendering **Right:** Actual photo of the event by Hubble Telescope

OCT. 11, 2014 - NASA's extensive fleet of science assets, particularly those orbiting and roving Mars, have front row seats to image and study a once-in-a-lifetime comet flyby on Sunday, Oct. 19. **Comet C/2013 A1**, also known as **comet Siding Spring**, will pass within about 87,000 miles (139,500 kilometers) of the Red Planet -- less than half the distance between Earth and the Moon and less than one-tenth the distance of any known comet flyby of Earth

- Siding Spring's nucleus will come closest to Mars around 11:27 a.m. PDT (2:27 p.m. EDT), hurtling at about 126,000 mph (56 kilometers per second).
- This proximity will provide an unprecedented opportunity for researchers to gather data on both the comet and its effect on the Martian atmosphere.
- This particular comet has never before entered the inner solar system, so it will provide a fresh source of clues to our solar system's earliest days.
- Siding Spring came from the Oort Cloud, a spherical region of space surrounding our sun and occupying space at a distance between 5,000 and 100,000 times Earth's distance from the Sun. It is a giant swarm of icy objects believed to be material left over from the formation of the solar system.
- Siding Spring will be the first comet from the Oort Cloud to be studied up close by spacecraft
- An invaluable opportunity to learn more about the materials, including water and carbon compounds, that existed during the formation of the solar system 4.6 billion years ago.
- During the comet fly-by, NASA programmed its orbiters to take measurements and images, then "duck and cover" behind the planet, just in case.

- In preparation for the comet flyby, NASA maneuvered its Mars Odyssey orbiter, Mars Reconnaissance Orbiter, and the Mars Atmosphere and Volatile EvolutioN (MAVEN), in order to reduce the risk of impact with high-velocity dust particles coming off the comet.
- The period of greatest risk to orbiting spacecraft will start about 90 minutes after the closest approach of the comet's nucleus and will last about 20 minutes, when Mars will come closest to the center of the widening trail of dust flying from the nucleus.
- The hazard is not an impact of the comet nucleus itself, but the trail of debris coming from it. Using constraints provided by Earth-based observations, the modeling results indicate that the hazard is not as great as first anticipated. Mars will be right at the edge of the debris cloud, so it might encounter some of the particles -- or it might not.
- The atmosphere of Mars, though much thinner that Earth's, will shield NASA Mars rovers Opportunity and Curiosity from any comet dust that reaches the planet. Both rovers are scheduled to make observations of the comet.

NASA's Mars orbiters will gather information before, during and after the flyby about the size, rotation and activity of the comet's nucleus

- The variability and gas composition of the coma around the nucleus
- the size and distribution of dust particles in the comet's tail.
- Observations of the Martian atmosphere are designed to check for possible meteor trails, changes in distribution of neutral and charged particles, and effects of the comet on air temperature and clouds.
- MAVEN will have a particularly good opportunity to study the comet, and how its tenuous atmosphere, or coma, interacts with Mars' upper atmosphere.
- Earth-based and space telescopes, including the Hubble Space Telescope, will be in position to observe the unique celestial object.
- The agency's astrophysics space observatories -- Kepler, Swift, Spitzer, Chandra -- and the ground-based Infrared Telescope Facility on Mauna Kea, Hawaii -- also will be tracking the event.
- NASA's asteroid hunter, the Near-Earth Object Wide-field Infrared Survey Explorer (NEOWISE), has been imaging, and will continue to image, the comet as part of its operations.
- The agency's two Heliophysics spacecraft, Solar TErrestrial RElations Observatory (STEREO) and Solar and Heliophysics Observatory (SOHO), also will image the comet.
- NASA's Balloon Observation Platform for Planetary Science (BOPPS), a sub-orbital balloon-carried telescope, has provided observations of the comet in the lead-up to the close encounter with Mars.
- Images and updates will be posted **online** before and after the comet flyby. ##

Siding Springs Encounter with Mars: Revealing Results

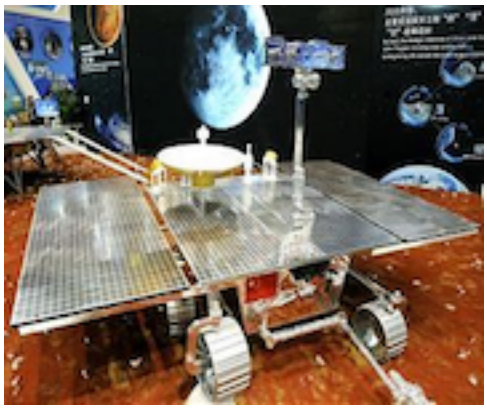
Excerpt from: http://www.space.com/28062-**best-astronomy-stories-2014**.html

- "The orbiters were able to study the effect of the massive dust dump, which "**literally changed**" **the Martian atmosphere**. (temporarily)
- The dust contained **high levels of sodium**, which would likely have given the sky a yellowish hue as it fell through the Martian atmosphere and burned up.
- Early analyses also detected **iron, zinc, potassium, manganese, nickel and chromium**.
- The dust also contained **high levels of magnesium**, which was a significant contrast to the Martian atmosphere. ##

China developing Mars rover

NOV. 12, 2014 www.spacedaily.com/reports/China_Exclusive_**China_developing_Mars_rover**_999.html
http://english.people.com.cn/n/2014/1112/c202936-8807773.html

- China's planned Mars vehicle will be larger, tougher and a better climber than its lunar rover.
- A real-sized model of the Mars rover is on display at the Airshow China 2014 in Zhuhai City.
- The mockup's design is tentative.
- It may have six wheels, like Yutu, but will be larger in size and better at crossing obstacles.



Prototype model of a Mars rover on display at
the China International Industry Fair in Shanghai.

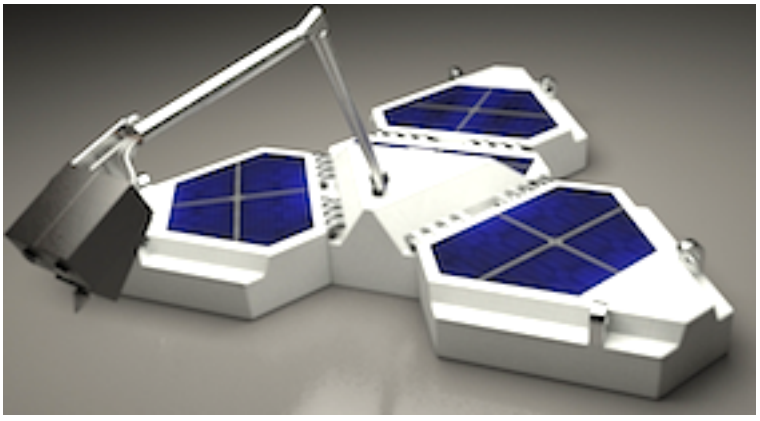
- Yutu can climb over obstacles no higher than 20cm, but has to bypass larger rocks, of which, Mars is full. So designers are seeking to improve the rover's adaptability to complex territory. Mars' environment is more complicated and adverse than that the Moon's. The worst scenario – dust storms – could significantly lower the energy output of the solar battery
- The 2-meter-long (6+ ft) model on display is the prototype. Final looks and functions under study.
- China plans to land a Mars rover around 2020, collect samples and bring them back around 2030.
- The rover will be solar-powered, weight similar to Spirit and Opportunity about 180 kg.
- Still early in the design process, the capsule's parachute and heat-proof structure that will enable it to land in the extremely thin air, one of the hardest parts of the Mars mission.
- Forty-three probes have been sent to Mars since 1960, of which 19 – 43% – succeeded. ##

Canadian Project Aims to Land 'Beaver' Mini Rover on Mars late 2018

DEC. 05, 2014 – www.space.com/27919-**canada-mars-rover-beaver**.html

A Canadian company, **Thoth Technology**, wants to land a couple of robots on Mars in late 2018, but to do so, it might needs pubic crowdfunding help.

The mission, called **Northern Light**, would deliver **a lander and a mini rover called "Beaver"** to Mars in the next four years.



Left: Prototype **Right: Artist's conception** of the Northern Light lander and robotic arm.

- The goal is to look for **biomarker gases that could indicate biological sources like methane**.
- The rover will have the capability to **grind into rocks, to determine the environment in which they were formed**.
- No landing site has been selected yet, but it will likely be close to the equator for maximum sunshine.

[Editor: As Mars axis is tilted like Earth's, the latitude of "maximum sunshine" depends on the season time. It could be anywhere from 21° N to 21° S]

- The full cost of the mission is expected to add up to $980,000, Roberts said. An Indiegogo campaign has raised roughly C$6,000 ($5,320) of that, and will close Jan. 3.
- More money will be needed to buy a ride on a rocket and to operate the mission from the Algonquin Radio Observatory, a Canadian telescope owned by Thoth Technology that would serve as the link between Mars and Earth.

Smart roving

- The lander, rover, instrument package and entry system will weigh about 75 kg (165 lbs) – about 30 % of the weight of NASA's Sojourner/Pathfinder mission — the first rover on Mars landing in 1997.
- But the 6 kg (13-lb.) Beaver will be much smarter than the larger Pathfinder rover, working almost fully autonomously during its planned 90-day mission on the surface.
- In contrast, the much larger Curiosity and Opportunity rovers require frequent guidance from NASA.
- The mini rover will be equipped with sensors to provide information on holes and obstacles, and will feed that data to an algorithm that uses probability to figure out where the rover should go next.
- Beaver will assess the need to avoid obstacles in accordance with science objectives for the mission.
- At each decision point, the rover can determine whether to drive forward, or to turn right or left slowly or quickly.
- As the company has only one ground station, they will be limited to an 8-hour contact period per day for tele-operation.
- But the rover can decide on its own how to explore the environment whenever it has the solar power available for motion.
- With this approach, the rover will be able to roam up to 1 km (0.6 mi) from the landing site.
- If the rover had to wait for commands, it wouldn't be able to go nearly that far. ##

New idea for transporting spacecraft could ease trip to Mars

www.marsdaily.com/reports/**New_idea_for_transporting_spacecraft_could_ease_trip_to_Mars**_999.html

DEC. 23, 2014 - A new method, **ballistic capture**, for transporting robotic rovers, satellites and astronaut-carrying spacecraft to Mars could save time and money, over **Hohmann transfer**.

- The traditional method for getting a spacecraft into orbit around Mars is the "Hohmann transfer." After leaving Earth's atmosphere, the craft makes a beeline for Mars at high speeds. As it approaches Mars, its thrusters fire in the opposite direction -- reducing speed and swinging the craft into orbit.
- Aa highly effective move -- road-tested and reliable Hohman Transfer is expensive and time specific with launches limited to a brief window when the orbit and rotation of Earth and Mars are just right.
- Ballistic capture, however, would allow **a more flexible launch window** and also do away with fuel-guzzling high-speed braking requires.
- Ballistic capture would see the spacecraft launched out ahead of Mars' orbital path, gradually slow and hold in place, waiting for Mars to swing by --its gravity pulling the craft into orbit as it approached.
- Ballistic capture offers the potential to enable cheaper more frequent visits to Mars.
- Proponents of Ballitic Capture are willing to admit that it isn't perfect. It takes **much longer than the typical six-month straight shot** that has spit a number of Mars current orbiters into their paths around the Red Planet.
- Ballistic capture would also put a craft into a much higher orbit than prefered for scientific missions.
- The new study also considers other options,including **aerocapture**, whereby a Hohmann transfer is tweaked to allow Mars' atmosphere to do some work in slowing down the craft's approach, reducing the fuel burned during the braking.
- NASA has used the ballistic capture technique on one of its lunar missions -- the GRAIL mission in 2011. The European Space Agency also used the technique for its SMART-1 lunar mission in 2004. ##

HUMANS TO MARS

NASA Seeks Ultra-lightweight Materials to Help Enable Journey to Mars

http://www.nasa.gov/press/2014/october/**nasa-seeks-ultra-lightweight-materials-to-help-enable-journey-to-mars**

Game Changing Development Program - Less weight requires less fuel

- Develop and demonstrate scalable and cost-effective manufacturing approaches to produce ultra-lightweight core materials both as flat panels and curved structures.
- NASA seeks proposals to develop & manufacture ultra-lightweight materials for aerospace vehicles and structures of the future that demonstrate **lower-mass alternatives to honeycomb or foam cores currently used in composite sandwich structures**.
- Composite sandwich structures are a special type of material made by attaching two thin skins to a lightweight core, a type of composite used extensively within the aerospace industry and in other applications where reducing weight while maintaining structural strength is important.
- A common use for these sorts of composites is the shrouds for launch vehicles and other key technology components that will enable our journey to Mars.
- The final products should have half or less the area density of conventional honeycomb cores, with equal or better mechanical properties.

NASA's Space Technology Mission Directorate (STMD) will continue to seek industry and university, partnerships to assure the agency has the capabilities it needs, focusing on

- In-space propulsion
- Advanced high-power solar arrays;
- Robotics
- Avionics for outer planetary exploration, especially high-reliability
- Low-mass, deep ice penetration systems (Europa etc.);
- Advanced materials, including large composite structures;
- Space observatory systems, with a focus on advanced optical coating materials.

The reduced mass will increase mission capability while decreasing mission costs and also may provide spinoffs that benefit diverse sectors of the economy and increase the nation's competitiveness.

Proposals will be accepted from U.S. organizations, including NASA centers and other government agencies, federally funded research and development centers, educational institutions, industry and nonprofit organizations.

NASA expects to make two awards of up to $550,000 each for this first development phase.

SpaceTech-REDDI-2015 NNH15ZOA001N-15GCD-C1 Ultra-lightweight Core Materials for Efficient Load-Bearing Composite Sandwich Structures Appendix, is available through the NASA Solicitation and Proposal Integrated Review and Evaluation System website by going to "Solicitations" and then "Open Solicitations" at: http://nspires.nasaprs.com/ ##

NASA Eyes Crew Deep Sleep Option for Mars Mission

"Putting a crew in stasis cuts baseline mission requirements from c. 400 tons to c. 220 tons"

OCT. 4, 2014 - http://www.space.com/27348-**nasa-mars-crew-deep-sleep**.html

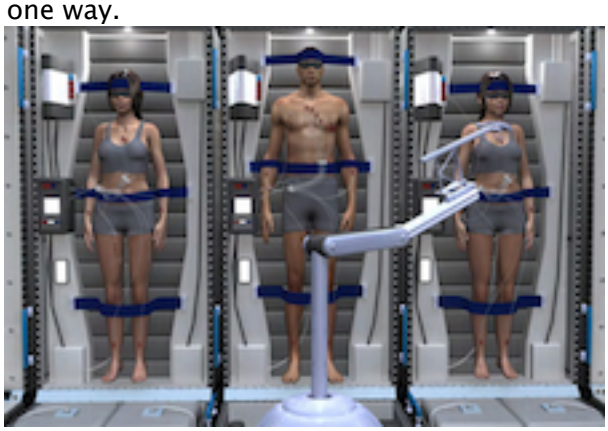
http://www.space.com/25684-**nasa-dreams-of-bootprints-on-mars-video**.html

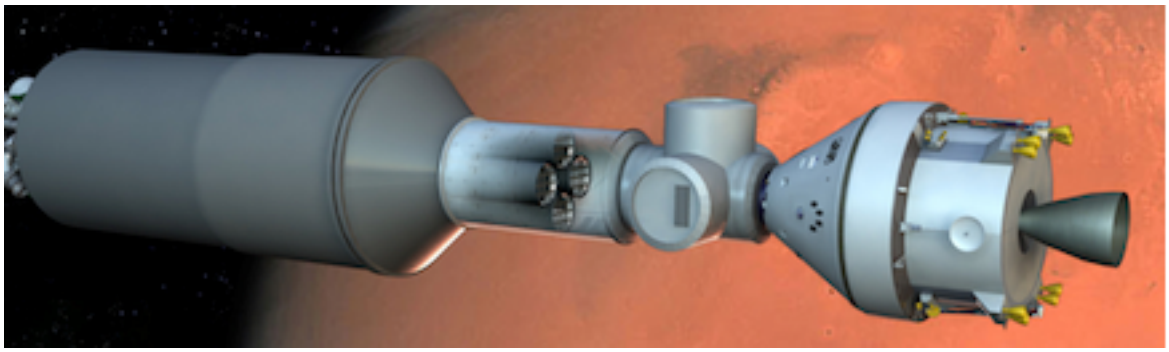
www.space.com/images/i/000/032/107/**original/deep-space-hibernation**-130826b-02.jpg?1377535389

A NASA-backed study explores an innovative way to dramatically cut the cost of a human expedition to Mars -- **put the crew "in stasis."** During interplanetary transit, the crew would receive low-level electrical impulses to key muscle groups to prevent muscular atrophy.

- The deep sleep or torpor, would reduce astronauts' metabolic functions with existing medical procedures. (Torpor can occur naturally in cases of hypothermia.)
- Therapeutic torpor has been a staple for critical care trauma patients in hospitals since 2003 Protocols exist in most major medical centers for inducing therapeutic hypothermia on patients to essentially keep them alive until they can get the kind of treatment that they need.

- Coupled with intravenous feeding, a crew could be put in hibernation for the transit time to Mars, about 180 days (6 months) one way.





Concept of a manned Mars spacecraft with a stasis habitat for hibernating astronauts (tubes at center).

- But so far, the duration of a patient's time in torpor state has been limited to about one week.
- We need to push that to 90 days, 180 days for the types of mission flight times we're talking about.
- Economically, the payoff looks impressive. **Crews can live inside smaller ships with fewer amenities like galleys, exercise, gear and of course water, food and clothing.**
- One design includes a spinning habitat to provide low-gravity to help offset bone and muscle loss.
- SpaceWorks' study, funded by NASA, shows a 5-fold reduction in the amount of pressurized volume for a hibernating crew and a 3-fold reduction in the total amount of consumables like food/water. ##

NASA Selects Advanced Oxygen Recovery Proposals for Mars Missions

http://www.nasa.gov/press/2014/october/**nasa-selects-advanced-oxygen-recovery-proposals-for-spacecraft-missions**

OCT. 7, 2014 - NASA has selected four partners to develop **game changing technologies to increase the oxygen recovery rate aboard human spacecraft by 75 percent while achieving high reliability.**

- These oxygen recovery/recycling technologies will drive human exploration to Mars and beyond.
- Sustained technology investments must be made to mature the capabilities required to reach the challenging destinations that await exploration; such as cis-lunar space, an asteroid, and Mars.
- "These ambitious projects are an example of how technology drives exploration."
- **Phase I awards are up to $750,000**, providing awardees with the funding for **15 months to complete the engineering development unit hardware phase**.
- Technologies selected tfor Phase II will develop prototype hardware with NASA support that provides up to $2 million per award for up to 24 months.

The organizations selected to develop advanced life-support technologies are:

- NASA's Glenn Research Center, Cleveland: "**Oxygen Recovery from Carbon Dioxide Using Ion Exchange Membrane Electrolysis Technology**"

- Glenn Research Center: "**A Combined Solid Oxide Co-Electrolyzer and Carbon Formation Reactor System for Spacecraft Life Support Oxygen Regeneration**"
- UMPQUA Research Co., Myrtle Creek, Oregon: "**Continuous Bosch Reactor**"
- U. Texas Arlington: "**Microfluidic Electrochemical Reactor for Oxygen Recovery via Carbon Dioxide Electrolysis**

In October 2010, aboard the International Space Station, NASA astronaut and Expedition 25 commander Doug Wheelock installed the Sabatier system, which extracts more water out of the ISS atmosphere. Sabatier creates water from the byproducts of the station's Oxygen Generation System and Carbon Dioxide Removal Assembly.

- Future maturation of these technologies may use ISS as a proving ground to retire risk and gain experience with capabilities needed for deep-space exploration.
- The advanced technologies found in these proposals are called for in **NASA's space technology roadmaps and space technology strategic investment plans**.
- **NASA Space Technology Roadmaps and Priorities**" identifies long-duration environmental control and life support systems as one of five **areas wth the greatest impact on deep space exploration.**
- Proposals were received from NASA centers, universities, research groups and industry.
- These awards are managed by the **Game Changing Development Program**.
- NASA's **Langley Research Center** manages the Game Changing Development Program.
- During the next 18 months, several more solicitations will be released, investing in high priority technology areas where advances are needed "**to achieve more capable, reliable and affordable science, exploration and commercial space capabilities**."
- NASA's Space Technology Mission Directorate remains committed to developing the critical, broadly applicable technologies required to enable future exploration missions beyond low-Earth orbit. ##

MIT study finds 'Mars One' passengers could die of starvation

www.marsdaily.com/reports/**MIT_study_finds_Mars_One_passengers_could_die_of_starvation**_999.html

OCT. 11, 2014 - **Mars One** is a nonprofit that has plans to put humans on Mars by 2025

Doctoral students at MIT believe current plans could put the colonists at risk of starving to death.

- The students used public information to simulate the mission and found that under the current plan for growing crops inside, it will be difficult to grow enough food for the colony and maintain safe oxygen levels.
- Their habitation simulations revealed that **crop growth, if large enough to provide 100% of the settlement's food, will produce unsafe oxygen levels in the habitat.**
- As a result, **some form of oxygen removal system would be required** -- a technology that has not yet been developed for spaceflight;"
- Over 200,000 people applied to be part of the one-way mission to Mars, but only 25 to 40 people will be chosen for the mission.
- The organization plans to produce a reality TV show that will document the lives of the first people to ever go to the planet.

[The editor has pointed out that on the basis of illustrations such as the one above, Mars One plans also do not provide for any, let alone an adequate blanket of Mars dust shielding against cosmic radiation: unlike Earth, Mars, having no molten magnetic core, does not have built-in protection such as the Van Allen Belts. Shielding would also help mitigate harsh Martian winters.}

MIT Students: Private Mars Colony "Project has Problems"

http://www.space.com/27451-**private-mars-colony-feasibility-study**.html
http://www.space.com/20764-**how-to-die-on-mars-the-mars-one-project-explained-video**.html

Organizers of a private Mars colonization effort may have to rethink their ambitious plans. An analysis led by students at the Massachusetts Institute of Technology (MIT) has identified a few purported problems with the blueprint laid out by the Netherlands-based nonprofit Mars One which aims to land four people on the Red Planet in 2025 as the vanguard of a permanent settlement.

The students are not saying, black and white, "Mars One is infeasible," but that it's not really feasible under the assumptions they've made about the technologies that could be helpful to invest in with high priority, to move them along the feasibility path."

The MIT student team analysis has identified a few purported problems with the blueprint laid out by the Netherlands-based nonprofit Mars One, which aims to land four people on the Red Planet in 2025 as the vanguard of a permanent settlement.

The study team looked at many different aspects of the proposed Mars One mission, from the rockets needed to get gear to the Red Planet to the details of how settlers would grow their food.

The results are sobering for would-be colonists, more than 200,000 of whom have applied to be a one-way Mars One astronaut. (There are no plans at the moment to bring the settlers back to Earth.)

Weaknesses in Mars One Goals

- Mars One aims to source the colony's drinking water on-site by baking Red Planet soil, which is known to harbor water ice, at least in some locations. But the technology needed to do this is not yet ready to fly on a space mission.
- The new analysis suggests that growing crops within settlers' habitats, would generate enough oxygen to make the living spaces a fire hazard.
- Piping in nitrogen could lower the oxygen to safe levels, but this fix would likely deprive the colony of a vital gas needed to compensate for leakage into the surrounding Martian atmophere. The possible end result? A space that would quickly become unlivable, suffocating colonists after about 10 weeks.

Ways to prevent this scenario:

√ growing food in isolated greenhouses
√ implementing an oxygen-extraction system.
√ Bring all the colony's food from Earth, the study determined.

- On Mars, you need lighting and watering systems, and for lighting, we found it requires 875 LED [light-emitting diode] systems, which fail over time. So you need to provide spare parts for that, making the initial system heavier.

- Mars One will probably need to launch a large quantity of spare parts in the early going, since resupply missions can blast off only once every 26 months, when Earth and the Red Planet are favorably aligned.
- Some 15 launches of SpaceX's Falcon Heavy rocket would be needed to get the colony set up for the first settlers' arrival — far more than the six that Mars One has envisioned.
- The multibillion-dollar project may be more expensive than Mars One representatives have estimated. (The intend is to pay most of its bills by staging a global media event around the colonization effort.)

Mars One is standing firmly behind its plans, however.

√ "The mission design has been discussed with engineering teams from aerospace companies like Paragon Space Development and Lockheed Martin," - Mars One co-founder and CEO Bas Lansdorp

√ "Engineers have actually been building these systems: each team we talked to is leading in the world.

√ Our current mission design is the result of our own studies and their feedback, and we are very confident that our budgets, timelines and requirements are feasible."

√ Mars One is glad that the Mars One project has inspired students to investigate the prospect of colonizing the Red Planet. "While students can probably not do better mission assessments than experts, they do tend to come up with very original ideas which are required for new developments." ##

"Mars One" Project Wants Help Choosing 2018 Lander Experiments

DEC. 2, 2013 - www.space.com/27901-**mars-one-lander-science-experiments**.html

You can help choose one of the science payloads that the Mars One "colonization" effort plans to launch toward Mars in 2018.

Netherlands-based nonprofit Mars One has selected 10 finalists from dozens of payload ideas submitted by **university** groups around the world.

One of these "unique and creative " experiments will be chosen to fly on Mars One's robotic lander mission in 2018 — and the public will pick the winner.

The ten finalists:

- Cyano Knights - Generating O2 out of CO2 (Germany)
- HELENA - Oxygen Production & Art Time Capsule (Australia)
- MARA-DS: Material Radiation Degradation Study (USA)
- Mars Micro-Greenhouse (United Kingdom)
- MIDDAS: Mars Ice Deposit Detection by Application of Seismology
- PECR: PhotoElectroChemicalReduction of CO2 (India)
- Seed (Portugal, Spain, and the Netherlands
- S.P.A.R.C.: Sensing Pressure and Atmospheric Research Console (USA)
- Urine Greenbox

For more information on each of these ten experiment proposals, see:
http://www.mars-one.com/news/press-releases/**mars-one-announces-ten-potential-university-payloads-to-fly-to-mars-in-2018**

The winning university payload will be announced on January 5th, 2015.

Mars One game plan

- Mars One aims to land four people on the Red Planet in 2025 as the vanguard of a permanent colony. New crews would arrive every two years thereafter, building up the settlement.
- There are no plans to bring any of these pioneers back home to Earth.
- The 2018 mission will send a robotic lander and orbiter to Mars to demonstrate some of the technologies necessary for human settlement.
- Unmanned missions in 2020 and 2022 will launch a scouting rover and lots of cargo to the Red Planet.
- Mars One plans to pay for its ambitious activities primarily by staging **a global media event around the entire effort,** from astronaut selection through the colonists' time on the Red Planet. More than 200,000 people applied to be Mars One astronauts; about 700 candidates remain, and interviews will soon narrow this pool down further. ##

Buzz Aldrin Says One-Way Trips to Mars Could Actually Work

OCT. 23, 2014 - http://www.space.com/27517-**buzz-aldrin-one-way-mars-trips**.htm

During a panel at MIT's AeroAstro 100 conference October 22nd, panelists pointed out the shortcomings of the Mars One program that need to be addressed if the project is not going to fail.

But Apollo 11 moonwalker Buzz Aldrin wants to send people on a trip to Mars, and doesn't want them to come home — at least not at first. The time and resources needed to get humans to Mars only make sense if the astronauts stay there and help to jump-start an outpost on the new world, he said

> **"It** [will] **cost the world — and the U.S.** — **billions and billions of dollars to put these people there, and you're going to bring them back?**
>
> **"What are you going to do when you bring them back here that can possibly compare [to] the value that they would be if they stayed there and Mars wasn't empty?**
>
> **"And then, they helped to work with the next group and it builds up a cadre of people.**
>
> **"When we've got 100 — or whatever it is — then we start bringing people back."**

Editor: For what it's worth, we've always felt the same way, "**Mars to Stay**" is the only plan that makes any sense. Cf, a number of articles reprinted in the MMM Mars Theme issue
http://www.moonsociety.org/publications/mmm_themes/mmmt_Mars.pdf
Specifically: MMM #19 Mars: Option to Stay
MMM #113 Marsandback, No! - Marstostay, Yes!
MMM #223 Mars: The Audacity to Stay
MMM #243 Most Economic Way to Open Mars; Only Going to Mars to Stay makes Sense
MMM #263 Marooned on Mars? We need to go "Prepared"

New Sci-Fi Film puts humans in real Marsscapes visited by Opportunity

DEC. 1, 2014 - http://www.space.com/27895-wanderers-science-fiction-short-film.html
www.theverge.com/2014/11/30/7310433/wanderers-sci-fi-short-film-imagines-when-humans-conquer-the-solar-system
http://www.huffingtonpost.com/2014/11/30/**wanderers-short-film**_n_6244990.html
http://**vimeo**.com/108650530 - http://www.erikwernquist.com/**wanderers**/

"**WANDERERS** is a short science fiction film by Erik Wernquist – a digital artist and animator from Stockholm, Sweden. This image from the film makes use of **photo taken by NASA's Opportunity Mars rover and provides true landscape** while adding in future Red Planet expeditionary crew.

"The film is a vision of humanity's future expansion into the solar system. Although admittedly speculative, the visuals in the film are all based on scientific ideas and concepts of what our future in space might look like, if it ever happens."

Best writeup: www.popsci.com/sci-fi-short-**wanderers-will-inspire-you-explore-solar-system**

[Most of the "editor's summaries" of news articles are in the form of bullet points of the contents. For the full text, see the links cited. - Peter Kokh kokhmmm@aol.com]

Proposed "Asteroid Day" to Raise Awareness of Space Rock Threat

DEC. 3, 2014 - www.space.com/27921-**asteroid-day-dangerous-near-earth-objects**.html
www.asteroidday.org
www.space.com/20315-**milions-would-die-if-tunguska-sized-meteor-exploded-over-nyc-video**.html
www.space.com/13524-**deflecting-killer-asteroids-earth-impact-methods**.html
www.space.com/16336-**private-asteroid-sentinel-space-telescope-infographic**.html

Humanity can dramatically reduce its vulnerability to cataclysmic asteroid strikes with just a little extra funding and a little extra effort. That's the message of "Asteroid Day."

Asteroid Day has two goals:

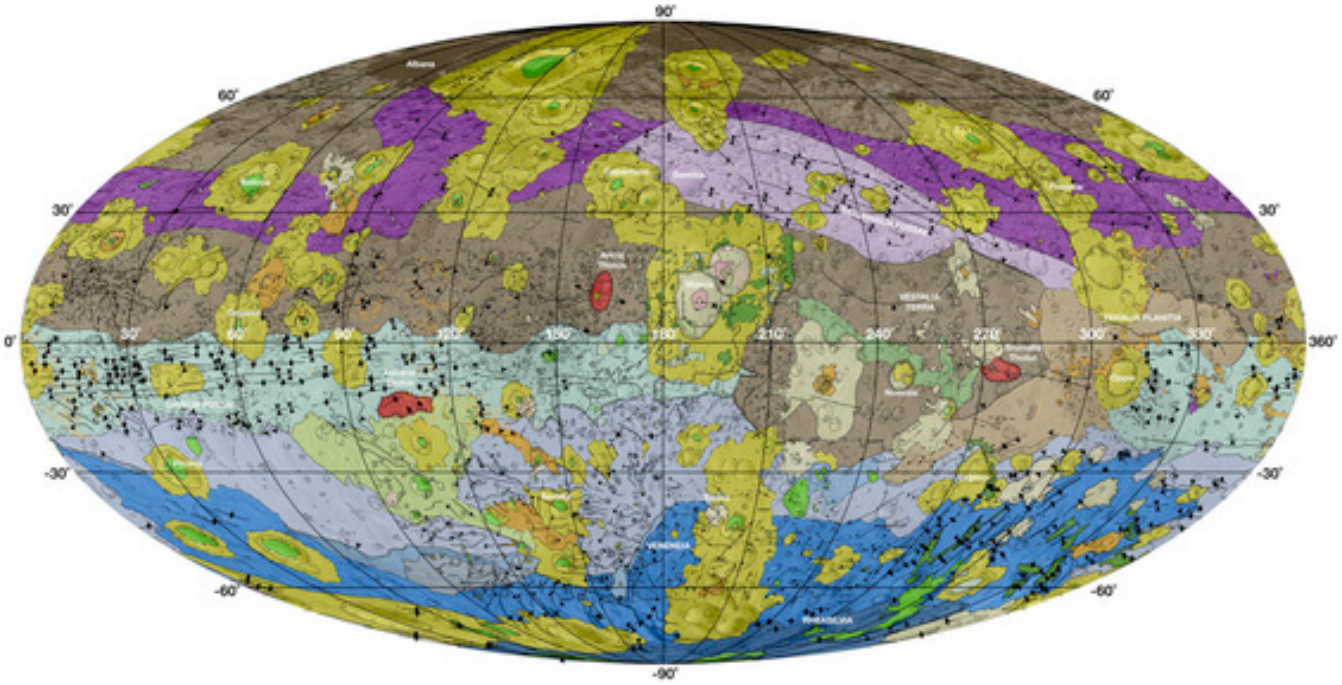
1. Raise awareness of the threats posed by space rocks
2. Boost the rate of near-Earth asteroid discovery a hundredfold.

- **This is a world problem which is avertable.**
- The 1st Asteroid Day would be **June 30, 2015**, the **107th anniversary of the "Tunguska ecent"** in 1908, when an object thought to be about 40 m (130 ft) wide exploded above the Siberian forest

- "If that event had taken place 6 1/2 hours later, Berlin would have rotated into the object's path, and that would have utterly changed the course of human civilization," said Bill Nye.
- Organizers are planning a series of events around the world for June 30, the first Asteroid Day
- Humanity has the know-how to prevent another Tunguska, researchers say:
- Threatening asteroids can be sped up or slowed down slightly, causing them to miss the planet.
- The ideal deflection effort would send a robotic "observer" probe out to rendezvous with the space rock, and then follow with a "kinetic impactor" to slam into the asteroid, altering its path
- The nonprofit B612 Foundation is developing an asteroid-hunting space telescope called "Sentinel" targeted for launch in 2018 or 2019.)
- Its imperative to find threatening objects early, when less effort is needed to deflect their course.
- NASA has found more than 95% of the really big NEOs out there — rocks at least 1 km (0.6 m) wide, large enough to threaten human civilization if they hit Earth — none of these poses a near term risk.
- There are probably about 1 million NEOs comparable in size to the one that caused the Tunguska event, and less than 1 percent of them have been spotted, according to Rusty Schweickart.
- A number of notable scientists and astronauts have signed Asteroid Day's "100X Declaration." ##

This Map of Vesta Is the Best Geologic Look Ever

NOV. 18, 2014 - http://www.space.com/27808-**asteroid-vesta-best-maps-dawn-mission**.html



http://i.space.com/images/i/000/043/806/original/geologic-map-earth.jpg?1416371115

High-resolution new maps show the cratered, rocky surface of Vesta in unprecedented detail. Images captured by NASA's Dawn spacecraft were woven together to create geologic maps of the giant asteroid. These most detailed ones yet of of Vesta's surface features serve as a geologic record of the asteroid that astronomers can compare to other planets and celestial bodies.

A special camera on the Dawn spacecraft made the geologic maps possible. The camera that uses seven different color filers that help analyze the different minerals covering Vesta's surface. The photos were used to create 3D topographic models, which were then converted into maps of the surface.

- Scientists combined 15 separate maps into one Vesta uber-map
- The map shows that meteorites have pummeled the asteroid since its formation about 10 million years after the birth of the solar system.
- Astronomers can piece together Vesta's geologic timeline based on the sequence of meteorite impacts.
- The **brown** colors on the map show the oldest and most heavily cratered areas on Vesta
- The **purple** shows where Vesta was struck by two large impactors;
- The **light purple** and **dark blue** colors show the interior basins of the two massive impacts.
- **Greens** and **yellows** show the youngest material on Vesta, which likely came from landslides or later meteorite strikes.
- It took over two years to sift through all the images and create the maps.
- Dawn is now on its way to the dwarf planet Ceres, and will likely arrive in March 2015.

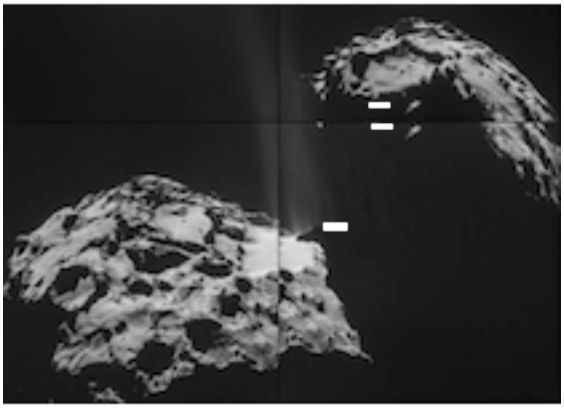
Rosetta Spacecraft's Comet Companion Is Spouting Jets (Photo)

OCT. 3, 2014 - http://www.space.com/27337-**rosetta-spacecraft-comet-jets-photo**.html
http://www.esa.int/spaceinvideos/Videos/2014/11/**Once_upon_a_time_preparing_for_comet_landing**

ESA's Rosetta spacecraft's comet target is starting to wake up as it gets closer and closer to the sun. Rosetta arrived in orbit around Comet 67P/Churyumov-Gerasimenko in August after a 10-year deep-space chase, has photographed jets of gas and dust erupting from the icy wanderer's surface.

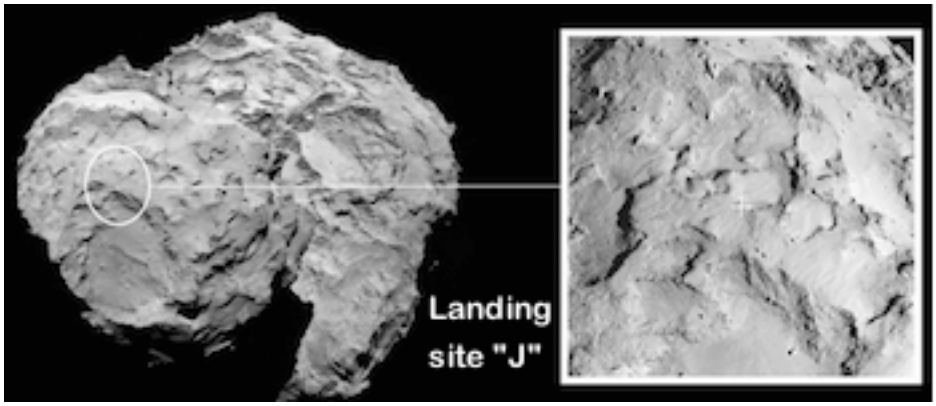
- The highllght of this image is the spectacular region of activity at the neck of 67P/C-G," in a 4-image montage taken on Sept. 26 when Rosetta was 26 km **"Putting a crew in stasis cuts baseline mission requirements from c. 400 tons to c. 220 tons"** from the comet.

- **We are seeing the product of ices sublimating and gases escaping from inside the comet, carrying streams of dust out into space.**
- As the comet gets progressively closer to the sun along its orbit, the surface will become warmer, and the level of activity will increase, producing a vast coma around the nucleus, along with a tail.
- The $1.7 billion (1.3 billion euros) Rosetta mission launched in March 2004 and took a circuitous path through space, finally catching up to the 2.5-mile-wide (4 km) Comet 67P on Aug. 6 of this year. On that date, **Rosetta became the first probe ever to orbit a comet.**



White lines point to jets

Full image: http://i.space.com/images/i/000/042/610/i02/**rosetta-jets-comet**-67p.jpg

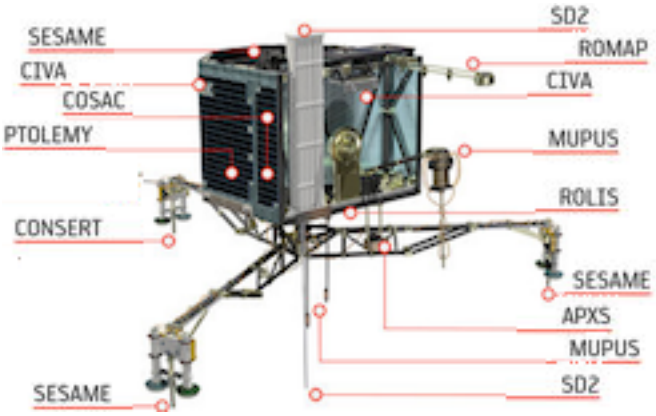


- On Nov. 12, the **Philae** lander will spiral slowly down toward the comet and, become the first robot to make a soft touchdown on a comet and snap photos and analyze samples of the comet.
- Rosetta should continue studying 67P through at least December 2015, observing how the icy body changes as it approaches the sun. ## blogs.esa.int/rosetta/2014/10/03/measuring-comet-67pc-g/

Philae bounce-lands successfully on comet

NOV. 12, 2014 -http://www.space.com/27761-philae-comet-landing-bounces-first-photos.html
http://www.space.com/27762-comet-landing-surface-and-descent-pics-beamed-to-earth-video.html
http://www.space.com/27757-rosetta-comet-landing-philae-science.html
http://www.esa.int/spaceinimages/Images/2014/11/Welcome_to_a_comet
http://www.space.com/27755-rosetta-comet-probe-landed-twice.html
http://www.space.com/27750-rosetta-comet-landing-photo.html
http://www.esa.int/Our_Activities/Space_Science/Rosetta/**Pioneering_Philae_completes_main_mission_before_hibernation**
http://www.marsdaily.com/reports/**Comet_lander_working_well_but_may_be_on_slope**_999.html
http://www.esa.int/var/esa/storage/images/esa_multimedia/images/2014/11/**comet_from_40_metres**/15051064-1-eng-GB/
http://www.esa.int/Our_Activities/Space_Science/Rosetta/**Three_touchdowns_for_Rosetta_s_lander**

comet from 40 meters up  full size image below



http://www.space.com/27774-**philae-comet-landing-drill-battery**.html

- Philae's drill instrument is designed to help scientists understand exactly what the icy world is made of, to potentially unlock secrets of the solar system's past.
- Philae's landing marks the first time humans have ever soft-landed a probe on the face of a comet.

Philae Comet Lander Falls Silent as Batteries Run Out

NOV. 15, 2014 - http://www.space.com/27782-**philae-comet-lander-silent-no-batteries**.html
http://www.space.com/27767-**philae-comet-landing-nearly-failed-infographic**.html
http://phys.org/news/2014-11-**comet-scientists-straight-days**.html

The first spacecraft ever to land on a comet has fallen silent, entering a long, cold sleep after running out of power. Its last transmission was on Nov. 14 at 0036 GMT before settling into hibernation as its batteries ran out. Philae had been studying the surface of Comet 67P/Churyumov-Gerasimenko for 57 hours when it went to sleep, possibly for good, after landing on the comet 2 days earlier.

- Philae unexpectedly bounced twice before landing when its anchor-harpoon system failed to fire.
- It ended up in a cliff on the head of the 4 km (2.5 mi) wide comet shaped like giant rubber duck.
- All 10 instruments on the probe, including a drill to bite into the comet, performed their jobs.
- Philae's solar panels never received enough sunlight to recharge its batteries.
- Before Philae's power ran out, ESA scientists commanded the lander to lift its body by about 4 cm (1.6 in) and rotate its top by 35° in the hope of moving its solar arrays into a more sun-favorable position.
- There is a chance that as the comet continues through the inner solar system, Philae may get enough solar energy to wake up and "phone home."
- As Rosetta continues to orbit the comet, it will continue to listen for a signal from Philae on the off chance the lander can still say hello.
- Rosetta will continue to listen for a signal, each time its orbit brings it into line-of-sight visibility with Philae, But it is unlikely that contact will be re-established with the lander in the near future.
- The Rosetta mission launched in 2004, traveling 6.4 billion km (4 billion mi) to reach Comet 67P/C-G.
- Rosetta will study the comet on its trip through the inner solar system, through December 2015. ##

Philae comet probe sends back science treasure in final hours

NOV. 15, 2014 - http://phys.org/news/2014-11-**comet-probe-science-treasure-hours**.html
http://www.space.com/27801-**philae-comet-lander-recovery-possible**.html

Europe's science probe Philae sent home a treasure trove of data from a comet heading towards the Sun before falling silent as its power ran out, mission control said Saturday.

Crowning a historic feat, the robot lab streamed data from its experiments back to its mother ship Rosetta in the final hours before its battery ran down.

- An eagerly-waited chemistry test of a sample drilled from the comet's icy and dusty surface.
- Lacking power, its instruments and most systems went into standby mode after three days of non-stop work, sending back data that will keep scientists busy for years.
- Philae had landed in a dark shadow after a bouncy triple touchdown. As a result, it did not get enough sunlight to recharge its batteries sufficiently to continue beyond its initial 60-hour work programme.
- Mission engineers do not rule out making contact with the lander in the coming months as Comet 67P/Churyumov-Gerasimenko moves closer to the Sun.
- Conceived more than 20 years ago, the Rosetta mission aims at shedding light on the origins of the Solar System 4.6 billion years ago, and maybe even life on Earth. ##

Rosetta Mission casts doubt that ancient comets brought water to Earth

http://news.sciencemag.org/sifter/2014/12/**rosetta-mission-casts-doubt-that-ancient-comets-brought-water-to-earth** - www.bbc.com/news/science-environment-30414519

The European Space Agency's **Rosetta mission**, which landed a spacecraft called Philae on a comet last month, has sent back data that suggest that comets may not have brought water to Earth as previously believed.

An instrument on the Rosetta orbiter analyzed the thin atmosphere of the comet for the presence of deuterium—a rare hydrogen atom that contains an extra neutron. Deuterium hydrogen still participates in the formation of water (H2O), but the extra neutron makes it heavier.

The data show that water on the comet contains three times the amount of deuterium as water on Earth. If ancient comets had brought water to our planet, we would expect relatively similar amounts of the heavy water in both places. ##

Editor: This is a quite unexpected result and it forces us to rethink the history of the Solar System. It may mean that the so called cometary bombardment of the inner solar system when a passing star disturbed the Oort Cloud, did not happen.

This always seemed an absurd hypothesis to us from the beginning, as it would require comets in the Oort cloud to lose precisely all their relative angular momentum not just some. Personally, I'm delighted! ##

European Comet Lander Philae May Wake Up from Space Slumber

DEC. 17, 2014 = http://www.space.com/28041-**rosetta-comet-lander-philae-wakeup**.html

Europe's Philae comet lander may be about to wake up from its lengthy, unplanned slumber.

Philae, part of the European Space Agency's Rosetta mission, went into hibernation in mid-November, a few days after executing a dramatic and historic touchdown on the surface of Comet 67P/Churyumov-Gerasimenko — the first-ever soft landing on one of these icy relics from the solar system's formation.

- It is approaching summer in Philae's presumed location, so it could soon get enough energy to open its eyes and start working again.
- It all depends on how far the sun will rise over the ocal horizon.
- We still don't know exactly where on the comet Philae lander.
- However, images from the most recent campaign, which extended from Dec. 12 through Dec. 14, are still coming down to Earth, and at least one of them would show Philae's location.
- Philae should survive the frigid conditions on the comet's surface and be ready to go when the time comes, The lander and its 10 science instruments were designed to operate in the cold.
- The unplanned (final) landing site may even prove to be a blessing in disguise. Photos taken by Philae shortly after its touchdown show a landscape that has scientists licking their chops, eager to conduct a lengthier investigation.
- "The material that we have ahead of us is certainly fantastic. We see the building blocks we are looking for — icy material loaded with organics."
- The nearby cliff may also allow Philae to keep operating on the comet's surface for longer than scientists had anticipated. Comet 67P/C-G is currently zooming toward the sun, its closest approach coming in August 2015, when the icy body will be about 1.2 times as far from the Sun as is Earth.
- Scientists had thought that increasing temperatures would render Philae inoperable by February or March. The intended landing site, which Philae hit before bouncing away the first time, was very open. But, having landed in a shaded spot, the lander may be able to keep working for significantly longer.
- The Rosetta mothership continues to study Comet 67P/C-G from orbit, and will fly within 4 miles (6 km) of the comet's surface in February, returning imagery with a resolution of just a few inches per pixel, researchers said.
- In July or thereabouts, the team will attempt to fly Rosetta through a "jet" of material outgassing from 67P's surface,..
- The Rosetta mission is currently scheduled to operate until December 2015, but team members are looking at possibly extending the mission into 2016 to keep studying 67P.
- The team would like to land Rosetta on the comet when the probe's end is near, rather than simply letting its fuel run out in orbit.

Asteroid Lutetia's Hidden Side hosts Hidden Crater

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

About 21 Lutetia: http://en.wikipedia.org/wiki/**21_Lutetia**

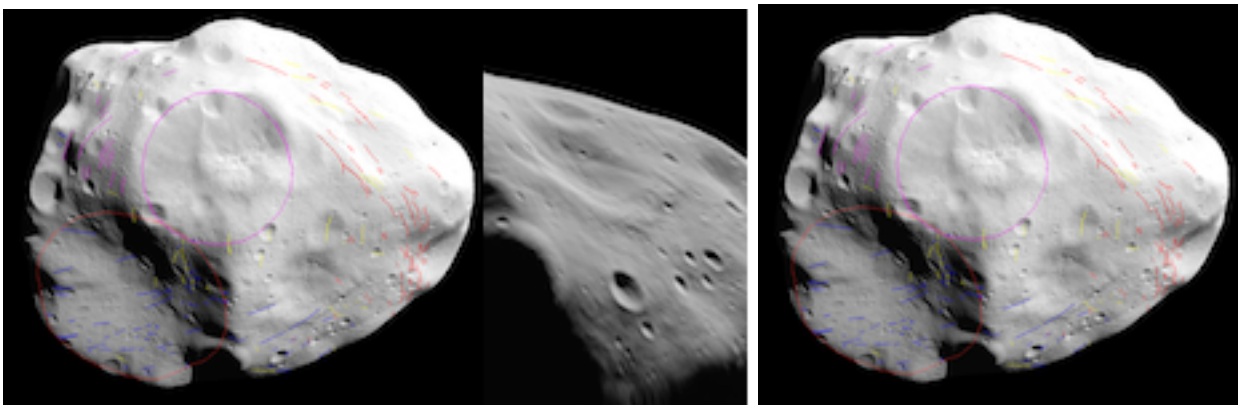
OCT. 3, 2014 - http://www.space.com/27337-**rosetta-spacecraft-comet-jets-photo**.html

http://blogs.esa.int/rosetta/2014/10/03/**measuring-comet**-67pc-g/

OCT. 8, 2014 - Grooves found on Lutetia, an asteroid encountered earlier by ESA's Rosetta spacecraft, point to the existence of a large impact crater on the unseen side of this rocky world.

- Rosetta flew past Lutetia at a distance of 3168 km in July 2010, en route to its 2014 rendezvous with its target comet, **67P/Churyumov-Gerasimenko**.
- Rosetta took images of the 100 km-wide asteroid for about two hours during the flyby, revealing numerous impact craters and hundreds of grooves all over the surface.
- Impact craters are commonly seen on all Solar System worlds with solid surfaces, recording an intense history of collisions between bodies. However, grooves are much less prevalent. To date, they have been discovered by visiting spacecraft only on Mars' moon Phobos and the asteroids Eros and Vesta.
- **From grooves to fractures**
- The way in which grooves are formed on these bodies mayinvolves impacts. Shock waves from the impact travel through the interior of a small, porous body and fracture the surface to form the grooves.
- For Lutetia, by assuming that the grooves were formed in concentric patterns around their source impact crater, 200 such features were identified, falling into distinct 'families', correlated with three different impact craters.

- One of the groove systems on Lutetia is associated with the Massilia crater, another with the North Pole Crater Cluster, comprising a number of superimposed craters. Both on the northern hemisphere.



21 Lutetia is a large main-belt asteroid of an unusual spectral type. It measures about 100 km (61 mi) in diameter 120 km (75 mi) along its major axis). It was named after Lutetia, the Roman name of the city that stood where Paris was later built.

Lutetia has an irregular shape and is heavily cratered, with the largest impact crater reaching 45 km (28 mi) in diameter. The surface is geologically heterogeneous and intersected by a system of grooves and scarps, thought to be fractures. Made of metal-rich rock, It has a high average density.

The Rosetta probe passed within 3,12 km (1,965 mi) of Lutetia in July 2010. It was the largest asteroid visited by a spacecraft until the Dawn mission arrived at 4 Vesta in July 2011. - wikipedia

A Hidden Connection: Three major impacts seriously deformed Lutetia's surface.

- A group of grooves on Lutetia points to a crater not seen by Rosetta, in the southern hemisphere.
- The inferred crater has the nickname '**Suspicio**'. The grooves related to Suspicio cover a large area on the asteroid, suggesting it may span several tens of kilometres . By comparison, **Massilia**, the largest known crater on **Lutetia**, about 55 km wide, and the largest of the polar cluster is about 34 km across.
- NOV. 6, 2014 - http://www.space.com/27662-**rosetta-comet-landing-site-agilkia**.html
  The Landing spot has been named "**Agilkia.**"
- By observing how subsequent small craters lie over the grooves on Lutetia, the scientists determined the relative ages of the three larger cratering events. Massilia is thought be the oldest of the three craters and the polar cluster the youngest, with Suspicio in between. ##

NASA's Asteroid-Capture Mission Won't Help Astronauts Reach Mars

OCT. 29, 2014 - http://www.space.com/27588-**nasa-asteroid-capture-mission-mars**.html

NASA's bold asteroid-capture mission is an expensive distraction that does little to advance the agency's overarching goal of getting humans to Mars, one prominent researcher argues.

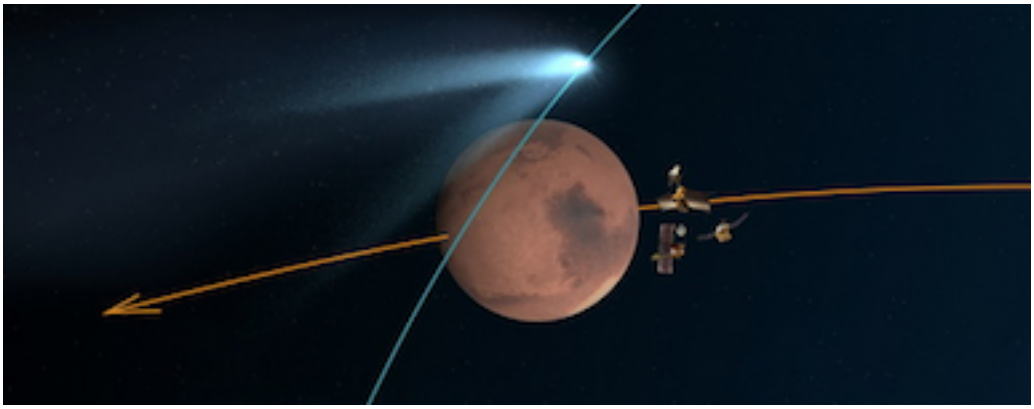
- For the past 18 months, NASA has been working on a plan to drag an entire near-Earth asteroid, or a boulder plucked from a large space rock, into lunar orbit using a robotic probe. The "captured" astrochunck could then be visited by astronauts aboard the agency's Orion crew capsule, ideally by 2025 at the latest.
- [**Editor:** See the report on Earth's mini-moons which are already "captured" and pastured in the Earth-Moon system at the top of the Moon Section, above]
- This "Asteroid Redirect Mission," ARM, will supposedly help develop the technologies and know-how required to send astronauts to Mars, which the space agency hopes to accomplish by the mid-2030s.
- [**Editor:** The counter claim is that "there's nothing about sending humans to Mars that requires us to capture an asteroid in a baggie. That would be a multibillion-dollar expenditure that is totally irrelevant. ##

PRE- & POST EVENT REPORT
As Comet Siding Spring nears Mars, NASA gears up for Epic Encounter

OCT. 9, 2014 - http://www.space.com/27395-**mars-comet-flyby-nasa-spacecraft**.html

http://www.space.com/20417-**collision-course-a-comet-heads-for-mars**.html - ideo

Comet Siding Spring will give Mars a historically close shave next weekend, and NASA aims to be ready for the dramatic cosmic event.



http://www.space.com/25257-**mars-comet-siding-spring-photos**-c2013-a1.html

NASA has trained its Mars orbiters and surface rovers on **Comet Siding Spring**, which will zoom within 139,500 km (87,000 mi) of Mars on October 19th. That separation is about a third the distance between Earth and the Moon.

- Their short assignment is to study the comet and its influence on Mars' atmosphere.
- This kind of close passage might happen once every million years - so it is a very special opportunity

First-time visitor

- Comet Siding Spring (C/2013 A1) was discovered in 2013 at Australia's Siding Spring Observatory.
- The comet is making its first trip through the inner solar system from the frigid, faraway Oort Cloud about 50,000 times the Earth-Sun distance — about 93 million miles, or 150 million km.
- Because Siding Spring has never been "heat-treated" before, the incoming comet likely remains largely unchanged since its formation 4.6 billion years ago.
- Studying its composition and behavior should provide clues about the conditions that existed at the birth of the solar system, as they're the remnants of our solar system's formation.
- Observations by a number of space telescopes, including NASA's Hubble, Swift, Spitzer and NEOWISE, have already returned some data on Siding Spring.
- From this early data, we think the comet's core is between 0.5 to 5 mi (0.8 to 8 km) in diameter.
- Further, the fuzzy cloud (or coma) surrounding Siding Spring's nucleus is about 160,000 km (100,000 mi) wide and its tail stretches for about 480,000 km (300,000 m (480,000 km).
- Beginning Oct. 19., NASA's three Mars orbiters — **Mars Odyssey**, the **Mars Reconnaissance Orbiter** (MRO) and the newly arrived **MAVEN** orbiter — will observe Siding Spring's flyby from space, while the agency's **Opportunity** and **Curiosity** rovers will watch from Mars' surface.
- Their new mission is to learn more about the comet's size, rotation speed, activity and composition.
- The interactions between comet particles and Mars' atmosphere could also help scientists better understand the Red Planet's air. MAVEN (**M**ars **A**tmosphere and **V**olatile **E**volutio**N**) is particularly well suited to perform this latter task, since the mission was designed to study Mars' upper atmosphere.

Expectations are high

- If all goes according to plan, MRO will take the 1st-ever good pictures of an Oort Cloud comet nucleus.
- Opportunity and Curiosity could make some history as well, if Martian dust storms don't cloud up the atmosphere too much.
- Various instruments will keep watching the comet after the flyby, as it recedes into space.

Protecting the spacecraft

- Siding Spring will sweep past Mars at about 203,000 kmh (126,000 mph) on Oct. 19th — so fast that even tiny particles shed by the comet could do some serious damage to an orbiting spacecraft.
- So NASA has taken pains to maneuver its Red Planet orbiters out of harm's way.
- When Mars gets very close to the dust tail, about 100 minutes after closest approach, all our spacecraft will be on the opposite side of the planet, So Mars itself will provide protected by Mars atmosphere. which, while just 1 % as dense as Earth's atmosphere, is still substantial enough. ##

Comet Siding Spring at Mars: How a Rare Celestial Event Was Discovered

www.space.com/27475-**comet-siding-spring**-mars-**history**.html

http://www.space.com/27468-**comet-siding-spring-s-mars-buzz-animated**.html

www.space.com/27479-**comet-s-mars-buzz-nasa-scientist-s-need-to-know-exclusive-video**.html

OCT. 12, 2014 – A comet that was born before the Earth formed is flying in from the edge of the solar system, bound for a dramatic date with Mars on Sunday, October 19, 2014. Comet Siding Spring—unknown and undiscovered until 2013 — will zoom past Mars Sunday afternoon in an encounter that could help scientists better understand how the solar system came to be.

- Siding Spring will fly 139,500 km (87,000 mi) from Mars at 2:27 p.m. EDT (1827 GMT) Sunday, about one-third of the distance from the Earth to the Moon. Researchers will observe the close encounter with the fleet of orbiters and rovers orbiting Mars or on its surface..
- This is the first comet from the Oort Cloud, a collection of icy bodies at the edge of the solar system that will be observed up close by spacecraft.
- ll comets examined in the past came from closer in, around Jupiter's orbit or the edge of the Kuiper Belt, a huge set of icy objects beyond Neptune.

"We can't get to an Oort Cloud comet with our current rockets," Carey Lisse, a senior astrophysicist at the Johns Hopkins University Applied Physics Laboratory, said during a NASA news conference last week. "These orbits are very long and extended — and at very great velocities ...

This is a free flyby, and that's a very fantastic event for us to study."

This comet's probable history

Siding Spring was created in the first few million years of Earth's solar system, Lisse said. It likely formed somewhere between the orbits of Jupiter and Neptune, where many similar objects coalesced into the giant planets. But a gravitational push kicked Siding Spring out into the Oort Cloud; it took another jolt from a passing star a million years ago or so to send it toward the inner solar system.

What the comet is like – our assumptions

- Half the comet is rocky, the other half volatile ices, such as water and carbon dioxide. Its flight past Mars is **the first time it will make it into the solar system, past Jupiter's orbit**. The comet had just crossed the "water-ice line," the point where water can exist as a liquid in the Solar System.
- About the size of an Appalachian mountain, Siding Spring will swing by Mars **in a retrograde direction, the opposite way in which the planets orbit around the Sun.** Any dust that comes off the comet will be moving at about 190,000 km/h (119,000 mph) relative to Mars.
- Anything that comes off the comet that hits either Mars or the spacecraft is going to pack a real large amount of kinetic energy
- That's one of the things those in charge of the orbiters now around Mars have been worried about.
- To meet these conditions, NASA has maneuvered its three operational Mars orbiters to be on the "safe" side of the Planet when dust exposure is highest.

NASA investigations

- To learn about the comet's shape, size and composition, an up-close look at its nucleus is necessary.
- **NASA's Mars Reconnaissance Orbiter will attempt to take high-resolution pictures of the comet's heart, making it the first time an Oort Cloud comet's nucleus will be seen up close.**
- NASA's **Hubble, Swift and Spitzer space telescopes** have mapped out the comet's dust, water molecules and carbon dioxide. The dust comes off more slowly than researchers had expected. Little activity was seen with the water ice until June, when it got close enough to the sun for ice to sublimate.
- Some other planned observations will come from NASA's Chandra X-Ray telescope, the newly arrived Mars Atmosphere and Volatile EvolutioN (**MAVEN**) mission.
- NASA's **Curiosity** and **Opportunity rovers** will also participate, attempting to take the first images of a comet from the surface of another planet.

Mars Reconnaissance Orbiter Studies Comet Siding Spring Flyby

http://www.marsdaily.com/**reports**/**Mars_Reconnaissance_Orbiter_Studies_Comet_Flyby**_999.html

OCT. 21, 2014 – NASA's Mars Reconnaissance Orbiter, which has sent home more data about Mars than all other missions combined, is also now providing data about a comet that buzzed The Red Planet.

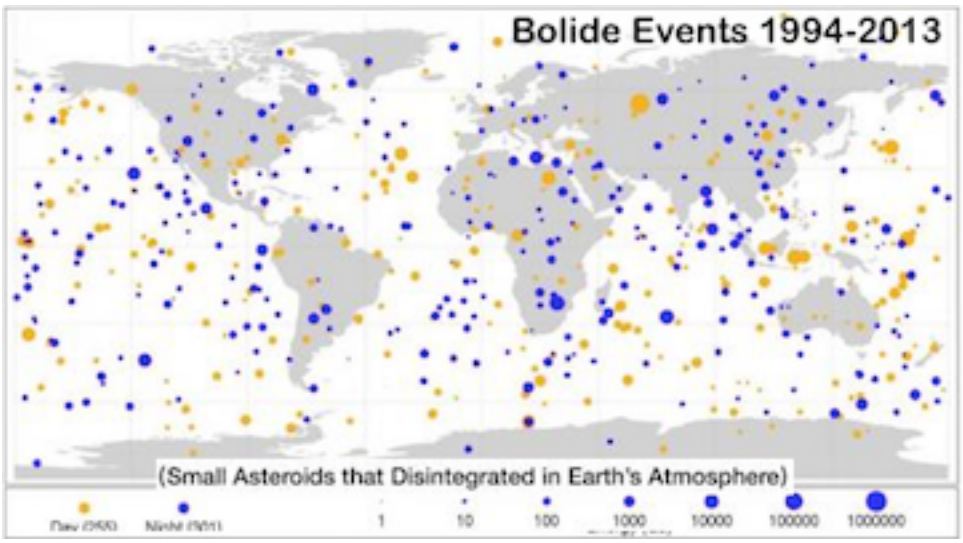
- The orbiter is in good health after sheltering behind Mars during the half hour when high-velocity dust particles from comet Siding Spring had the most chance of reaching the paths spacecraft i orbit Mars.
- This is the comet's first visit this close to the sun from the outer solar system's Oort Cloud, so concerted observation may yield fresh clues to our solar system's earliest days – 4+billion years ago.
- These instruments -- the High Resolution Imaging Science Experiment (**HiRISE**), the Compact Imaging Spectrometer for Mars (**CRISM**), and the Context Camera (**CTX**) -- also observed the comet for days before the flyby and continues to make observations of it since.
- The orbiter's other three instruments are being used to study possible effects of gas and dust in the comet's tail interacting with the atmosphere of Mars. These are the Mars Climate Sounder (**MCS**), the Mars Color Imager (**MARC**I) and the Mars Shallow Radar (S**HARAD**).
- Following the flyby, operators of NASA's MAVEN) orbiter are assessing the status of that orbiter and operators for NASA's Mars Odyssey are anticipating resumption of communications..
- Observing ojectives are to image the comet nucleus, study its surrounding coma of dust and gas, and to search for signatures of that material interacting with the Mars atmosphere. Observations of the comet will continue for another day or so, as the comet and Mars separate, with
- The comet (will)l reach(ed) its closest approach to the sun on Oct. 25. ##

New map: frequency of small asteroid impacts, clues on larger asteroids

http://phys.org/news/2014-11-**frequency-small-asteroid-impacts-clues**.html – NOV. 15, 2014

(Phys.org) —A map released tby NASA's Near Earth Object (NEO) Program reveals that small asteroids frequently enter and disintegrate in the Earth's atmosphere with random distribution around the globe.

- The map visualizes data gathered by U.S. government sensors from **1994 to 2013.**
- The data indicate that Earth's atmosphere was impacted by small asteroids, resulting in a bolide (or fireball), on 556 separate occasions in a 20-year period.
- Almost all asteroids of this size disintegrate in the atmosphere and are usually harmless.
- The notable exception was **the Chelyabinsk event**, the largest asteroid to hit Earth in this period.
- The new data could help scientists better refine estimates of the distribution of the sizes of NEOs including larger ones that could pose a danger to Earth.
- NASA has increased – by a factor of 10 – investments in asteroid detection, characterization and mitigation activities over the last five years. NASA has aggressively developed strategies and plans with its partners in the U.S. and abroad to detect, track and characterize NEOs.



Small asteroids impacting Earth's atmosphere to create very bright meteors, technically called "bolides" and commonly referred to as "fireballs". Sizes of red dots (daytime impacts)

- These activities also will help identify NEOs that might pose a risk of Earth impact, and further help inform developing options for planetary defense.
- The Asteroid Grand Challenge aims to create a plan to find all asteroid threats to human populations and know what to do about them.
- An Asteroid Redirect Mission (ARM) will identify, redirect and send astronauts to explore an asteroid.
- The mission could demonstrate basic planetary defense techniques for asteroid deflection.

Hayabusa 2 Mission Aims For Asteroid Sample-Return

DEC. 3, 2014 - www.space.com/27886-**japan-launches-asteroid-spacecraft-hayabusa2**.html

www.space.com/27910-**japan-hayabusa2-asteroid-mission-infographic**.html

www.space.com/27888-**ambitious-hayabusa-2-mission-aims-for-asteroid-sample-return-video**.html

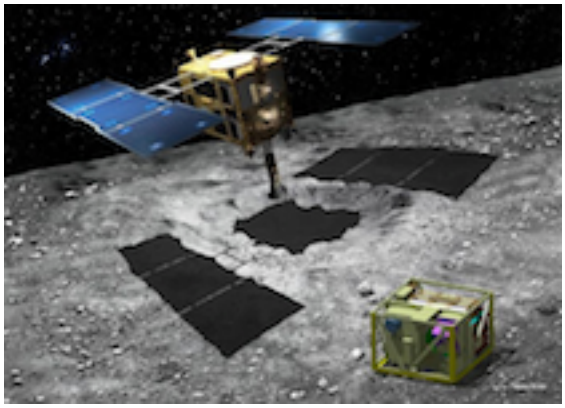
http://en.wikipedia.org/wiki/(162173)_1999_JU3

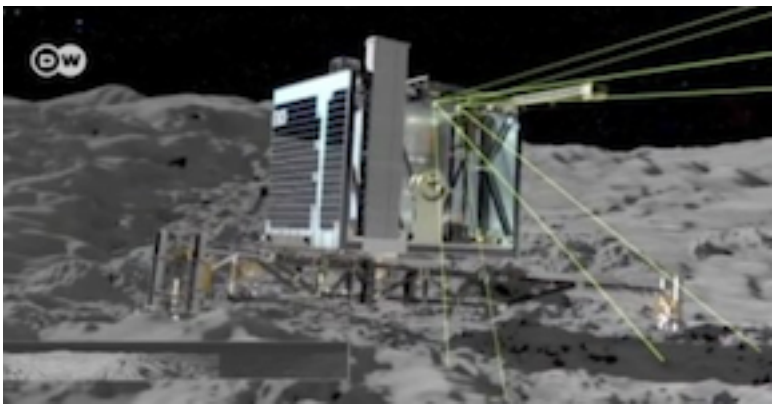
http://www.space.com/27886-**japan-launches-asteroid-spacecraft-hayabusa2**.html

www.dw.de/after-philaes-**comet-landing-germanys-mascot-lander-heads-for-an-asteroid**/a-18106196

http://www.sciencemag.org/content/346/6213/1040.short

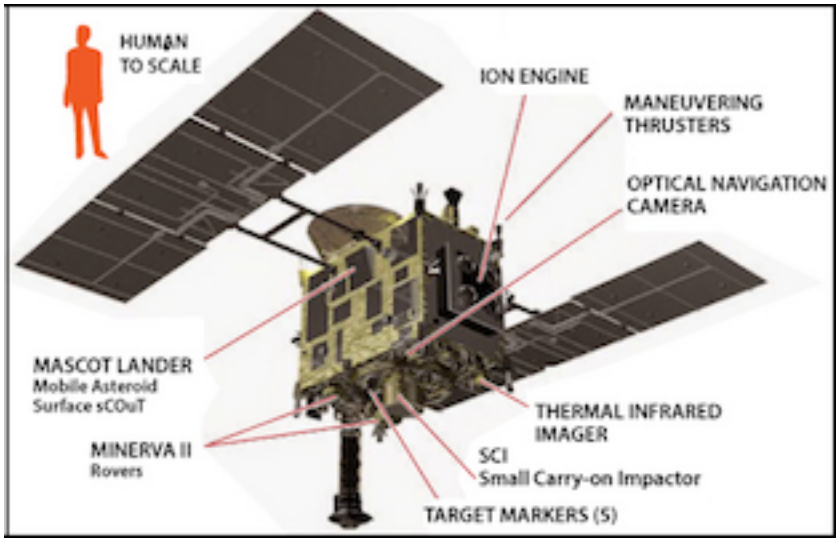
Japan Aerospace Exploration Agency's (JAXA) Hayabusa 2 asteroid mission launched from the country's Tanegashima Space Center, If all goes well, the spacecraft should return samples of the asteroid 1999 JU3 to Earth in late 2020.





Left: Hayabusa 2 Sampler **Right:** MASCOT lander

- "Hayabusa" means "**peregrine falcon**" in Japanese.
- Hayabusa2 is JAXA's bigger, bolder follow-up to its historic Hayabusa mission, which brought the first pristine asteroid samples from **asteroid Itokawa** to Earth in 2010 after its seven-year mission.



- It will explore unnamed **asteroid 1999 JU3** and will take samples 3 times during the mission.

√ Asteroid Dimensions 980 +/- 29 m (3215 +/ 95ft)

√ Asteroid Rotation period 0.3178 ± 0.0003 d = 7hr 37 m

- It will also use an ion engine to catch up with its target, and also collect rock samples and return them to a landing site in the Australian outback. But Hayabusa 2 is designed to get a larger sampling.
- Hayabusa2 carries backups of hardware that failed on the first Hayabusa, to ensure a successful return of asteroid samples.
- An explosive impact device (SCI) allows study the asteroid's composition from a safe distance.
- Unlike rocky (S-type) Itokawa, Asteroid 1999 JU3 is a so-called carbonaceous, or C-type, space rock. 1999 JU3 may hold water and organic materials.

  "Minerals and seawater which form the Earth as well as materials for life are believed to be strongly connected in the primitive solar nebula, We expect to clarify the origin of life by analyzing samples acquired from a primordial celestial body such as this asteroid to study organic matter and water in the solar system, and how they coexist while affecting each other."
- To reach asteroid 1999 JU3, Hayabusa2 will conduct an Earth flyby in 2015 to pick up speed, then aim for a rendezvous with its target in 2018.
- Hayabusa 2 will orbit the asteroid for 18 months, landing three times to pick up sample material.
- Hayabusa2 will deploy three rovers and a German/European lander called MASCOT, all of which will work independently on the surface to gather information on the asteroid's composition and history. ##

Space Rock Sheds Light on Mysterious Mineral on Earth

NOV. 28, 2014 - http://www.space.com/27884-**bridgmanite-mineral-meteorite**.html
http://news.sciencemag.org/earth/2014/11/**respect-long-overdue-earth-s-most-abundant-mineral-finally-gets-official-name**?

A rock from space is giving scientists the first glimpse of a mineral long thought to be **the most abundant mineral on Earth**, but which we lacked a natural sample of until now. This discovery could shed light on the structure and dynamics of Earth's interior, and on the early history of the solar system.

- The search for this mineral in meteorites has been going on for decades — it was just a matter of |finding the right method for detecting it.
- It is **a high density version of magnesium iron silicate**, the most abundant mineral on Earth, makin up about 38 % of the planet's volume. But it's only stable at very high pressures and temperatures.
- Until now, researchers had only seen lab-generated versions of it.

http://news.sciencemag.org/sites/default/files/styles/thumb_article_l/public/sn-**bridgmanite.jpg**
A thin section of a Tenham meteorite reveals a vein of bridgmanite.

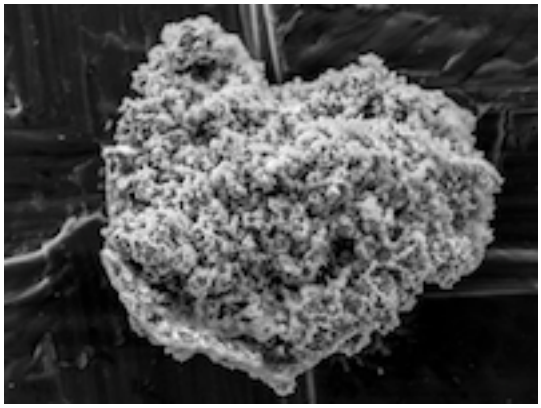
- Under the heat and pressure found in Earth's lower mantle, which extends from about **660-2,600 km (410-1,615 mi) below Eartht's surface**, magnesium silicate can form what is called a perovskite structure, which can be imagined as **an array of double pyramids that are joined at their corners. The centers of each pyramid are made of silicon, the apexes and corners are made of oxygen, and magnesium and iron reside in the spaces between each double pyramid**.
- Scientists had not discovered a naturally occurring version of this mineral until now — the mineral would not survive the long journey from the lower mantle to Earth's surface because it would readily morph into lower-density minerals.

- That scientists had not found any specimens of magnesium iron silicate perovskite in nature also meant **it could not get an official mineral name** from the International Mineralogical Association.
- Thus the most abundant one on Earth remained nameless **even though we knew its structure**.
- So researchers instead looked to space. They hypothesized that high speed cosmic impacts could generate the pressures and temperatures needed to create this mineral, and samples of it could then come to Earth as meteorites knocked off their parent asteroids or planets.
- A carefully isolated magnesium iron silicate perovskite has pw been given has the name "bridgmanite."
- Researchers analyzed a Tenham meteorite, from a meteor shower in Australian 1879. This meteorite bore signs that it was part of an asteroid that experienced a great impact. The stone also possessed minerals called akimotoite and ringwoodite, similar in composition and origin to bridgmanite.
- In prior attempts to find bridgmanite in meteorites, researchers often used electron microscopes. probing the rocks with electron beams that can turn bridgmanite to glass.
- Instead, high-energy X-rays from a synchrotron, a kind of particle accelerator were used.These rays do little damage to bridgmanite, thus helping the scientists prove its composition and crystal structure.
- They found that bridgmanite was higher in iron and sodium than they had expected based on synthetic samples - an interesting insights for what might be going on in the lower mantle,.
- Detecting bridgmanite in other meteorites could shed light on the strength of the impacts their parent bodies experienced. The pressures and durations of these impacts in turn would allow us to estimate the size of the parent bodies of these meteorites.
- With enough data, we can, for given points in time in the solar system's history, figure out how large bodies in the solar system were. ##

Comet Dust found in Antarctic Ice and Snow

DEC. 5, 2014 - http://news.sciencemag.org/space/2014/12/**comet-dust-found-antarctica**
www.sciencedirect.com/science/article/pii/S0012821X14007031

Past and present chondritic porous micrometeorites preserved on the Earth's surface



A single particle of comet dust collected from Antarctic ice,
as seen through an electron microscope. Full size image:
http://news.sciencemag.org/sites/default/files/styles/thumb_article_l/public/sn-cometdustH.jpg?itok=LAE3Z2-R

Researchers have discovered comet dust preserved in the ice and snow of Antarctica. This is the first time such particles have been found on Earth's surface. The discovery unlocks a promising new source of this material.

- The oldest astronomical particles available for study, comet dust can offer clues about how our solar system formed.
- Until recently, the only way scientists could collect "chondritic porous interplanetary dust particles," or comet dust, without going to space has been by flying research planes high in the stratosphere. Several hours of flying time typically yield one particle of dust.
- Working with such small samples significantly limits the kinds of tests and analysis scientists can perform on the material.
- In Antarctica, researchers found 2-4 more orders of magnitude mass potentially collectible this way.

Dust gathered in Antarctica is also cleaner.

- Until now, scientists gathered comet dust on plates coated with silicon oil to trap the particles. That leaves them contaminated with both the oil and the organic compounds later used to clean them.
- Comparing particles found in Antarctica with ones collected in the stratosphere will help scientists figure out which components of the dust are part of their natural chemical makeup and which come from contaminants.
- Previously, scientists thought the highly porous, extremely fragile particles couldn't survive on Earth.

How the particles were found

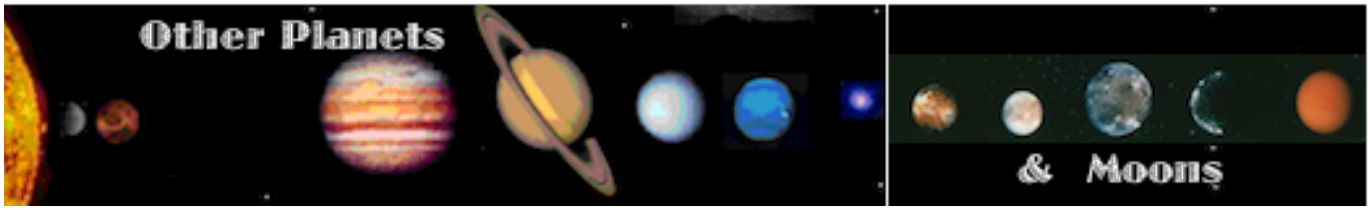
- Researchers collected snow and ice from two different sites in Antarctica starting in 2000.
- By melting the ice and filtering the water, they collected more than 3000 micrometeorites, tiny particles from space that were 10 microns in diameter or larger.
- Analyzing micrometeorites one by one under a stereomicroscope over a period of 5 years yielded more than 40 particles with the characteristics of comet dust.
- They were indistinguishable from comet dust collected in the stratosphere, and they also matched samples collected from the coma of a comet by NASA's Stardust mission in 2006.
- The result shows that such fragile particles can be preserved not only in … snow, but also in ice.
- A good next step would be to make a more detailed analysis of the organic material in the particles.
- "The study of this dust will shed more light on the material that served for planetary formation, ##

How to Spot Potentially Dazzling 'New Year's Comet' – "Q2"

DEC. 29, 2014 – www.space.com/28116-**comet-lovejoy-january-2015-skywatching**.html
http://en.wikipedia.org/wiki/C/2014_**Q2_(Lovejoy)**

A newfound comet could put on a spectacular show in Earth's skies this January. Catalogued as 2014 Q2, or Q2 for short — it should be a fine object to view in small telescopes and binoculars during much of January. In dark light pollution free skies, the comet may even be visible with the unaided eye.

- Amateur astronomer Terry Lovejoy first discovered 2014 Q2 just before dawn on Aug. 17, 2014, from his roll-off roof observatory in Birkdale, Queensland, Australia.
- As of Dec. 26, Lovejoy was shining at magnitude 5.3.
- Observers using binoculars and small telescopes have described it as a circular patch of white light, about half the apparent width of the Moon), brighter near the center and fading off around the edges.
- The size of the comet's coma (atmosphere surrounding the cosmic body's nucleus) currently measures about 369,000 km (c. 229,000 mi) (comparable to the distance between Earth and the Moon.
- No tail has been reported, but a wispy, narrow appendage extends outward from the comet
- The coma has strong greenish hue due to the presence of cyanogen, a poisonous gas, as well as diatomic carbon: both glow green when illuminated by sunlight. This is called "resonant fluorescence."
- The comet will reach its closest point to Earth — 43.6 million miles (70.2 million km) — on Jan. 7.
- The comet should be at its brightest around Jan. 7, shining as bright as magnitude 4.6, thus making it one of the brightest comets located high in a dark sky since Comet Holmes in October 2007.
- That's a bit brighter than Eta Ursae Minoris, the faintest of four stars in the bowl of the Little Dipper. So, If you can see all four stars in the Little Dipper's bowl, you should be able to see the comet. ##

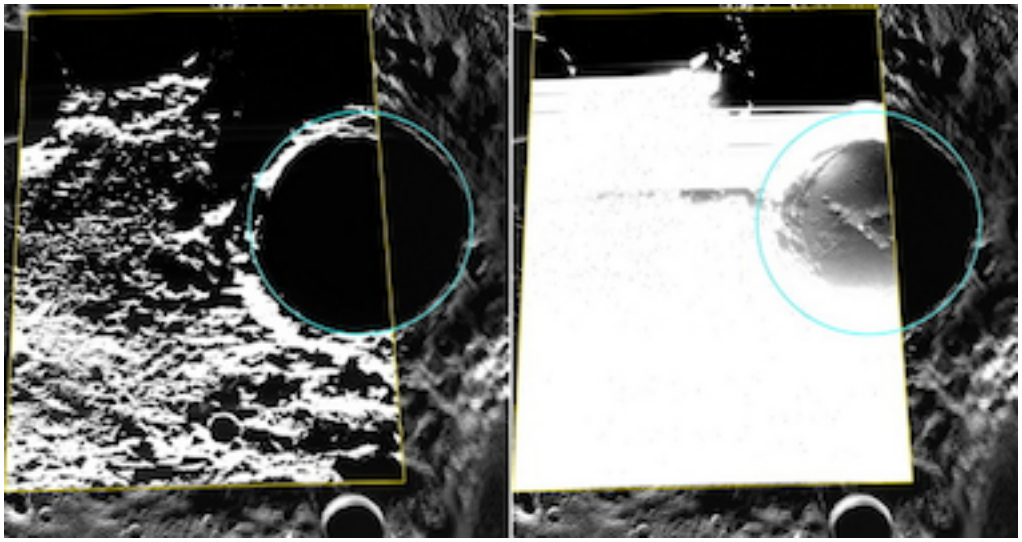


[Most of the "editor's summaries" of news articles are in the form of bullet points of the contents.
For the full text, see the links cited. - Peter Kokh kokhmmm@aol.com]

MERCURY

First Photos of Water Ice on Mercury Captured by NASA Spacecraft

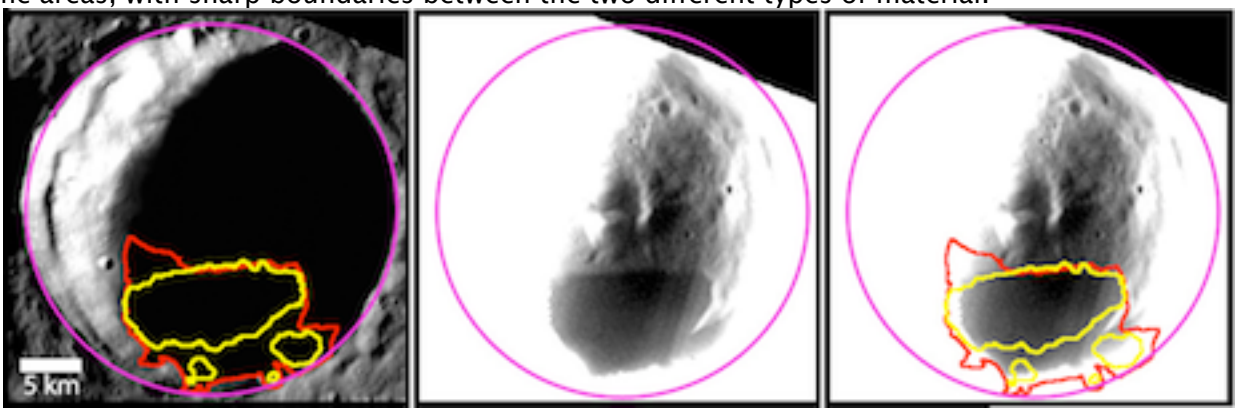
OCT. 15, 2014 - http://www.space.com/27450-**messenger-mercury-water-ice-photos**.html
http://www.space.com/18690-**water-ice-on-mercury-how-it-was-found-video**.html



Full size: http://i.space.com/images/i/000/042/862/i02/mercury-messenger-kandinsky-geology.jpg
Kandinsky crater lies near Mercury's north pole, and may have hosted water ice. MESSENGER spacecraft's Wide Angle Camera broadband image appears at left, outlined in yellow, and superimposed on an MDIS polar mosaic. The view on the right shows the same image but with the brightness and contrast adjusted to show details of the crater's shadowed floor.

- The first-ever photos of water ice near Mercury's north pole have quite a story to tell.
- The images, taken by NASA's MESSENGER orbiter(short for MErcury Surface, Space ENvironment, GEochemistry, and Ranging), suggest that the ice lurking within Mercury's polar craters was **delivered recently**, and **may even be topped up by processes that continue today**, researchers.
- More than 20 years ago, Earth-based radar imaging first spotted signs of water ice near Mercury's north and south poles — a surprise, perhaps, given that temperatures on the solar system's innermost planet can top 427 °C (800 °F).
- In late 2012, MESSENGER confirmed those observations from orbit around Mercury,discovering ice in permanently shadowed craters near the planet's north pole
- This find was announced after integrating results from thermal modeling studies with data gathered by the probe's hydrogen-hunting neutron spectrometer and its laser altimeter, which measured the reflectance of the deposits.
- Now the MESSENGER team has captured optical-light images of the ice for the first time, by taking advantage of small amounts of sunlight scattered off the craters' walls.
- The texture of the ice at the bottom of Mercury's 113 km (70-mi) wide Prokofiev Crater suggests that the material was put in place relatively recently rather than billions of years ago.

- Images of other craters show dark deposits, believed to be frozen organic-rich material, covering ice in some areas, with sharp boundaries between the two different types of material.



Left: a view of Berlioz crater, with the areas that contain radar-bright material marked in yellow and persistent shadows marked in red. **Middle:** details within the shadowed crater.
Right: A distinctively darker region sits on the crater's floor, which corresponds well with the radar-bright and shadowed regions

- Sharp boundaries indicate that the volatile deposits at Mercury's poles are geologically young, relative to the time scale for lateral mixing by impacts.
- Earth's Moon also harbors water ice inside permanently shadowed polar craters, but its deposits look different from those on Mercury. This could be because Mercury's ice was delivered more recently.
- If you can understand why one body looks one way and another looks different, you gain insight into the process behind it, which in turn is tied to the age and distribution of water ice in the solar system.
- This will be a very interesting line of inquiry going forward. ##

MESSENGER Data Suggest Recurring Meteor Shower on Mercury

DEC. 12, 2014 - http://www.spacedaily.com/reports/prnewswire-space-news.html

Mercury appears to get hit by a periodic meteor shower, possibly associated with a comet that produces multiple events annually on Earth.

- Clues to this shower were discovered in the very thin halo of gases that make up Mercury's exosphere, under study by NASA's MESSENGER (MErcury Surface, Space ENvironment, GEochemistry, and Ranging) spacecraft.
- The plasma and dust environment around Mercury had been relatively unexplored.

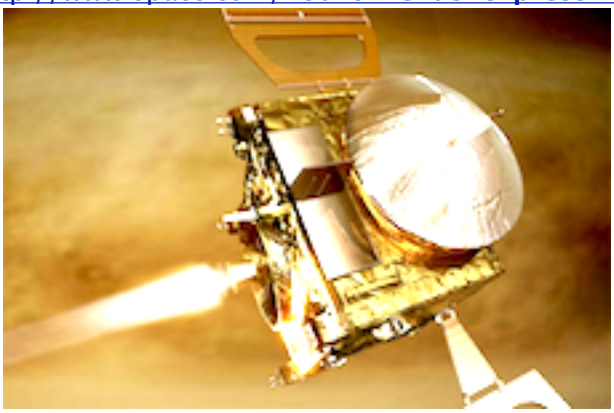
How it happens

- A meteor shower occurs when a planet passes through a swath of debris shed by a comet or asteroid.
- The smaller bits of dust, rock and ice are pushed away from the sun by the force of solar radiation, creating the comet's sometimes-dazzling tail.
- The larger chunks get deposited like a trail of breadcrumbs along the comet's orbit.
- The suggested hallmark of a meteor shower on Mercury is a regular surge of calcium in the exospherenoted by MESSENGER's Mercury Atmospheric and Surface Composition Spectrometer
- Seasonal surges of calcium occurred regularly over the first nine Mercury years [89 days long each or 2.2 Earth years], since MESSENGER began orbiting the planet in March 2011.
- The suspected cause of these spiking calcium levels is a shower of small dust particles hitting the planet and knocking calcium-bearing molecules free from the surface. This impact vaporization, renews the gases in Mercury's exosphere as interplanetary dust and meteoroids rain down on it.
- A periodic source is a cometary debris field. Examination of the handful of comets in orbits permit their debris to cross Mercury's orbit indicated that the likely source of the planet's event is Encke.
- Mercury is a giant dust collector, under steady siege from interplanetary dust and then regularly passes through this other dust storm, likely from comet Encke.
- However, the calcium spikes found in the MESSENGER data were offset a bit from the expected results. probably due to changes in the comet's orbit over time due to the gravitational pull of other planets.##

VENUS

Venus Express to Flame Out in Blaze of Glory

DEC. 17, 2014 - http://www.space.com/28043-**venus-express-mission-ends**.html

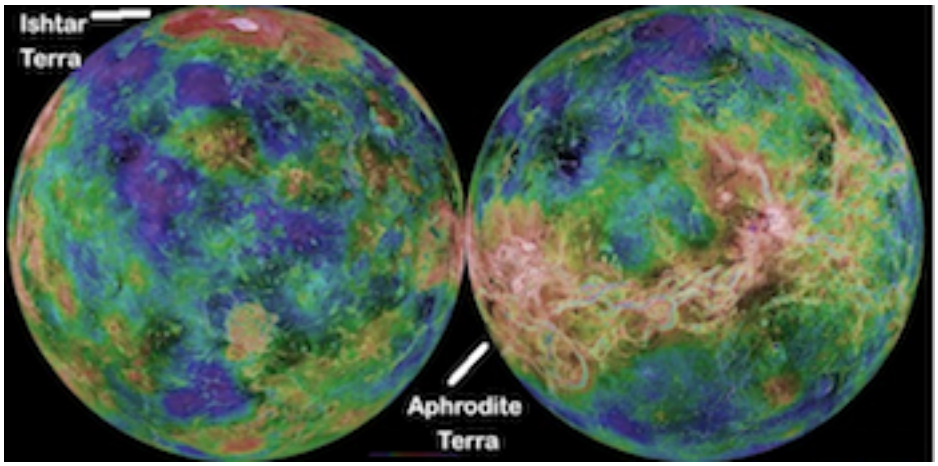


www.esa.int/Our_Activities/Space_Science/**Venus_Express**

- After more than eight and a half years in orbit around Venus, ESA's Venus Express is about to dive into the corrosive, sulfuric acid-laden atmosphere of this intensely overheated planet.
- Earlier this year, after its science observations had officially concluded, Venus Express performed a series of aerobraking maneuvers that sent the spacecraft skimming through the upper layers of Venus' atmosphere, gathering a slew of intriguing data as it went.
- Its fuel reserves dwindlng, Venus Express could not maintain its altitude and was lost on Nov. 28.
- Although some contact has since been re-established the communication is unstable, and there is no longer any way for the spacecraft to further increase its altitude.
- Venus Express' orbit will steadily degrade as it ultimately sinks into Venus' atmosphere.
- Although Venus Express will soon be gone, mission scientists and engineers are very pleased with the achievements of the mission and the success of the spacecraft, which has performed exceedingly well since its launch in 2005 during its main and extended science missions.
- The mission had lasted much longer than planned and it will now soon go out "in a blaze of glory." ##

Venus Gets Weirder: Liquid CO2 Oceans May Have Covered Surface

DEC. 28, 2014 - http://www.space.com/28112-**venus-weird-superfluid-oceans**.html



Left: the "continent" **Ishtar Terra** hugs Venus North Pole - **Right: Aphrodite Terra** hugs the equator The green and blue areas are ocean-like basins. Venus is extremely hot,dry, with a crushing atmosphere. "Venus may have once had strange oceans of **carbon dioxide fluid** that helped shape the planet's surface."

"Earth's twin" is the world closest to Earth in size, mass, distance and chemical makeup. However, compared to life-rich Earth, Venus is "hellish", with a crushing atmosphere and clouds of corrosive sulfuric acid floating over a rocky desert surface hot enough to melt lead.

What about "once upon a time?" Could it once have had oceans like Earth?

- Research suggests that Venus possessed enough water in its atmosphere in the past to cover the entire planet (highs and lows smoothed out) in an ocean about 25 meters(80 ft) deep — if all that water could somehow fall down as rain.
- But Venus has probably always been too warm for such water vapor to cool down and precipitate.
- But instead of seas of water, Venus might have once possessed bizarre oceans of carbon dioxide fluid.
- The atmosphere of Venus is 96.5 % carbon dioxide.
- While carbon dioxide can exist as a solid, liquid and gas, past a critical point of combined temperature and pressure, carbon dioxide can enter a "supercritical" state.
- Such a supercritical fluid can have properties of both liquids and gases.
- it can dissolve materials like a liquid, but flow like a gas.
- Scientists had generally thought the physical properties of supercritical fluids changed gradually with pressure and temperature. However, in computer simulations of molecular activity, supercritical matter could shift dramatically from gaslike to liquidlike properties.
- The atmospheric pressure on the surface of Venus is currently more than 90 times that of Earth.
- Rut in the early days of the planet, Venus' surface pressure could have been dozens of times greater.
- This could have lasted over a relatively long time period of 100 million to 200 million years.
- Under such conditions, supercritical carbon dioxide with liquidlike behavior might have formed.
- "This makes it plausible that geological features on Venus like rift valleys, **riverlike beds**, and plains are the fingerprints of near-surface activity of liquidlike supercritical carbon dioxide.
- Researchers found that depending on the pressure and temperature, clusters of gas-like supercritical carbon dioxide might have formed in this supercritical carbon dioxide on Venus that "looked like soap bubbles of gas covered by a thick layer of liquid."

Editor: Ahem! River channels are carved by water, but rift valleys and plains by geological processes.

Ten weirdest facts about Venus: www.space.com/15988-**venus-planet-weird-facts**.html

JUPITER & ITS MOONS

JPL Selects Europa CubeSat Proposals for Study

www.spacedaily.com/reports/**JPL_Selects_Europa_CubeSat_Proposals_for_Study**_999.html

http://www.space.com/27428-**cubesat-mission-europa-jupiter**.html

OCT. 11, 2014 - NASA's Jet Propulsion Laboratory in Pasadena, CA, has chosen **proposals from ten universities to study CubeSat concepts** that could enhance a **Europa mission** now under study.

- The CubeSat concepts will be incorporated into **a JPL study describing how small probes could be carried as auxiliary payloads.**
- The CubeSats would then be released in the Jovian system to make measurements and enhance our understanding of Jupiter's moon Europa.
- CubeSats are small, lightweight and low-cost satellites, often only inches on a side.
- With support from NASA, JPL is working to include small spacecraft on deep space exploration missions to complement primary spacecraft.
- The conceptual Europa mission, called **Europa Clipper**, would conduct d**etailed reconnaissance of the icy moon and investigate whether it could harbor conditions suitable for life.**
- Awardees will receive up to $25,000 each to develop their CubeSat concepts for inclusion in the study, which will be completed next summer.
- **CubeSat concepts from the following universities** were chosen by JPL's Planetary CubeSat office for inclusion in the study:
  + Arizona State University, Tempe

+ Georgia Tech Research Corporation, Atlanta
+ Stanford University, Stanford, California
+ The Regents of New Mexico State University, Las Cruces, New Mexico
+ The Regents of the University of Colorado, Boulder
+ The Regents of the University of Michigan, Ann Arbor
+ University of Alaska, Fairbanks
+ University of Southern California, Los Angeles
+ University of Illinois, Urbana
+ University of Washington, Seattle

Science objectives for the University CubeSats would include reconnaissance for future landing sites, gravity fields, magnetic fields, atmospheric and plume science, and radiation measurements.

> "Using CubeSats for planetary exploration is just now becoming possible, so we want to explore how a future mission to Europa might take advantage of them."

ANALYSIS: Possible Europa Tectonics Could be Boon for Alien Life

http://news.discovery.com/space/**europas-icy-crust-moves-like-tectonic-plates-on-earth**-140910.htm

http://www.space.com/27846-**europa-may-harbor-simple-life-forms-video**.html

OCT 17, 2014 - Combined with the ocean of water, nutrients are actively cycling to and from the surface. The icy surface appears to have plate tectonics. Also, there appears to be an abundance of oxygen in the ocean that's heated by the tidal squishing of Europa's orbit around Jupiter.

All of these factors point to a possibly habitable world where it has been hypothesized that multicellular life could thrive. But to test this hypothesis, we need to start sending missions to Europa so a close-up picture of its life-giving potential may be formulated — a mission that could be accelerated by the introduction of hitchhiking cubesats to the next big NASA missions to Jovian orbit. ##

Extreme Shrimp May Hold Clues to Alien Life (on Europa)

http://www.spacedaily.com/reports/**Extreme_Shrimp_May_Hold_Clues_to_Alien_Life**_999.html

NOV. 25, 2014 - At one of the world's deepest undersea hydrothermal vents, tiny shrimp are piled on top of each other, layer upon layer, crawling on rock chimneys that spew hot water.

Bacteria, inside the shrimps' mouths and in specially evolved gill covers, produce organic matter that feed the crustaceans.

Shrimp called Rimicaris hybisae at deep hydrothermal vents in the Caribbean seem to have different dietary habits depending on the proximity of other shrimp. Those who live in dense clusters like this one live off bacteria primarily, but in areas where the shrimp are distributed more sparsely, the shrimp are more likely to turn carnivorous, and even eat each other

Scientists at NASA's Jet Propulsion Laboratory in Pasadena, California, are studying this mysterious ecosystem in the Caribbean to get clues about what life could be like on other planetary bodies, such as Jupiter's icy moon Europa, which has a subsurface ocean.

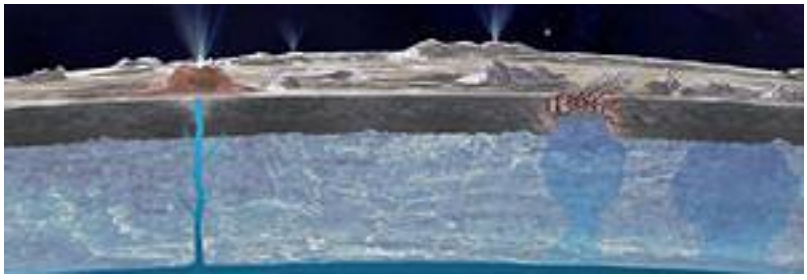
- "For two-thirds of the Earth's history, life has existed only as microbial life. On Europa, the best chance for life would be microbial."
- The particular bacteria in the vents are able to survive in extreme environments because of chemosynthesis, a process that works in the absence of sunlight and involves organisms getting energy from chemical reactions.
- In this case, the bacteria use hydrogen sulfide, abundant at the vents, to make organic matter.
- The temperatures at the vents can climb up to a scorching 400°Ç (750 °F), but waters just an inch away are cool enough to support the shrimp.
- The shrimp are blind, but have thermal receptors in the backs of their heads.
- The objective of this research is to see how much life or biomass can be supported by the chemical energy of the hot submarine springs..
- Hydrogen sulfide is toxic to organisms in high concentrations, but the bacteria feeding the shrimp need a certain amount of this chemical to survive.
- The shrimp position themselves on the very border between normal, oxygenated ocean water and sulfide-rich water so that they and the bacteria can coexist in harmony, a remarkable symbiotic system. The Von Damm field at 7,500 ft (2,300 m) and Piccard at more than 16,000 ft (4,900 m), are the world's deepest.
- A bonus finding is that some of the shrimp, Rimicaris hybisae, appear to be cannibalistic.
- When the shrimp arrange themselves in dense groups, bacteria seem to be the main food supplier, as the shrimp likely absorb the carbohydrates that the bacteria produce.
- Where the shrimp are distributed more sparsely, they are more likely to turn carnivorus, eating snails, other crustaceans, and even each other.
- Whether an animal like this could exist on Europa heavily depends on the actual amount of energy that's released there, through hydrothermal vents.
- "You go along the ocean bottom and there's nothing, effectively," Coleman said. "And then suddenly we get these hydrothermal vents and a massive ecosystem. It's just literally teeming with life." ##

How Can We Search For Life On Icy Moons Such As Europa?

www.spacedaily.com/reports/**How_Can_We_Search_For_Life_On_Icy_Moons_Such_As_Europa**_999.html

NOV. 26, 2014 - Our solar system is host to a wealth of icy worlds that have water beneath the surface.

- Cassini recently uncovered evidence of a possible ocean under the surface of Saturn's moon, **Mimas**.
- Other worlds under examination include Jupiter's moon, **Europa**. In 2013, NASA's Hubble Space Telescope observed evidence that Europa erupts water, while the Cassini spacecraft has observed geysers spewing on Saturn's moon, **Enceladus**.



One of the ways the team will look for these “signatures” is to use analog environments on Earth, locations that scientists believe are similar, in certain respects, to what could be present on other worlds. In theory, life on another world could evolve from a chemical soup similar to that of certain places on Earth, such as within hot springs.

How likely is habitability on such icy worlds, and how would we search for it?

A research team led by Isik Kanik at NASA's Jet Propulsion Laboratory in Pasadena, California was selected for a new grant from the NASA Astrobiology Institute for a five-year project looking at

- How metabolism could come about by way of chemical differences on icy worlds, and

- How signatures of these unbalanced states can be detected, assuming that metabolism works similarly on these other worlds as it does on Earth.

Accessible environments on Earth

- Could life on another world evolve from a chemical soup similar to that of certain places on Earth, such as within hot springs?
- The Cedars, in California, and Cabeco de Vide, in Portugal, host natural springs that represent two extreme metabolic environments, with **energy sources produced by water-rock interactions** and particular **types of organisms that find a way to take advantage of them**.
- Both are analogs to deep -sea hydrothermal systems on Earth's seafloor,very costly to explore: life-supporting environments similar to those that could exist on Europa or early Mars.
- **Moving life from vents to the surface**
  NASA is considering sending a spacecraft to Europa. If they go and look for signatures of life, how are they going to interpret findings of organic molecules?
- The idea is to model how life could evolve in the laboratory environment. Championed by the NASA AsThe sub-team set up experiments in a hydrothermal reactor in the laboratory using simulated ocean water, some organic molecules, and then mixing them and looking at what comes out.

Highlights from 250 papers based on this work over five years.

- The construction and use of the hydrothermal reactor for life experiments
- Finding methane that arose abiotically, or without the presence of life, and that was transported from igneous mafic rocks through rain or snow.
- How laboratory simulations have revealed that interactions between geology and energy sources that produce chemistry that could lead to life, similar to how a fuel cell works
- How geologic disequilibrium may lead to life in submarine environments
- How life came to be in icy worlds

Questions related to the possible emergence and evolution of life in icy environments.

- What geological and hydrologic factors drive chemical disequilibria at water-rock interactions on Earth and other worlds?
- Three basic ingredients for life to emerge: water, free energy and chemicals. Chemical reactions need to keep happening in one direction or the other - either using or giving off energy
- If reactions reach equilibrium, there is no energy to be used or made available. Therefore nothing happens. So assuming that metabolism works similarly on these other worlds as it does on Earth.
- At these sites, the team will look at what kind of gases come out, and analyze the water and gases from these places, taking some samples back to the lab to make sure they have been done correctly.
- The team also investigated serpentinization as it might have occurred on the early Earth before life emerged. This system provides a comparison of the natural sites where biology is present, allowing the team to understand the interaction between chemistry and biology.
- Do geo-electrochemical gradients - changes in geology and electrochemistry - in hydrothermal vents eventually create chemistry that leads to life?
- How, where and for how long might disequilibria exist in icy worlds, and what does that imply in terms of habitability?" This will involve making models of how seafloors may be different on icy worlds due to to factors such as temperature and pressure.
- What can observable surface chemical signatures tell us about the habitability of subsurface oceans?" Simulations will take place of icy bodies, including factors such as a vacuum, radiation and the appropriate surface temperatures.
- The aim here is to link what is seen on the surface with what is happening below. ##

Signs of Europa Plumes Remain Elusive in Search of Cassini Data

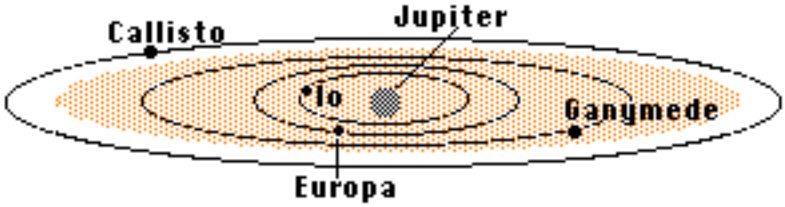
www.spacedaily.com/reports/**Signs_of_Europa_Plumes_Remain_Elusive_in_Search_of_Cassini_Data**_999.html

DEC. 19, 2014 - Europa displays many signs of activity: its fractured crust, dearth of impact craters.

Scientists continue to hunt for confirmation of plume activity.

- While they have readily detected water as it erupts in plumes ofn Saturn's Enceladus, they have found no evidence for liquid water on Europa's surface,
- This could mean that Europa's plumes are smaller, and/or less frequent.

- But Cassini remains in orbit around Saturn, whereas it only flew by Jupiter and Europa once, and so has more opportunities to observe Enceladus.
- Indications of possible plume activity were reported in Hubble Space Telescope observations 2013
- Cassini's 2001 Jupiter flyby provided UVIS the opportunity to directly measure the environment near Europa, which is not possible with Hubble.
- For more than a decade, Cassini's UVIS has observed the cold, dense doughnut of gas that encloses the orbit of Enceladus.
- The massive amount of gas breathed into orbit around Saturn by the Enceladus plumes acts like a brake on electrons being dragged through it by Saturn's magnetic field, which rotates with the planet.
- Apparently there is no such brake at Europa.
- UVIS saw a hot plasma, rather than a cold one, around Europa's orbit, suggesting that Europa is not outputting large amounts of gas -- including water.
- Snapshots provided by missions that visited Jupiter prior to Cassini provided strong indications that Io is the major contributor of material to the environment around Jupiter, and indicated a hot, low density plasma for which hypervolcanic Io is the source.



Only Callisto orbits outside Jupiter's Radiation Belt

- Scientists are now using the Hubble Telescope for a six-month long survey looking for plume activity,
- NASA is also studying various possible Europa missions for future exploration.
- A fresh look at Cassini 2001 data shows that Europa's tenuous atmosphere is even thinner than previously thought and also suggests that the thin, hot gas around the moon does not show evidence of plume activity occurring at the time of the flyby.
- The new research suggests that if there is plume activity, it is likely intermittent.
- In fact, from their data, the researchers calculated that Europa contributes 40 times less oxygen than previously thought to its surrounding environment.
- The team found that Europa's tenuous atmosphere, which was already thought to be millions of times thinner than Earth's atmosphere, is actually about 100 times less dense than those previous estimates.
- A downward revision in the amount of oxygen Europa pumps into the environment around Jupiter would make it less likely that the moon is regularly venting plumes of water vapor high into orbit - at least at the time the data was acquired.
- It is still possible that plume activity occurs, but that it is infrequent, or the plumes are smaller than we see at Enceladus.
- If eruptive activity occurred during Cassini's flyby, it was at a level too low to be detectable by UVIS.

Indications of possible plume activity were reported in 2013 by researchers using NASA's Hubble Space.

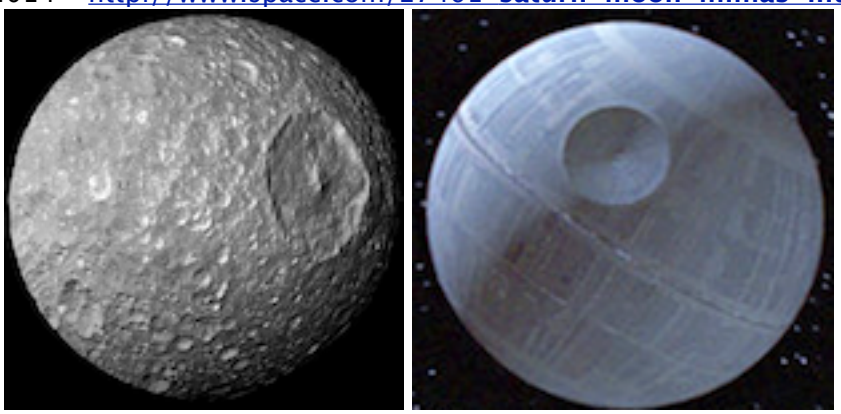
- Apparently, Europa is not outputting large amounts of gas -- including water.
- Scientists are currently using the Hubble Space Telescope to conduct an extensive six-month long survey looking for plume activity, and NASA is also studying various possible Europa missions for future exploration. ##

PostScipt: Evidence of a plume: www.space.com/28102-**jupiter-moon-europa-plume-mystery**.html

SATURN & ITS MOONS

Saturn's 'Death Star' Moon Mimas Is Weird Inside

OCT. 16, 2014 - http://www.space.com/27461-**saturn-moon-mimas-interior**.html



Left: Mimas with its prominent crater - **Right:** The "Death Star" in Star Wars 1 (later,4)

There's something strange going on below the surface of Saturn's Death Star-looking moon Mimas, whose rotation and orbit around Saturn make the moon look like it's rocking and back forth and oscillating similar to the way a pendulum swings.

- The rocking motion, called libration, is commonly observed in moons that are influenced by the gravity from neighboring planets.
- Using images of the moon captured by the Cassini orbiter, Radwan Tajeddine, a research associate at Cornell University, discovered that the satellite's libration was "much more exaggerated in one spot" than predicted. It must be caused by the moon's weird interior.

Feel the libration

- Astronomers have long been using the rotation and orbit of celestial bodies to guess what their interiors might be like. Most of the rocking is explained by the interacting forces from Mimas' rotation and orbit, but one libration was much larger than expected.
- The team tested five different models of what Mimas might look like below the surface to see which one could explain the exaggerated rocking.
- They quickly ruled out the possibility that Mimas has a uniform interior
- What fits is (a) an interior with two different layers or (b) an abnormal mass under the moon's 88 mi, (142 km) crater that makes it look like the Death Star from the "Star Wars" franchise.
- One idea is that the moon has an elongated, oval-shaped core. This elongation might have happened as the moon formed under the push and pull of Saturn's rings.
- The teeter tottering could also come from a subsurface ocean, like the one on Jupiter's moon Europa.
- But a subsurface ocean is an unlikely explanation. The heat radiating from the core escapes through the moon's ice-covered shell and would cause any subsurface ocean that existed to quickly freeze.

3D Mimas map

- Mimas is the smallest and closest of Saturn's main eight moons. Its giant crater covers almost one-third of the moon's icy surface.
- For the past 10 years , the Cassini space probe has been collecting data on Mimas. A 3D map of the moon from the collected photos gives clues on how Mimas spin. ##

Organic molecules in Titan's atmosphere are intriguingly skewed

www.spacedaily.com/reports/**Organic_molecules_in_Titans_atmosphere_are_intriguingly_skewed**_999.html

> Titan is in some ways the most Earthlike body in the Solar System, with a thick atmophere and prominent lakes, rivers, and seas.
>
> But that's where the resemblance ends. In place of water, Titan's frigid surface flows with liquid organic molecules, including methane (CH4) and ethane (C2H6).

OCT. 24, 2014 - While studying the atmosphere on Titan, scientists discovered intriguing "**zones of organic molecules unexpectedly shifted away from its north and south poles**" These misaligned features seem to defy conventional thinking about Titan's windy atmosphere, which should quickly smear out such off-axis concentrations.

ALMA image of the distribution of the organic molecule HC3N at intermediate-to-lower elevations in the atmosphere of Titan. Denser, brighter concentrations are oriented more evenly about the poles than is observed for HC3N at higher elevations. The globe outline represents Titan's orientation at the time of the observations. = For larger image go here. https://public.nrao.edu/images/non-gallery/2014/c-blue/10-21-Titan/TitanHC3N_nrao.jpg

- This discovery was made during a very brief 3-minute "snapshot" observation with the **Atacama Large Millimeter/submillimeter Array** (**ALMA**).
- The array's extreme sensitivity and resolution tracked the atmospheric distributions of hydrogen isocyanide (HNC) and cyanoacetylene (HC3N), which initially appeared to be concentrated evenly over Titan's north and south poles, consistent with observations made by the Cassini orbiter, of high concentrations of some gases over the pole experiencing winter.
- This unexpected and potentially groundbreaking discovery of east-to-west wind variations have never been seen before in Titan's atmospheric gases and presents a fascinating new problem.
- As usual, unexpected findings lead the way to better, more comprehensive understanding - in this case, of the processes that shape Titan's complex chemistry.
- Titan's atmosphere acts as a chemical factory, using energy from the Sun and Saturn's magnetic field to produce a wide range of organic molecules.
- Studying this complex chemistry may provide insights into the properties of Earth's very early atmosphere, which may have shared many chemical characteristics with present-day Titan.

The surprise came when

- Researchers compared gas concentrations at different atmosphere levels. At the highest altitudes, pockets of organic molecules were shifted away from the poles - unexpected because the fast-moving, E>W winds in Titan's middle atmosphere should thoroughly mix the molecules formed there.
- There is no obvious explanation for these findings yet.
- At the moment, the scientists are considering thermal or other effects tied to interaction with Saturn's powerful magnetic field, which extends far enough to engulf Titan, as potential sources of this skewed molecular concentration.

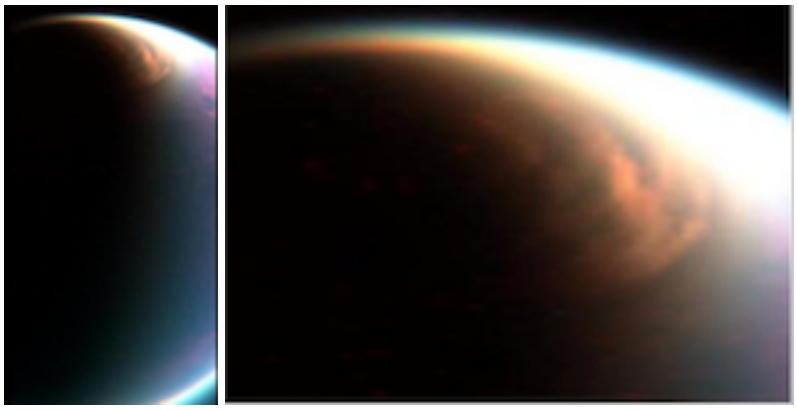
ALMA's role

- This marks **ALMA's first foray into atmospheric studies of a major body in our Solar System.** Further observations are expected to improve our understanding of the atmosphere and ongoing processes on Titan and other objects throughout our Solar System. ##

Surprise! Methane Ice Cloud Floats High Above Titan

OCT. 26, 2014 - http://www.space.com/27558-**saturn-moon-titan-methane-cloud**.html

In a December 2006 flyby of Titan, Cassini imaged a methane ice cloud high in the stratosphere over Titan's north pole, during northern hemisphere winter (now shifting from spring into summer.)



- That methane clouds could form this high in Titan's atmosphere surprised observers.
- Methane clouds had been seen on Titan before in the troposphere, the lowest part of the moon's thick, nitrogen-rich atmosphere.
- While wispy clouds of ethane and several other materials have been observed in the stratosphere, this region had been regarded as not quite cold enough to support methane clouds. (Cloud formation requires colder temperatures at higher altitudes, as air higher up contains less moisture.)

More recent Cassini data show that the stratosphere is patchy, with temperatures as low as −209 °C (−344 °F) in places, cold enough for methane ice particles to form.

Titan's sequence of seasons http://en.wikipedia.org/wiki/Climate_of_Titan#Seasons

"Titan's orbital tilt with respect to the sun is very close to Saturn's axial tilt (about 27°), and its axial tilt with respect to its orbit is zero. The direction of incoming sunlight is driven almost entirely by Titan's day-night cycle and Saturn's year cycle."

"Seasonal change is driven by Saturn's year: it takes Saturn about 29.5 Earth years to orbit the Sun, exposing different amounts of sunlight to Titan's northern and southern hemispheres during different parts of the Saturnian year."

So Spring, Summer, Autumn, Winter are each 1/4th as long as Saturn's year: 7.375 Earth years.

The methane cloud likely formed when relatively warm air rose to the stratosphere from the surface of Titan's southern hemisphere, back when it was summer in December 2006, then circulated up to the north polar region and sank back down, cooling as it went. Such a mechanism could produce methane clouds at altitudes ranging from 30–50 km (19–31 mi).

Similar mechanisms are behind the formation of stratospheric clouds here on Earth, the only body in the solar system besides Titan known to possess bodies of stable liquid on its surface. (Earth's weather system is based on water rather than hydrocarbons.)

The new study was published last month in the journal Icarus. ##

Hazy Titan Holds Clues About Life's Origins

NOV. 27, 2014 – http://www.space.com/27880-saturn-moon-titan-origin-life.html

There are several theories as to where did life on Earth come from.

- From comets? From Mars, or did something happen in the chemistry of Earth that made life possible.
- Titan is a possible laboratory that can help us better understand the conditions on Earth before life arose is — sometimes referred to as a "prebiotic" environment.
- Voyagers 1 and 2 flew by Saturn in the 1980s, revealing a moon, Titan, completely socked in with haze, quite a contrast with Earth's airless, cratered Moon.
- Since 2004, when the Cassini-Huygens mission arrived on location, Cassini has flown by Titan
- hundreds of times and peered at its surface by penetrating the clouds with radar.
- The European Space Agency's Huygens lander also made a soft landing on the moon in 2005.
- One of the big research questions is the composition of the haze.
- A new study is trying to recreate substances in the atmosphere called tholins, organic aerosols that are produced when radiation bakes the nitrogen and methane-rich atmosphere.
- Such organics are considered precursors to life.

- The study of organic chemistry on Titan could extend our understanding of the diversity of prebiotic chemistry, and perhaps life's origin on Earth.

Dissolving tholins

- The study of Titan's tholins helps us understand the basic properties of organic materials on Titan.
- How are they are structured? Can aerosols be dissolved in liquid in Titan's surface or atmosphere? How stable can these organics be?
- Titan's tholins are thought to contain chemical precursors of life, and studying the molecules' structure helps scientists better understand whether life's possible precursors have formed on Titan.
- The **solubility study** helps to hint where to find them on Titan
- The **stability study** suggests the most capable detection methods.
- The tholins were created by making a mix of 5% methane and 95% nitrogen in a reaction chamber at room temperature.
- The mixture was exposed to an electrical discharge for 72 hours, creating a muddy substance — the tholin — on the walls of the vessel.
- The substances produced had a similar optical appearance to what Cassini has observed in Titan's atmosphere.

The next step

- Researchers then investigated how well the tholins would dissolve in several solvents: **polar solvents** (methanol, water, dimethyl sulfoxide and acetonitrile) and **non-polar solvents** (pentane, benzene and cyclohexane).
- Generally, polar solvents dissolve polar compounds best and non-polar solvents dissolve non-polar compounds best.
- Titan's tholins preferentially dissolve in polar solvents, **suggesting little or none of the substance would be dissolved in the lakes or oceans on Titan**, which consist of non-polar ethane/methane.
- Thus, the tholins should be on the surface of land or an the bottom of the lakes and oceans, He noted.

Picking future landing sites

- The Huygens probe only survived on the surface of Titan for a few hours
- A NASA Innovative Advanced Concepts proposal would send a submarine to explore Titan;s lakes - a proposal at the first stage of investigation and decades away, if funding is approved.

Possible methods of detecting organics

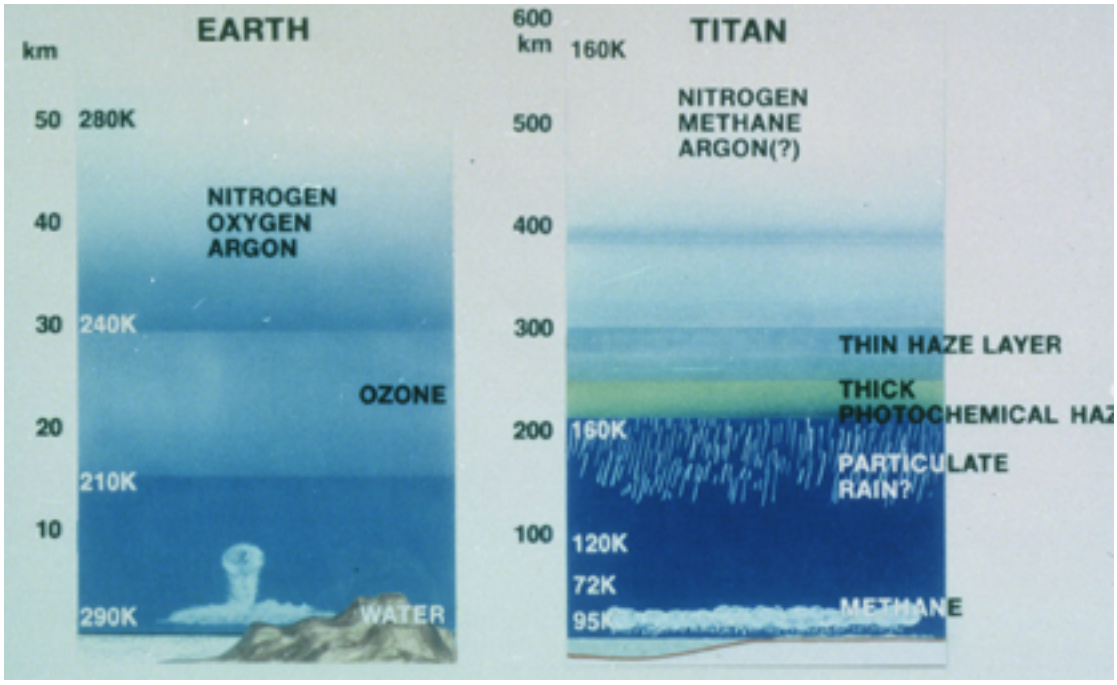
- Liquid chromatography-mass spectrometry (LC-MS) a
- Nuclear magnetic resonance spectroscopy (NMR).
- Both methods can nondestructively provide detailed structural information of organic mixtures

Greater search for life's origins

The team found several nitrogenated organic molecules in Titan's tholins, some very important to the prebiotic chemistry and the origin of life.

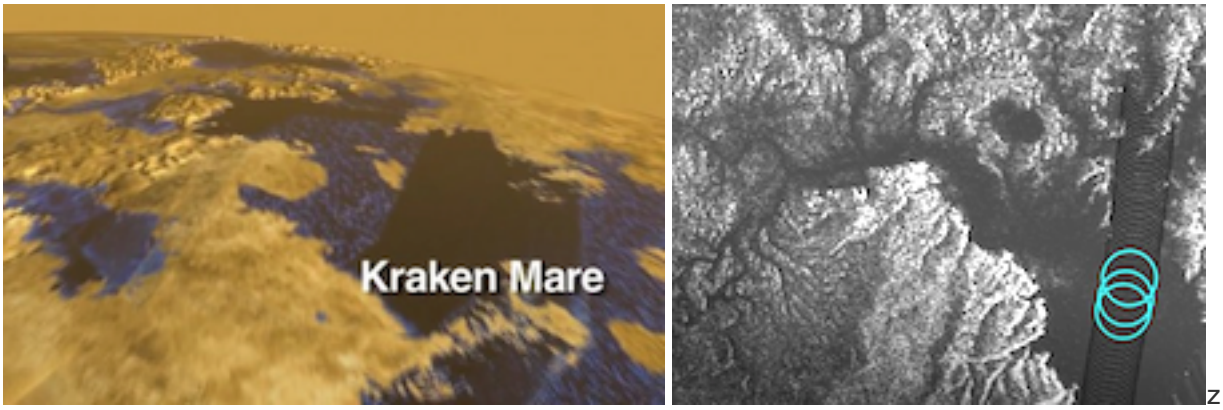
Implications for the rest of the solar system.

- While helping to understand the basic properties of organics on Titan, this study also provides the basis for the development of in situ analysis of methods and instruments for a Titan mission and other outer planet explorations, such as Mars, Jupiter's icy moon Europa or Saturn's moon Enceladus, which has been recorded spouting water-rich plumes into the atmosphere.
- In 2007 scientists discovered that the tholins form at much higher altitudes than previously believed, at greater than 1,000 km (621 mi) as opposed to a few hundred kilometers above the ground.
- The results also revealed an unexpected high number of ions (negatively charged atoms) in Titan's clouds, as well as detecting benzene, an element that is required to put together the tholins.
- The negative ions were a complete surprise, and suggests that they may play an unexpected role in making tholins from carbon-nitrogen precursors."
- A more recent finding revealed that Titan's atmosphere s likely older than Saturn's atmosphere, suggests that Titan did not form as part of a proto-Saturn, but instead formed separately in the gas and dust floating around the young solar system while the sun and planets were being formed. ##
- Suggested reading: http://www.astrobio.net/topic/**solar-system/saturn/titan/titan-versus-earth/**



Depth of Biggest Sea on Saturn's Moon Titan Measured by NASA Probe

NOV. 11, 2014 - http://www.space.com/27725-**saturn-moon-titan-sea-depth**.html
http://www.marsdaily.com/reports/**Cassini_Sails_into_New_Ocean_Adventures_on_Titan**_999.htm l



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Radar data from Cassini reveal depth of liquid methane/ethane seas on Titan
http://i.space.com/images/i/000/043/576/original/krakens-mare.jpg?1415663920

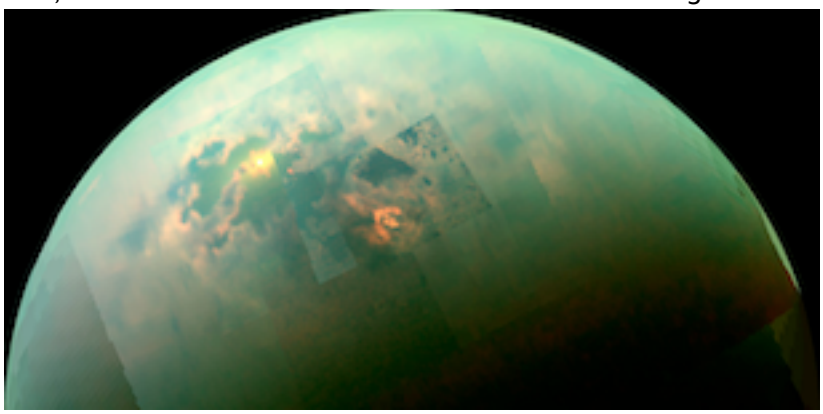
- **Kraken Mare**, the biggest hydrocarbon sea on Saturn's huge moon Titan, is at least 20-35 m (66-115 ft) deep and perhaps much deeper, a new study of observations made on August 21st suggests.
- Just one small portion of Kraken Mare was probed — an area near the mouth of a flooded river valley — not necessarily the sea's most extreme depths.
- Cassini looked at a 200 km (125-mi) stretch of the Mare but took no readings from most of the track.
- In areas where no signal was received, Kraken Mare might be too deep for the radar beam to penetrate.
- Altimetry data from the area in and around Kraken Mare also showed relatively steep slopes leading down to the sea, which suggests that Kraken Mare might indeed be quite deep.
- Kraken Mare is a huge body of liquid ethane and methane near Titan's north pole. The sea covers 400,000 sq km (154,000 sq mi). In contrast, the total area of North America's 5 "Great Lakes" is only 61% as large (244,106 sq km = 94,250 sq mi .) Kraken Mare is better compared to our Black Sea.
- The spacecraft also observed two mysterious bright objects in Kraken Mare that appear similar to a strange island-like feature previously spotted in Ligeia Mare, about 170 m (560 ft) deep.

- Cassini scientists don't know for sure what these features are but say they may be waves, bubbles or some kind of floating debris.
- Researchers are presenting the new results this week at a meeting of the Division for Planetary Sciences of the American Astronomical Society in Tucson, Arizona.
- At 3,250 miles (5,150 km) wide, Titan is about 50 percent bigger than Earth's Moon. The Saturn satellite is the only solar system body besides Earth known to possess bodies of stable liquid on its surface, though Titan's lakes and oceans are composed of liquid hydrocarbons rather than water.
- The $3.2 billion Cassini spacecraft will continue studying Saturn and its many moons until September 2017, when it will make an intentional death dive into the ringed planet's thick atmosphere. ##

Cassini Sees Sunny Seas on Titan

OCT. 31, 2014 - http://www.spacedaily.com/reports/**Cassini_Sees_Sunny_Seas_on_Titan**_999.html

As Cassini soared past Saturn's large moon Titan recently, it caught a glimpse of bright sunlight reflecting off hydrocarbon seas. Previously, Cassini had captured, separately, views of the polar seas and the sun glinting off them, but this is the first time both have been seen together in the same view.



Full size image: http://www.jpl.nasa.gov/spaceimages/details.php?id=pi1a8432

- An arrow-shaped complex of bright methane clouds hovers near Titan's north pole. The clouds could be actively refilling the lakes with rainfall.
- A "bathtub ring," or bright margin, around Kraken Mare -- the sea containing the reflected sunglint -- indicates that the sea was larger at some point, but evaporation has decreased its size.
- Titan's seas are mostly liquid methane and ethane.
- Cassini found only great fields of sand dunes near the equator and lower latitudes, but located lakes and seas near the poles, particularly in the north.
- The new view shows Titan in infrared light. It was obtained by Cassini's Visible and Infrared Mapping Spectrometer (VIMS) on Aug. 21.

Tennessee research offers explanation for Titan dune puzzle

www.spacedaily.com/reports/University_of_**Tennessee_research_offers_explanation_for_Titan_dune_puzzle**_999.html

DEC.9, 2014 - Unlike any other moon, Titan has a dense atmosphere, rivers and lakes made up of ethane and methane. It also has windswept dunes that are hundreds of yards high, more than a mile wide and hundreds of miles long--despite data suggesting Titan experiences only light breezes.

- New research at the University of Tennessee, Knoxville, shows that winds on Titan must blow faster than previously thought to move sand. The discovery may explain how the dunes were formed.
- The dunes have been created by particles the size of grains of sand not previously suspected.
- We still don't understand the source of these particles or the winds strong enough to move them.
- The biggest mystery has been the shape of the dunes.

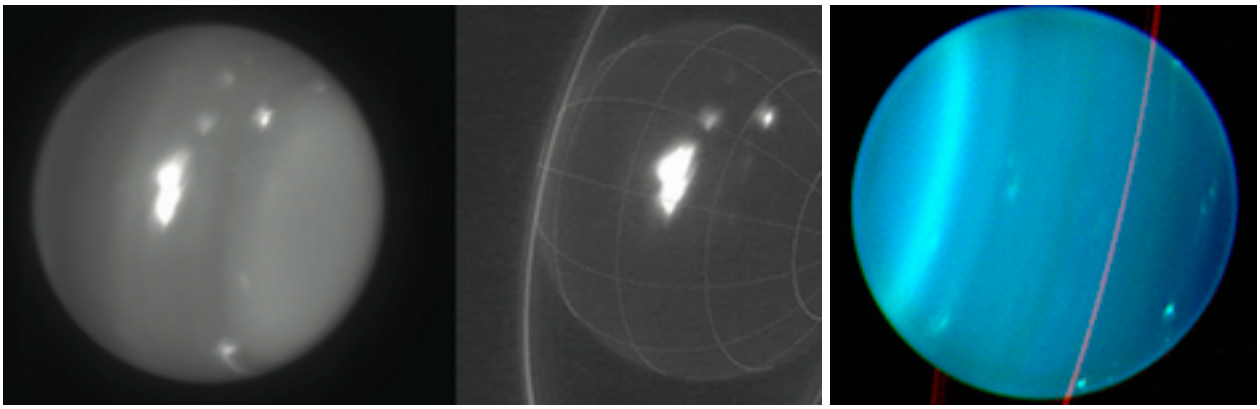
- The Cassini data showed that the predominant winds that shaped the dunes blew from east to west. However, the streamlined appearance of the dunes around obstacles like mountains and craters indicated they were created by winds moving in exactly the opposite direction.
- To get to the bottom of this conundrum, a defunct NASA high-pressure wind tunnel we used to recreate Titan's surface conditions, and its dense atmosphere.
- They used 23 different varieties of sand in the wind tunnel to capture possible sand behavior on Titan.
- After two years of many models and recalibrations, the team discovered that the minimum wind on Titan has to be about 50 percent faster than previously thought to move the sand.
- The discovery of the higher threshold wind offers an explanation for the shape of the dunes, too.
- A rare event may cause the winds to reverse momentarily and strengthen."
- Atmospheric models show that the wind reverses twice during a Saturn year, 29 Earth years long, when the sun crosses over Titan's equator, causing the atmosphere--and subsequently the winds--to shift.
- It is only during this brief time of fast winds blowing from the west that the dunes are shaped.
- The high wind speed might have gone undetected by Cassini because it happens so infrequently. ##

URANUS

Extreme Storms on Uranus Puzzle Astronomers

NOV. 13, 2014 = http://www.space.com/27770-**extreme-uranus-storms-puzzle-astronomers**.html

- in 2007, when Uranus' once-every-42-year equinoxe occurred and the sun shined directly on the equator. Seven years later, Uranus is finally having some summer storms, leaving scientists wondering why the massive storms are so late.
- Usually quiet, the gas giant planet now has such "incredibly active" weather that some of the features are even visible in amateur telescopes.
- This is by far the most active weather on Uranus in the past decade, a different picture of the quiet planet Voyager 2 saw when it flew by in1986.



Left: These infrared images of Uranus show a white spot that is actually a massive storm. Image by the Keck II telescope atop Mauna Kea in Hawaii Aug. 6, 2014 in 2.2-micron wavelength
Right: Normal appearance in true color

Here's where the mystery comes in:

- As far as anyone can tell, Uranus has no source of internal heat. Sunlight is thought to be responsible for changes in its atmosphere, such as storms. But the sun's light is currently weak in Uranus' northern hemisphere, so scientists are puzzled as to why that area is so active today.
- Eight large storms have been tracked in Uranus' northern hemisphere with the Keck II telescope between Aug. 5 and 6.
- One storm stood out from the rest: Shining in 2.2 microns, a wavelength sensitive to clouds in the tropopause (just below the stratosphere), it made up 30 % of all of the light reflected from Uranus.
- Another storm, visible at 1.6 microns, was seen by amateur astronomer with a 1-meter telescope.

Uranus' extreme weather

- Based on the colors and structure of the storm spotted by amateurs, astronomers believe it could hint at a vortex deeper in the atmosphere — similar to the Great Red Spot on Jupiter.
- Follow-up observations with the Keck II telescope revealed that the storm was still raging, although it had changed its shape, and possibly its intensity.
- The Hubble Space Telescope examined the entire planet of Uranus Oct. 14 in several wavelengths revealing storms spanning several altitudes, over a distance of about 9,000 km (5,600 miles).

Facts: http://en.wikipedia.org/wiki/**Uranus**

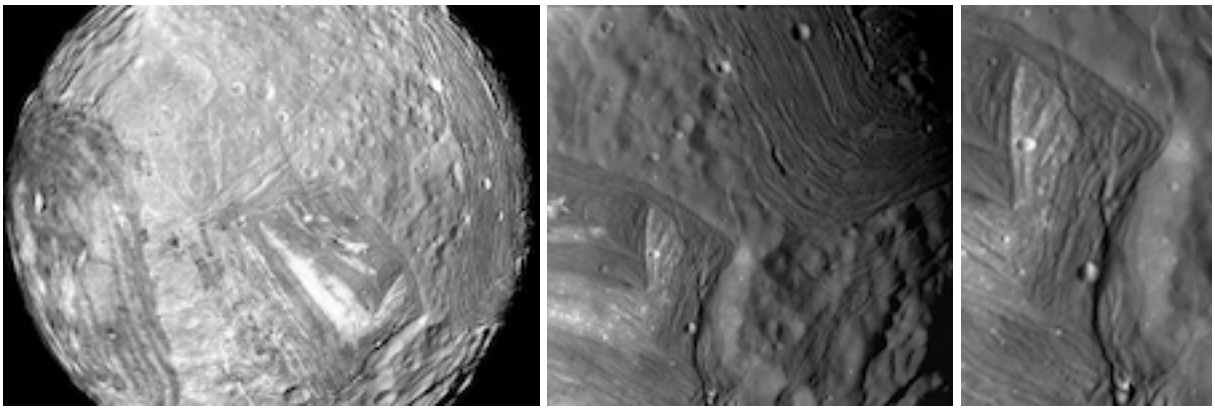
- Uranus was the first planet to be discovered not known to the ancients - it is actualy at the threshold of "naked eye" visibility.
- Uranus is the 3rd largest planet after Jupiter and Saturn, a bit larger than Neptune but less massive
- Its axis is tilted degrees so it is tilted on its side, actually a bit past that so that it rotates "retrograde" in the opposite direction of all the other planets.
- Uranus had 5 known moons prior to the Voyager 2 flyby: The current total of moons is 27.
- Uranus has an atmospheric layer that is the richest concentrated source of Helium-3 in the Solar System, possibly one day an enormous economic asset for fusion reactors. (source?) ##

Bizarre Shape of Uranus' 'Frankenstein' Moon (Miranda) Explained

OCT. 3, 2014 - http://www.space.com/27334-**uranus-frankenstein-moon-miranda**.html

The strange appearance of Uranus' moon Miranda may finally have an explanation.

- Miranda appears to be a bizarre jumble of parts that didn't quite merge properly.
- Now, researchers suggest they may know why Miranda looks so odd: Constant squeezing and stretching from Uranus caused the moon's insides to heat up and churn.
- This ball of ice and rock boasts one of the oddest and most varied landscapes known among extraterrestrial bodies, including giant canyons up to 12 times deeper than the Grand Canyon (6,000 ft or 1,800 m) - that is nearly 14 miles or 22 km deep!
- Miranda has three giant features known as "coronae" unique among known objects in the solar system, shaped crudely, either like ovals or trapezoids, each at least 200 m (120 m) wide.



L: Uranus' icy moon Miranda: image from NASA's Voyager 2 probe on Jan. 24, 1986.
C & R: Photo of Miranda, taken by NASA's Voyager 2 shows unusual "chevron" figure and regions of distinctly differing terrain on the mysterious satellite.

- The three coronae — **Arden**, **Elsinore** and **Inverness** (named after locations in Shakespeare's plays) are separated from their more heavily cratered surroundings by belts of concentric ridges and troughs, making the coronae look like mismatched patches. .

How did these coronae form?.

- One possibility is that Miranda may have been disrupted by some catastrophic impact, after which its pieces chaotically reassembled. The coronae formed as rocky material sank downward, triggering concentric wrinkles on Miranda's surface as it contracted.

- Another possibility is that the coronae formed as buoyant domes of ice rose, causing Miranda's surface to crumple as matter was added to it. However, it was not known where the heat to drive this ice upward might have come from.
- The gravitational pull of Uranus may have distorted Miranda enough to heat it up, leading its innards to churn much as Earth's does — thus explaining the coronae.
- Miranda's orbit around Uranus was once eccentric, or oval-shaped, moving it closer to and farther from Uranus over time. Three-dimensional computer simulations of Miranda's interior performed for the new study revealed the resulting tidal forces would repeatedly stretch and squeeze Miranda enough to generate substantial amounts of heat — about 5 gigawatts, or 2.5 times the peak power output of the huge Hoover Dam on the southwestern United States' Colorado River.
- This heat would cause Miranda's icy mantle to churn with convection, during which warm buoyant ice would have risen to Miranda's surface to contort it and create the coronae.
- Computer models accurately explain the locations of the coronae and deformation patterns within it.
- The features on Miranda may look really strange, but they formed in a way that is really similar to what happens on Earth, where convection in the interior drives surface deformation,.
- However, for convection to drive Miranda's surface deformation, the surface must be much weaker than predicted by laboratory experiments.

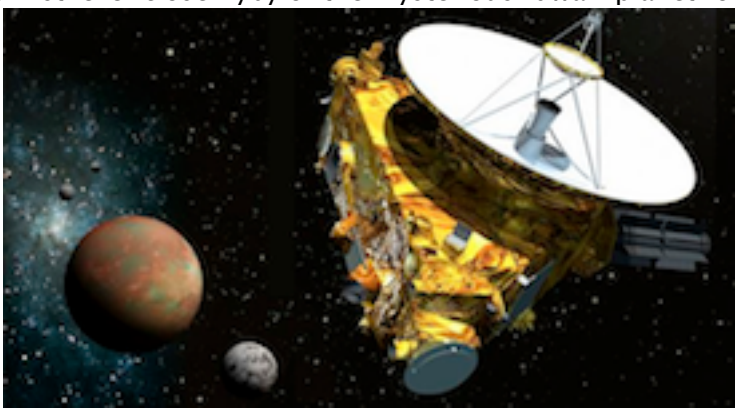
Stay tuned! ## http://en.wikipedia.org/wiki/**Uranus** - http://en.wikipedia.org/wiki/**Moons_of_Uranus**

PLUTO & BEYOND

New Horizons Pluto Probe Wakes From Hibernation

DEC. 6, 2014 - www.space.com/27946-**pluto-spacecraft-new-horizons-wakeup**.html (**Video**)

New Horizons emerged from a 99-day hibernation on Dec. 6, 2014, gearing up for a six-month Pluto encounter with the first-ever close flyby of the mysterious "dwarf planet" on July 14, 2015.



Dormancy periods

- New Horizons launched in January 2006, and has spent about two-thirds of its long flight asleep, with 18 separate hibernation periods ranging from 36 to 202 days.
- Keeping the probe dormant so often has reduced wear and tear on its electronics and kept costs down.
- The probe went into hibernation for the final time on August 29, 2014. When it awakes this time, the mission team will check out its operating systems and science gear, and devise and test the command sequences that will guide New Horizons on its flyby of Pluto and its five known moons, including Charon, half the diameter of Pluto, and tidally locked with it, both worlds always presenting the same face to the other.

The Encounter beginning Jan 15, 2015 - six months, seven different science instruments

- Study the geology and topography of Pluto and its largest moon, Charon,
- Map the two objects' surface compositions and temperatures
- Study Pluto's atmosphere
- Search for undiscovered moons and rings ##

Beyond Pluto: NASA Eyes Distant Targets for New Horizons Probe

OCT. 13, 2014 - http://www.space.com/27416-**new-horizons-mission-beyond-pluto**.html
http://www.nasa.gov/press/2014/october/**nasa-s-hubble-telescope-finds-potential-kuiper-belt-targets-for-new-horizons**/

Looking for objects that the spacecraft could visit after this historic encounter.

Pluto may not be the end of the line for the New Horizons probe. The Hubble Space Telescope spotted a few objects that the New Horizons probe might be able to explore after it zooms past the Plato system on July 14, 2015.

- Team members are assessing candidates now, to get a better understanding of their orbits — with an answer before the end of 2014.
- Finding another Kuiper Belt object (KBO) to explore has proven challenging, however.
- KOs are in general much smaller than Pluto, and probably much more primitive in terms of their chemistry and their appearance and they are very faint.
- To date, four years has been spent searching for post-Pluto targets,. The hunt turned up some KBOs, but none of them was within New Horizons' course correction fuel reach.

Possibilities Remain

- The Hubble search is complete, yielding hundreds of images from that part of the sky. Some candidates have been identified, but whether they are within New Horizons' fuel reach, won't be known for some months while we track them as they move in their orbits.
- A plus, New Horizons' fuel reach may be a bit greater than had originally envisioned.
- A recent trajectory-correction burn was so accurate that an additional January burn won't be necessary.
- Each cancelled burn saves a little fuel and makes the Kuiper Belt mission more feasible.
- New Horizons has been in hibernation since August 29. It will wake up on December 6 to begin preparing for the Pluto flyby, beginning in January.

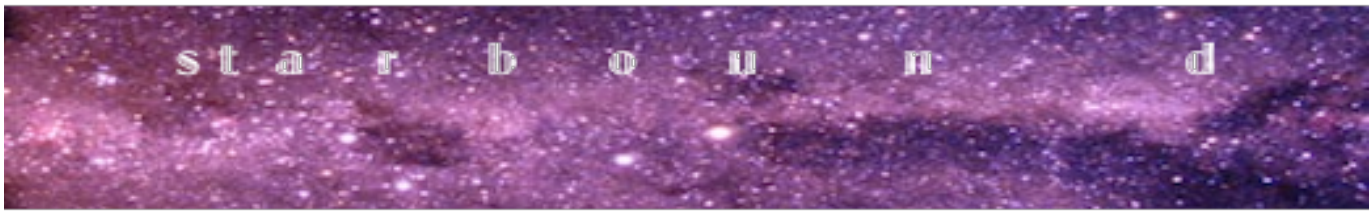
MORE

http://www.space.com/11431-**photos-pluto-charon-moons-dwarf-planet**.html
http://www.space.com/26786-**pluto-and-giant-moon-charon-imaged-by-probe-video**.html

Hubble Telescope Spots Post-Pluto Targets for New Horizons Probe

OCT. 15, 2014 - http://www.space.com/27445-**hubble-telescope-new-horizons-kuiper-belt**.html
www.space.com/26522-**pluto-mission-s-close-approach-is-less-than-year-away-video**.html

- **New Horizons** may have another frigid object in its sights after zooming past Pluto next summer.
- The Hubble Space Telescope has spotted **three** faraway bodies that the probe could potentially visit after completing its highly anticipated flyby of the Pluto-Charon system in July 2015.
- **One of these newly identified objects is definitely reachable**
- Further tracking is required to determine if the other two are indeed accessible.
- The $700 million New Horizons mission launched in 2006 with the primary goal of returning the first-ever up-close looks at Pluto and its moons. Mission leaders have always wanted the probe to fly by another object in the Kuiper Belt — the ring of frigid bodies beyond Neptune — after the Pluto encounter.
- An additional flyby would i**ncrease researchers' knowledge of the mysterious Kuiper Belt objects (KBOs)** Relatively pristine building blocks left over from the solar system's formation 4.6 billion years ago, KBOs have never been "heat-treated" by the Sun.
- Mission scientists began the hunt for additional KBOs in 2011 using some of the world's biggest ground-based telescopes.
- The search has been challenging since most KBOs are very small, and all of them are dim and far away.
- The search turned up some new objects, but none of them were within New Horizons' fuel reach.
- So the team applied for time on Hubble. The scientists were granted use of the iconic spacecraft for an initial pilot study this past June, and then for a wider survey that lasted from July to September. ##

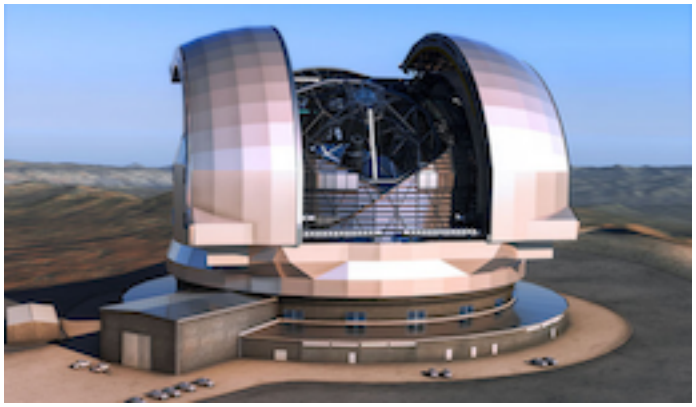


[Most of the "editor's summaries" of news articles are in the form of bullet points of the contents.
For the full text, see the links cited. - Peter Kokh kokhmmm@aol.com]

EARTH-BOUND TELESCOPES

Biggest-Ever Telescope, the "E-ELT", Approved for Construction

www.space.com/27930-**european-extremely-large-telescope-construction-approved**.html



Artist's illustration depicts the **European Extremely Large Telescope** (E-ELT) in its enclosure. It eventually will be the world's largest "eye on the sky."

www.space.com/27930-european-extremely-large-telescope-construction-approved.html

www.space.com/13977-**photos-world-largest-telescope-eelt**.html

DEC.3, 2014 - The world's largest telescope has gotten its official construction go-ahead, keeping the enormous instrument on track to start observing the heavens in **2024.**

- The E-ELT will feature a light-collecting surface 39 m (128 ft = 1,535" (compared with Palomar's 5m =200" wide mirror and with 61 times Palomar's light gathering capacity) wide, has been greenlit for construction atop Cerro Armazones in Chile's Atacama Desert.
- The huge mirror will be a complex of 798 individual segments
- There is already a lot of progress in Chile on the summit of Amazones.
- E-ELT construction was first approved in June 2012 on the condition that contracts worth more than 2 million euros ($2.48 million) could be awarded only after 90 % of the total funding required to build the telescope (1.083 billion euros, or $1.34 billion, at 2012 prices) had been secured.
- An exception was made for "civil works," including the leveling of the site and a road up Cerro Armazones, ESO officials said.
- The 90-percent threshold was reached in October, when Poland agreed to join ESO.
- 90 percent of the project's costs go toward "Phase 1," which will get E-ELT up and running. Contracts for this work will be awarded in late 2015.
- 10 percent of the costs are allocated to "Phase 2," development of nonessential elements. These include about one-quarter of E-ELT's 798 individual mirror segments (which together make up the huge main mirror) and part of the telescope's adaptive optics system, which helps cancel out the blurring effects of Earth's atmosphere.
- The funds now committed will allow the construction of a fully working E-ELT that will allow the initial characterization of Earth-mass exoplanets, the study of the resolved stellar populations in nearby galaxies as well as ultra-sensitive observations of the deep universe."

E-ELT will be King of the Scopes for only a few years

- The Giant Magellan Telescope (GMT) will soon start taking shape atop Las Campanas, another Chilean peak. GMT will arrange seven 27.6-foot-wide (8.4 m) primary mirrors into one light-collecting surface 80 feet (24 m) across; project officials are aiming for "first light" in 2021. www.space.com/15020-**giant-magellan-telescope-video-animation**.html
- And the **Thirty Meter Telescope** (TMT) — which, not surprisingly, will boast a light-collecting surface 30 m, or 98 feet, wide — is slated to start observing from **Hawaii's Mauna Kea in 2022**. Like E-ELT, TMT's primary mirror will be composed of hundreds of relatively small segments.
- All three megascopes should help researchers tackle some of the biggest questions in astronomy, including the nature of the mysterious dark matter and dark energythat make up most of the universe.

OUR CLOSEST STAR: THE SUN

IRIS Provides Five New findings About Sun's Atmosphere

http://www.spacedaily.com/reports/prnewswire-space-news.html

OCT. 16, 2014 -- NASA's **I**nterface **R**egion **I**maging **S**pectrograph (**IRIS**) has provided scientists with five new findings into how the Sun's atmosphere, or corona, is heated far hotter than its surface, what causes the sun's constant outflow of particles called the solar wind, and what mechanisms accelerate particles that power solar flares.

- The new information will help researchers better understand how our nearest star transfers energy through its atmosphere
- This will help track the dynamic solar activity that can impact technological infrastructure in space and on Earth.
- These findings reveal a region of the Sun more complicated than previously thought. Combining IRIS data with observations from other Heliophysics missions is enabling breakthroughs in our understanding of the sun and its interactions with the solar system.

1. The first result identified **heat pockets of 200,000 degrees °F, lower in the solar atmosphere than ever observed by previous spacecraft.**
   - Scientists refer to the pockets as solar heat bombs because of the amount of energy they release in such a short time.
   - Identifying such sources of unexpected heat can offer deeper understanding of the heating mechanisms throughout the solar atmosphere.
2. IRIS also observed numerous, **small, low lying loops of solar material in the interface region** for the first time with unprecedented resolution that will enable scientists to better understand how the solar atmosphere is energized.
3. The third finding of IRIS shows for the first time structures resembling mini-tornadoes occurring in solar active regions.
   - These tornadoes move at speeds as fast as 12 miles per second and are scattered throughout the chromosphere, or the layer of the Sun in the interface region just above the surface.
   - These tornados provide a mechanism for transferring energy to power the million-degree temperatures in the corona.
4. Another finding uncovers evidence of **high-speed jets at the root of the solar win**d. The jets are fountains of plasma that shoot out of coronal holes, areas of less dense material in the solar atmosphere and are typically thought to be a source of the solar wind.
5. The final result highlights **the effects of nanoflares throughout the corona**. Large solar flares are initiated by a mechanism called magnetic reconnection, whereby magnetic field lines cross and explosively realign. These often send particles out into space at nearly the speed of light. Nanoflares are smaller versions that have long been thought to drive coronal heating. IRIS observations show high energy particles generated by individual nanoflare events impacting the chromosphere for the first time.
   - IRIS has been looking at a region of the sun with a level of detail that has never been done before,

- The results focus on a lot of things that have been puzzling for a long time and they also offer some complete surprises

The parties involved:

- IRIS is a Small Explorer mission managed by NASA's Goddard Space Flight Center, in Greenbelt, Maryland for the agency's Science Mission Directorate at NASA Headquarters. NASA's Ames Research Center in Moffett Field, California, provides mission operations and ground data systems.
- The Norwegian Space Centre is providing regular downlinks of science data.
- Lockheed Martin designed the IRIS observatory and manages the mission for NASA. The Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, built the telescope.
- Montana State University in Bozeman designed the spectrograph. Other contributors for this mission include the University of Oslo and Stanford University in Stanford, California. ##

Huge Sunspot Full Of X and M Flares | Video

OCT. 22, 2014 http://www.space.com/27512-**sun-storms-formation-solar-physics**.html
http://www.space.com/27519-**huge-sunspot-full-of-x-and-m-flares-video**.html

STARS

Strange 'Hybrid Star' Discovered After 40-Year Search

OCT. 9, 2014 - http://www.space.com/27389-**hybrid-star-discovery-thorne-zytkow-object.**html

For astronomers, it's the equivalent of buried treasure in space: a strange hybrid star — actually, one star packed inside the shell of another, larger star. This happens when a dying star swallows a smaller, dead star.

For decades, this exotic cosmic scheme was only a wild theory, called a "**Thorne-Zytkow Object**" (**TZO**), and its existence was first proposed in 1975. TZOs are theorized to form from binary systems containing two massive stars:.

- **a neutron star (an** extraordinarily dense corpses of normal stars.
- **a red supergiant** (dying stars with the greatest diameters of any stars — "so big that if you placed them where our sun is, they would extend out to, or even beyond, the orbit of Saturn."

The hunt for a hybrid star

- When a red supergiant engulfs an orbiting neutron star, the merger would result in "a shell of burning material around the neutron core — a shell that would generate new elements as it burned.
- Convection, the circulation of hot gas inside the star, would reach right into the burning shell and carry the products of burning all the way to the surface of the star long before the burning was complete.

Telltale signs

- A TZO should appear virtually identical to a very bright red supergiant. However, a TZO's unique innards should produce **unusually large amounts of rubidium, strontium, yttrium, zirconium, molybdenum and lithium**, setting it apart from a normal red supergiant.
- Scientists detected a red supergiant with that distinct chemical signature of a TZO, named **HV 2112**. The star is **a member of the Small Magellanic Cloud**, a dwarf "satellite galaxy" of the Milky Way, about 200,000,light-years distant, easily visible to the naked eye from the Southern Hemisphere.
- There are **excess levels of rubidium, molybdenum** and **lithium** in HV 2112's gaseous shroud.

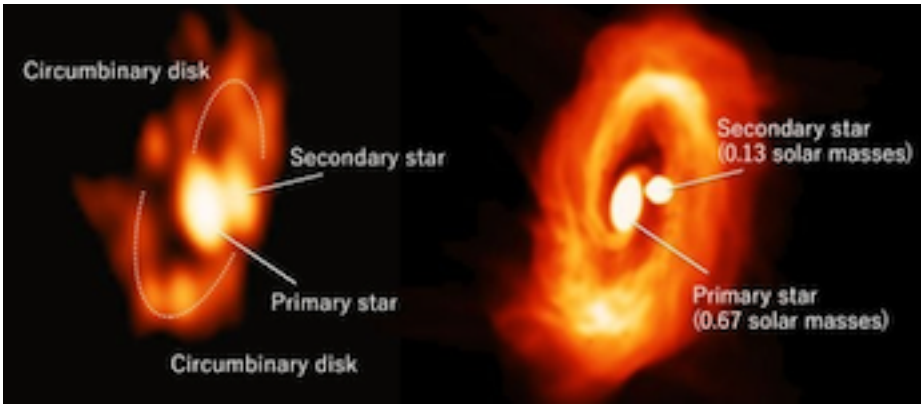
If HV 2112 is a bona fide TZO, it could offer the first solid evidence for a completely different model of how stars' interiors can work. Inside these stars, we also have **a new way of producing elements**, and **knowing where the various elements come from is a critical ingredient in trying to understand how the universe works**. If "everything is made of star stuff' — inside TZOs, we might have found a totally new way to make some of it."

Further reading: http://www.space.com/24-**top-10-star-mysteries**.html

The Birth Of Little Twin Stars

DEC. 19, 2014 - www.asianscientist.com/2014/12/general/**birth-twin-stars**/

- High resolution observations and supercomputer modeling have allowed astronomers to understand the formation of binary stars form in interstellar clouds of molecular gas and dust.
- Previous studies of star formation primarily focused on formation of single stars like the Sun, and a standard theory of single star formation has been established. In contrast, our understanding of binary star formation has been limited.
- More than half of stars with a mass similar to that of the Sun are known to be binaries, making it crucial to unveil the physical mechanism of binary formation for a more comprehensive understanding of star formation.
- Theoretically, a disk surrounding the "baby twin" stars is considered to feed materials to the central baby twin stars and grow them. While recent observations have found such disks surrounding the baby-twin stars, named "**circumbinary disks**", those observations could not image the structures and gas motions of the disks to feed materials to the binary, because of the insufficient imaging resolution and sensitivity.
- Astronomers at the Institute of Astronomy and Astrophysics, Academia Sinica, found spiral arms of molecular gas and dust around the "baby twin" stars, binary protostars.



- Using the ALMA telescope, they observed the baby-twin star L1551 NE, located in the constellation of Taurus at a distance of 460 light years, with a 1.6 times better imaging resolution and a six times better sensitivity than those of their previous observations with the SubMillimeter Array (SMA).
- **Must watch video:** http://youtu.be/lU-YFi8Lxpo

How Big is the Universe?
26 Pictures Will Make You Re-Evaluate Your Entire Existence

http://www.buzzfeed.com/daves4/**the-universe-is-scary**

This is a must see presentation

"There are more stars in space than there are grains of sand on every beach on Earth" - Carl Sagan

EXO-PLANETS

How Planets Get Multiple Suns Like 'Star Wars" Tatooine

http://www.space.com/27589-**alien-planets-multiple-suns-tatooine**.html

http://www.sciencemag.org/content/346/6209/537.full

OCT. 29, 2014 A planet may form in a star system with more than one sun, similar to "Tatooine," the fictional home world of Luke Skywalker in "Star Wars." This finding could help explain how planets orbiting multiple stars are born and, in turn, one day reveal many new potential locations of alien worlds.

- While Earth orbits a single star, early half of sunlike stars are in binary systems, of two stars orbiting each other as a pair. And there are many 3-star systems, and even some with up to seven stars.

- Worlds that orbit binary stars are classified as circumbinary planets. The first real-life alien world found around two suns is Kepler-16b, a gas giant orbiting the star Kepler-16 about 200 light-years from Earth.

Planets with Extra Suns

- In sbinary systems where the two (or more) suns are far enough apart, planets can orbit one star but not the other. Such planets are known either as circumprimary planets or circumsecondary planets, depending on which star they orbit in the binary system — the brighter or more massive primary star, or the fainter or less massive secondary star. For instance, Alpha Centauri Bb is a rocky planet orbiting Alpha Centauri B, the dimmer of the Alpha Centauri AB binary system, about 4.2 light-years from Earth.

Planet formation

- Planets are born from masses of gas and dust whirling around stars.
- Planet formation is a slow process; one of these protoplanetary discs must exist for a long time before a planet can form. Scientists had thought the gravitational pull that binary stars would exert on these discs might disrupt the material within too much for it to easily coalesce into worlds. Evidently not.
- In the past decade, many exoplanets have been found around binary stars..
- There are wide binary systems in which each “star” is itself a close binary. Systems up to seven suns have beed found.
- Planets can form wherever there is a ring of sufficiently concentrated dust.

Binary mystery

To help solve the mystery, astronomers investigated the multiple-star system GG Tau-A, which is only 1-5 million years old, located about 450 light-years from Earth, in the constellation Taurus the Bull. It gets complicated.

Editor: The question arises: how long-lasting are these systems? Long enough for life to evolve to the point where we find it on Earth? Or are such complex systems

Unlocking the Secrets of an Alien World's Magnetic Field

NOV. 20, 2014 - http://www.space.com/27828-**alien-planet-magnetic-field-strength**.html

The strength of an alien world's magnetic field may have been deduced for the first time, by analyzing extraordinarily fast winds slamming against it from the planet's sun..

- This research could help gauge the strength of other exoplanets’ magnetic fields
- The magnetic field of a planet can influence its evolution in crucial ways; as a shield against stellar wind particles, which erode the atmosphere (it is important to know if this field is big or small.
- The target planet, HD 209458b, orbits a sunlike star, HD 209458, in the constellation Pegasus about 150 light-years from Earth.
- This planet is about 70 percent the mass of Jupiter (222 X mass of Earth) , but nearly 40 percent wider 193,000 km (122,000 mi)
- Classified as a "hot Jupiter," a gas giant that orbits its star closer than Mercury does to the Sun, HD 209458b circles its star at a distance of less than one-twentieth the distance between the Sun and Earth, c. 7.5 million km (3 million mi) .
- As a result, its atmosphere is slowly being blown away in a comet-like tail. Astronomers have informally dubbed the world "Osiris," after the Egyptian god torn to pieces by his evil brother Set.
- Hubble Space Telescope findings support prior research suggesting that “hot Jupiters” have relatively weak magnetic fields compared with their cooler gas giant cousins.
- Hot Jupiters, orbiting very near their suns, experience powerful gravitational pulls that likely slow the rates at which they spin until they are tidally locked, always with the same side towards their suns.
- Slower rotation leads to weaker magnetic fields, and finally, none at all. ##

SEARCH FOR EXO-PLANETS & LIFE

Aliens May Be Out There, But Too Distant for Contactng

OCT. 06, 2014 - http://www.space.com/27346-**aliens-too-distant-contact**.html

- **The Milky Way may be home to some 3,000 extraterrestrial civilizations**
- **But the vast distances between our galactic cousins will make contact extremely rare, a new study concludes**.

Data collected by NASA's Kepler space telescope and other observatories indicate

- **Earth is one of some 40 billion potentially habitable worlds**
- About one new life-friendly planet forms every year
- **On average, you'd expect the civilizations to be separated by at least 1,000 light-years** in the Milky Way.
- For communication purposes you need to allow for twice the travel distance,
- So you're talking about civilizations that have to be around for at least a few thousand years in order to have the opportunity to talk to each other,.
- We don't really know how long civilizations persist on average,
- One example available -- Earth -- indicates that life essentially developed as soon as the conditions were right, but intelligent life arose comparatively late.
- It's really just essentially in the last few minutes of the overall evolution of life on the planet
- Basic conclusion is that SETI signals will be rare in the Milky Way."
- There have been huge technological leaps in radio astronomy and in data processing techniques compared to what was available for Search for Extraterrestrial Intelligence, or SETI, programs 60 years ago.
- SETI also is benefitting from sister radio astronomy projects, such as the ongoing quest to find the source of mysterious transient radio bursts.
- Everyone is interested, not just scientists and space enthusiasts. People in the street are interested to know what else is out there.

Additional reading:

http://news.discovery.com/space/alien-life-exoplanets/**space-how-aliens-can-find-us**-111108.htm
http://news.discovery.com/space/alien-life-exoplanets/**alien-life-discovery-could-happen-within-20-years**-140521.htm

"If we ever meet Aliens, they'll probably be Robots"

"The Dominant Life Form in the Cosmos Is Probably Superintelligent Robots"

http://motherboard.vice.com/read/**the-dominant-life-form-in-the-cosmos-is-probably-superintelligent-robots** - a conversation between Susan Schneider and Setg Shostak.

DEC. 19, 2014 - If and when we finally encounter aliens, they probably won't look like little green men, or spiny insectoids. They may not even be biological creatures at all, but rather, advanced robots.

- Such robots might "outstrip our intelligence in every conceivable way."
- Philosophers, scientists and futurists have forecast the rise of artificial intelligence here on Earth and within our solar sytem.
- Some thinkers—outside the realm of science fiction, that is—have considered the notion that artificial intelligence is already out there, and has been for eons (translate "billions of years."
- The common idea of aliens as biological creatures may not make any sense from a timescale viewpoint. The latest findings of the Kepler telescope shows potentially habitable worlds strewn across the galaxy,
- It is becoming harder and harder to assert that we're alone in the universe.
- And if and when we do encounter intelligent life forms, we'll want to communicate with them.
- Schneider's paper is among the first to tackle the subject.

Editor: For robots, not dependent on a biosphere, spending years, even centuries, or millennia between star systems will not be a "psychological problem." But maintaining their working parts, replacing them when necessary, may be. They can also be put (or put themselves) to sleep for extended periods during intersystem travel.

But to whom would they report? Or would they just gather knowledge to download to living sentient beings when they happen upon a solar system so occupied?

The speed of light is not a rule for biological sentients alone. Robots will be equally constrained. Interstellar traveling robots could spread the knowledge and culture output of isolated civilizations far and wide. But even if they could be "debriefed" only by advanced civilizations, that could be a problem.

Personally, I believe that the Star Trek fictional "**Prime Directive" to not interfere with the cultural and intellectual evolution of "developing" civilizations** "is" a "directive" that should be self-evident to civilizations throughout the universe(s). ##

NASA Selects New Science Teams for Astrobiology Research

www.nasa.gov/press/2014/october/**nasa-selects-new-science-teams-for-astrobiology-research**/

OCT. 6, 2014 - RELEASE 14-273 - NASA has awarded **5-year grants** totaling almost $**50 million** to 7 research teams nationwide to study the origins, evolution, distribution, and future of life in the universe.

Average funding for each team will be c.ct $8 million. The interdisciplinary teams will become members of the NASA Astrobiology Institute (NAI), at NASA's Ames Research Center, Moffett Field, CA.

The selected teams are:

- **NASA's Goddard Space Flight Center**, Greenbelt, Maryland. Research will investigate **one theorized source of Earth's water and the organic molecules needed for life:** comets and the other small bodies in our solar system. The results will inform the search for habitable environments in our solar system and habitable planets around other stars.
- **NASA's Ames Research Center**, Moffett Field, California. Research will address **the chemistry which occurred to create the organic molecules that may have been brought to the early Earth by comets and other small bodies.**
- NASA's Jet Propulsion Laboratory, Pasadena, California.Research will conduct laboratory experiments and field research in environments on Earth, such as The Cedars in Northern California, to **understand the habitability of extraterrestrial icy worlds: Europa, Ganymede and Enceladus**.
- **The SETI Institute in Mountain View**, California; Guiding principles to better understand **where to search for life, what to search for, and how to recognize finding evidence of past or current life**. The goal of the proposed research is to best prepare for NASA's Mars 2020 rover.
- **The University of Colorado in Boulder**. Research will study "**Rock-Powered Life**." Rocky planets store enormous amounts of chemical energy that, when released through the interaction of rocks with water, can power living systems on Earth, as well as on other planets such as Mars.
- **University of California, Riverside**. Research will examine **the history of oxygen in Earth's atmosphere and ocean between 3.2 and 0.7 billion years ago**. This is a time range in which the amount of oxygen present is thought to have increased from almost nothing to the amounts present today. This work will address the question of **how Earth has remained persistently inhabited through most of its dynamic history** and would provide NASA exploration scientists a template to investigate the presence of habitable conditions on Mars and other planetary bodies.
- **University of Montana in Missoula**. Research to unlock **the secrets of life's transitions from small "units" conducting simple chemical reactions to self-organizing, self-reproducing, energy-gathering systems that range in complexity from single cells to ecosystems.**

The intellectual scope of astrobiology is vast, from understanding **how our planet went from lifeless to living**, to understanding **how life has adapted to Earth's harshest environments**, to **exploring other worlds with the most advanced technologies to search for signs of life.**

For more information about the new teams, NAI, and NASA's astrobiology program, visit:

http://astrobiology.nasa.gov

Moons Can Help Planets Remain Stable Long Enough for Life to Form

http://www.spacedaily.com/reports/**Moons_Can_Help_Planets_Remain_Stable_Long_Enough_for_Life_to_Form**_999.html - OCT. 14, 2014

The Moon is more than just Earth's partner in space - it may have helped stabilize Earth's orbit enough for it to become hospitable for the evolution of complex forms of life.

- A new study suggests that **large moons** can form and remain stable for long times around distant planets as well, potentially helping alien life evolve.
- If the recently discovered rocky alien planet Kepler-62f has a moon, the moon could last more than 5 billion years, perhaps long enough to help foster the evolution of complex life.
- The investigators detailed their findings in the International Journal of Astrobiology.
- In the past twenty-some years, the existence of more than 1,700 planets beyond the Solar System has been confirmed, and they may soon prove the existence of thousands more of such exoplanets.
- Of special interest are distant planets in habitable zones, the regions around stars just warm enough for worlds to possess liquid water on their surfaces. On Earth there is life virtually wherever liquid water is found
- To support complex forms of life, a world needs more than just an orbit within its star's habitable zone. It probably also needs **a climate that remains stable over long time span**s as well.
- Earth's seasons, for example, depend on the axial tilt, as the amount of light hitting the northern and southern hemispheres varies with the way the northern and southern hemispheres point toward or away from the Sun.
- Earth's axial tilt was stabilized with the help of the gravitational pull of its large moon, which is roughly one-quarter the diameter of the Earth.
- **"If the Earth did not have the Moon, the Earth's axial tilt would have changed rapidly and the climate of the Earth would have changed often**,
- **In contrast, Mars** has relatively small moons, and its axial tilt has changed substantially over long periods of time, fluctuating chaotically on a 100,000-year time scale.
- **A planet whose axial tilt fluctuates wildly like Mars may not maintain a favorable climate for a long enough time for complex forms of life to evolve.** For example, it took about 3.8 billion years for life Because the Earth has had a long-term stable climate, life on the Earth has had time to evolve from single cells to complex life forms.
- The Moon is a key reason why Earth has had a relatively stable climate for a long time, one of the key factors in Earth's evolution of complex life forms.

Three potential scenarios are possible.

1. First, a moon could get closer and closer to its planet until it breaks apart or collides with its host, as Mars' moon Phobos is predicted to do about 50 million years from now.
2. Next, a moon could get farther and farther away until it escapes the planet.
3. Last, a moon can reach a stable distance from its planet, as is the case for the dwarf planet Pluto's moon Charon.

The researchers examined four typical planet compositions:

1. Earth-like planets composed of 67 percent mostly silicon-based rock and 33 percent iron;
2. Planets with 50 percent rock and 50 percent ice;
3. Planets with 100 percent rock; and
4. Planets with 100 percent iron.

The findings runs counter to the belief that lower-mass stars are good for habitable planets because they live longer than higher-mass stars, potentially giving them more time for life to evolve. While the lifetime of a planet with a mass twice the Sun's mass is about 1.2 billion to 1.3 billion years, the lifetime of a star with half the Sun's mass is about 80 billion years. However, he noted "our results show that small-mass stars may not be good parent stars for habitable planets."

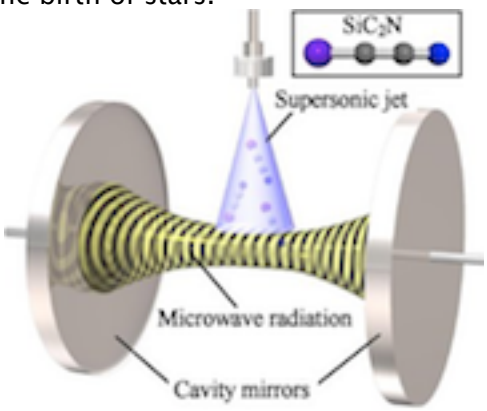
Read the whole article for more details.

Generally, the more a star system is like ours, the greater the chance of an "Earth-Moon-like pair with stable parameters that allowed life to reach the stage it has on Earth. ##

Extra-Solar Space: The Final Frontier In Silicon Chemistry

http://www.asianscientist.com/2014/11/in-the-lab/**space-final-frontier-silicon-chemistry**/

NOV. 13, 2014 - The chemical profile of carbon-containing molecules capped by silicon and nitrogen could give scientists insight into the birth of stars.



- The unique electromagnetic emission spectrums of two new, highly-reactive silicon compounds, which will help astronomers look for similar molecules in the interstellar medium.
- Silicon, one of the most common elements in the Earth's crust, is also sprinkled abundantly throughout interstellar space.
- The only way to identify silicon-containing molecules at cosmic distances, and to understand the chemistry that created them—is to observe through telescopes their electromagnetic radiation.
- We can identify molecules from the frequencies of the electromagnetic waves emitted by them,
- Using spectroscopic techniques, scientists have already detected silicon-containing molecules in the gaseous clouds that envelop some stars and in the sparsely populated space between stars.
- In space, silicon is often found in dust grains containing stable compounds called silicates.
- Highly reactive molecules, like SiCN, have been detected in the gas phase in the interstellar medium.
- The plan is to look for silicon and nitrogen-terminated carbon chain molecules in the gaseous cloud surrounding a giant infrared star called IRC+10216. If [SiC_2N and SiC_3N] molecules are identified in astronomical objects and their abundances are determined, we will be able to obtain valuable information on the mechanisms for the formations of these molecules.
- This information may provide clues to the formation pathways of other silicon-bearing molecules.
- The new information could give yield clues about the chemical composition of the universe and the conditions that birth stars and planets.

The article can be found at:
http://scitation.aip.org/content/aip/journal/jcp/141/18/10.1063/1.4900740.

SPACE TELESCOPES

Hubble Maps the Temperature & Water Vapor on Extreme Exoplanet

http://www.spacedaily.com/reports/**NASAs_Hubble_Maps_the_Temperature_and_Water_Vapor_on_an_Extreme_Exoplanet**_999.html

WASHINGTON, OCT. 9, 2014 -- A team of scientists using the Hubble Space Telescope has made the most detailed global map yet of the glow from a turbulent planet outside our solar system, revealing its secrets of air temperatures and water vapor.

The exoplanet WASP-43b, first discovered in 2011, is a world of extremes, where seething winds howl at the speed of sound from a 3,000 °F (538 °C) "day" side, hot enough to melt steel, to a pitch-black "night" side with plunging temperatures below 1,000 °F (1650 °C).

- Astronomers have mapped the temperatures at different layers of the planet's atmosphere and traced the amount and distribution of water vapor.
- The findings have ramifications for the understanding of atmospheric dynamics and how giant planets like Jupiter are formed.

- These measurements have suggested a new kinds of way to compare the properties of different types of planets
- **WASP-43b** is some 260 light-years away. As it rotates in an orbit edge-on to Earth, astronomers detected it by observing regular dips in the light of its parent star as the planet passes in front of it.
- These observations provide a 2-Dl map on the longitude and altitude of the planet's thermal structure that can be used to constrain atmospheric circulation and dynamical models for hot exoplanets.
- As a hot ball of mostly hydrogen gas, there are no surface features on the planet, such as oceans or continents that can be used to track its rotation. Only the severe temperature difference between the day and night sides can be used by a remote observer to mark the passage of a day on this world.
- WASP-43b is about the same size as Jupiter, but nearly twice as dnse. The planet is so close to its orange dwarf host star that it completes an orbit in just 19 hours. The planet also is gravitationally locked so that it keeps one hemisphere facing the star, just as ther Moon keeps one face toward Earth.
- This was the first time astronomers have been able to observe three complete rotations of any planet - during a span of four days.
- They used spectroscopy, dividing the planet's light into its component colors, to determine the amount of water and the temperatures of the atmosphere.
- By observing the planet's rotation, the astronomers also were able to precisely measure how the water is distributed at different longitudes.
- Because there is no planet with these tortured conditions in our solar system, characterizing the atmosphere of such a bizarre world provides a unique laboratory for better understanding planet formation and planetary physics.
- Water in its atmosphere is vaporized, rather than condensed into icy clouds like on Jupiter.
- The amount of water in the giant planets of our solar system is poorly known because water that has precipitated out of the upper atmospheres of cool gas giant planets like Jupiter is locked away as ice.
- In so-called "hot Jupiters," gas giants that have high surface temperatures because they orbit very close to their stars, water is in a vapor that can be readily traced.
- Water is thought to play an important role in the formation of giant planets, since comet-like bodies bombard young planets, delivering most of the water and other molecules that we can observe
- To learn how giant planets form, we need to know how enriched they are in different elements.
- The team found that WASP-43b has about the same amount of water as we would expect for an object with the same chemical composition as our sun, shedding light on the fundamentals about how the planet formed. The team next aims to make water-abundance measurements for different planets. ##

Can you believe it? Hubble turns 25 in April 2015!

http://www.space.com/27772-**hubble-turns-25-in-april-2015-quick-look-back**-video.html

Innovative 'Starshade' Tech Could Illuminate Rocky Alien Planets

NOV. 14, 2014 - http://www.space.com/27765-**starshade-tech-alien-planet-search**.html

Nineteen variations of 1/100th-scale starshades were tested in the Nevada desert as part of a Northrop Grumman-led technology development study for NASA's Science Mission Directorate. Starshades provide the capability to block the light from a star while allowing light from orbiting planets to be seen by future space-based telescopes. **Full size image**:

http://i.space.com/images/i/000/043/694/original/100th-scale-starshade.jpg?1415917054

- "Starshade" technology was put to the test earlier this year in the Nevada desert.
- A starshade, also dubbed an “external occulter”, is a precisely shaped screen that flies in far-away formation with a space telescope. The device blocks a star's light to create a high-contrast shadow, so that only light from an orbiting exoplanet enters the telescope for detailed study.
- Researchers studying the technique are drawing upon a track record of success in fielding large, deployable antennas in space.
- A fully deployed starshade could be some 34 m (110 ft) wide, with a (20 m 65ft) inner disk and 28 outstretched flowerlike petals, each over 7m (22 ft) long.

Subscale testing

- Moving beyond the drawing board, subscale versions of starshades have undergone nighttime desert testing at central Nevada's Smith Creek dry lake bed over 5 nights in late May / early June this year.
- Desert tests hoped to find how computational optical predictions stack up against in-the-field performance of two different starshade shapes.
- The Nevada site offered thin air and very dark skies, and a modified Celestron telescope and ultrabright, light-emitting diodes (LEDs) placed about 1.6 k (1 mile) away.
- The LEDs were all finely aligned with an automated stand topped by a starshade model sitting in the middle of the test range.
- Data and images were gathered at the telescope stand.

What we want a starshade to do

- Look at a lighthouse from a mile away and spot a firefly that's just a centimeter (0.4 inch) away from that lighthouse, trying to block the light from the lighthouse.
- In the simplest terms, a starshade is a specially shaped finger placed in front of a bright source to dim the light – “a traveling dark spot" – helping telescopes gather photons arriving from a target planet.–

Deployment Options in space of simple and reliable systems,

- There's heritage to be found in Northrop's lead work on NASA's Tracking and Data Relay Satellite System, as well as in building the James Webb Space Telescope (JWST).
- The starshade could be used with JWST, which is scheduled to blast off in 2018, or with other space scopes being considered. In the end. ##
-

DISCOVERIES ABOUT EARTH RELEVANT TO LIFE ON EXO-PLANETS

Low Oxygen stifled Animals' Emergence on Earth

http://www.sciencemag.org/content/346/6209/537.full

(access restricted web page) published summary below.

“Between the appearance of complex cells about 2 billion years ago and the explosive diversification of multicellular animals some 800 million years ago was the so-called boring billion—a long span of time during which evolution seems to have mired.

Now, a new study looking at chromium isotopes in ancient ironstones suggests that the oxygen content of the atmosphere during that time was only 0.1% of present oxygen levels—at least an order of magnitude smaller than previous lower limits for oxygen content at the time. Oxygen levels rose again about 800 million years ago, coinciding with animal diversification—and suggesting that such environmental conditions can play a powerful role in controlling biological evolution.”

– study by Carolyn Gramling

Editor: The length of time when oxygen levels are low, may vary greatly world to world due to conditions yet undetermined. Thus we can't assume that the ltime it took for animal diversification on Earth is typical. On some worlds, this evolution threshold, could happen significantly earlier, and on other worlds, not at all.

To The Stars International Quarterly Editorial Team

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

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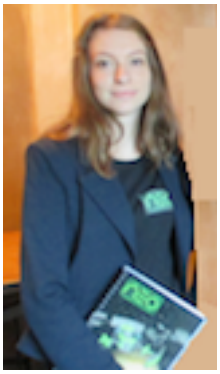

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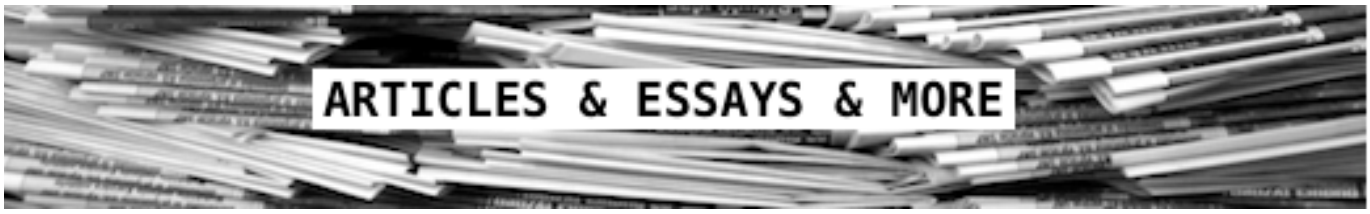
As well as Reporters from various nations and student groups



{The following articles by the Editor are reprinted from Moon Miners Manifesto #279, October 2014, with added illustrations}

Are we ever going to Settle the Moon?

By Peter Kokh

The quick answer to this deceptively simple question is "No" and "Yes!"

- **"No," if we leave it to government(s) and space agencies.** As visionaries, we are a decided minority and must remember that many congressional decisions are not made on any logic except what is best financially for the individual Congressmen and Senators – and for improving the chances of their re-election. We are fooling ourselves if we think we can make "lunar settlement" a popular campaign.
- **"Yes," if we do what we can, as entrepreneurs, and supporters**, to predevelop technologies needed on the Moon, especially those that could also be profitable here on Earth >
- A rationale for determining what must be imported and what can best be made on the Moon will insure the best use of funds – both expenses and profits
- Giving priority to those technologies that could be adapted to solving problems (especially environmental) here on Earth. That settling the Moon can help preserve and even restore Earth's environment, is a concept that will earn us the support of many who are quite disinterested in "space" and things related to "space."
- We can work slowly but surely and methodically to put the key pieces together so that beginning settling the settlement of the Moon makes sense to those otherwise disinterested in "space" in general.
- That many of the technologies needed to create and maintain self-sufficient mini-biospheres on the Moon, on Mars, or elsewhere in space might help clean up our bad environmental habits here on Earth could win us allies. Settling the Moon, or Mars, is a lot more than a matter of nuts and bolts!
- We must develop transportation systems in which everything is reused as is, or designed to serve new purposes once its initial service is complete. The number one reason space is so expensive is the throwaway philosophy inherited from the rocketeers of Peenemünde, including von Braun: "If it is not the payload (read warhead), it is expendable." Can you imagine flying from New York to Los Angeles, if at an intermediate stop (Chicago, Dallas-FT. Worth, etc.) it took 10,000 man hours to get your plane ready for takeoff? Or your plane was junked and a new one rolled out for the rest of the trip? Can you imagine driving that distance and every time the fuel tank showed close to empty, you threw away the car and bought another one fully fueled? Absurdities like this come from the scouting mentality. We go to the Moon or Mars not to stay and set down roots, but to scout and report back. So there is no need for infrastructure.
- Meanwhile, we concentrate on what we can do now, without megabucks, but with carefully chosen "foundation projects" and earned investments. PK

A fresh look at the idea of "Spinning-up" Industries Needed on the Moon

By Peter Kokh

When it comes to the Moon, why have we who would go been wasting time, waiting for others who would not pioneer. to pave the way? It makes no sense!

Early Period Industrial Materials and products made from them

(1) **GGC: Glass fiber-Glass Composites:** some 27 years ago, back in 1987, I wrote a paper "Spinning-up" Glass-Glass Composite Technology – www.moonsociety.org/publications/mmm_papers/glass_composites_paper.htm

The idea of Glass-glass composites was that of Dr. Gerard K. O'Neill, founder of the Space Studies Institute (Princeton, NJ) and of the L5 Society. O'Neill reasoned that we could make components for Solar Power Satellites with such composites, more easily than by starting up aluminum alloy or iron alloy industries. Glass fibers with a high melting point would be embedded in glass with a lower melting point, thanks to an immixture of lead. The result of his experiments was an ice-cube-sized chunk of glass with amazing strength.

And that one demonstration was as far as it got. SSI was content and did not investigate further, leaving development of GGC was left to the future - SSI showed no imagination at all. No one asked what we could do with such a material that would have physical or esthetic qualities with such appeal and marketability, that we could develop GGC here and now, and make a lot of money doing so, ending up with an industry adaptable to the Moon so that when we got there, we could hit the ground running.

One of our suggestions was that if we could color the glass fibers that would then be immersed in a clear glass matrix, we might find that we had an ideal high-end furniture material.

Could we produce Glax™ products with colored fibers to look like this? For "high end" furniture?
We haven't tried.

Glax™ products could replace wood in markets where wood was scarce (desert countries, plains countries), Additional potential applications are enormous: boat hulls, countertops, tableware, window panes, skylights, -----?

Never mind that Space Studies Institute dropped the ball! Its not too late!

(2) **Basalt fiber-Basalt Composites**: meanwhile people in India and elsewhere have discovered the magic of **basalt fibers.** Basalt happens to be the dominant material in the lunar maria or dark "seas" of frozen lava, that give the Moon's near side its familiar "Man in the Moon" personality. But unlike GGC, BBC (basalt/basalt fiber composites) did not remain in the laboratory. Rockbar, the basalt composite answer to "rebar" is sweeping the concrete structure industry: it has a very low coefficient of expansion and does not rust. By the time we get to the Moon, a cornerstone Basalt-Basalt Fiber Composite industry will be ready to hit the ground running.

What can be made of BBC? Habitat modules? countertops? bath tubs? Planters? Molded seating? We can find out by experimenting here and now. All such BBC items made on the Moon, will be that much less to import. Could we make durable, no tear, no rip fabrics to spread over a frame on which to pile moondust shielding for unpressurized "hangers" in which to park and connect pressurized living modules as alternative to contour crafting

(3) "Spin-up" not "Spin-off!" - In the usual "spin-off" paradigm, NASA embarks on a crash research program at exorbitant cost and then turns over the resultant technology at no cost to commercial enterprises with the **taxpayer** footing the bill.

In "spin-up," however, a private enterprise, motivated by profit, examines a technology needed on the space frontier and endeavors to identify potentially profitable terrestrial applications. The company then develops the technology, specifically for those terrestrial applications, with the consumer paying the bill.

As a result, when the technology is needed on the space frontier, it is **already "on-the-shelf", at least in an analogous form in need of relatively inexpensive adaptation**. Taxpayers and consumers are materially the same people, but unwilling in the first instance, and quite willing in the second.

Note that on the "oreless" Moon, familiar industrial and manufacturing materials may be neither practical or economic, More appropriate industries may now be just conceptual. But we can examine them for potential profits in our down to Earth market, and "spin-up" such technologies for application on the Moon.

Biospheric Technologies

Surely, the spin-up "wish list" will include more than these two "composite" materials. For example, on the Moon, we must live in sealed mini-biospheres, in which pioneers will essentially be living "downwind and downstream of themselves." Biosphere II was a noble start in that direction. We learned a lot from its shortcomings and in that sense, to call it a "failure" is a contemptible attitude. Pioneers will need new technologies to manage wastes and other "outputs"- solid, liquid, or gaseous.

If we could develop such technologies here and now, that would help us here on Earth gradually halt our downward environmental slide, while trouble-shooting technologies that must succeed on the Moon. Here is another example of "spin-up" - developing technologies absolutely essential on the Moon (and Mars) but also quite useful and valuable here on Earth.

Other Spin-up technologies

We don't claim to have a complete list, just these doable examples. But you get the picture. By "spin-up" we develop technologies essential for lunar (or Martian) settlement and pay the bill for that R&D by sales of kindred products here on Earth. By pursuing the "spin-up" path - just the opposite of NASA's "spin-off"- we advance the day when lunar settlement will be both possible and affordable.

For more on "spin-up" read http://moonsociety.org/publications/m3glossary.html#ST

What else can you/we do? Have an idea for a lunar appropriate technology which does not yet exist on Earth? Brainstorm that idea for possible profitable applications on Earth, then pre-develop that technology to put money in your pocket now, and to put "on the shelf" a technology most useful on the lunar frontier. For years we have heard the litany of NASA "spin-**offs**" - Bah humbug! Let's turn that paradigm on its head with "Spin-**ups**." PK

Exports to Earth need to be greater in value than imports from Earth
The "M.U.S./c.l.e." Equation

By Peter Kokh

They lie when they say that there is no up or down in space. In reality, everything is in a series of "gravity wells" in which climbing up and out requires much more fuel than dropping down and in. It takes 23 times as much rocket fuel to boost a given payload off the Earth's surface into Geosynchronous Earth Orbit, GEO, some 23,000 miles above the surface, than it does to boost the same payload off the Moon and down the gravity well to that same destination. And it costs much more fuel than that to ship anything to the Moon from Earth than it does to ship something from the Moon to Earth's surface.

It makes sense to preferentially import lightweight items to the Moon, and pay for them with heavy items shipped off the Moon - when we can. And that gives us an ideal guide for choosing what to import and what to manufacture for Earth/GEO markets.

Note: building materials, furnishings, even food can be "downported" from the Moon to hotels and stations in Earth orbit at significantly less cost than equivalent (and probably more sophisticated) items can be "upported" the much shorter distance from Earth's surface. This is the foundation of the lunar economy. In choosing what to export as well as what to import, the "M.U.S./c.l.e." equation works.

Orbiting space hotels with "made on Luna" decor and furnishings, would give those who could not afford a trip to the Moon, some feeling for what lunar settlements are like.

Early lunar industries will be simple. It pays to export simple products with some value, if not on Earth's surface, then in GEO and LEO markets such as orbiting hotels, stations, shipyards, and more.

Read our 1988 paper, "**MUS/cle Strategy for Lunar Industrial Diversification" - "**A Strategy For Following Up Lunar Soil-Processing with Industrial M. U. S./ c. l. e."

http://www.moonsociety.org/publications/mmm_papers/muscle_paper.htm

"You will have noticed that our "muscle" was spelled as a two part acronym, "**M.U.S.** / **c.l.e**.". For our strategy calls for the M.U.S (**Massive, Unitary, Simple**) parts to be made by the settlement and the c.l.e. (**Complex, Lightweight, Electronic**) components to be made on Earth for upport and mating on the Moon (or early space colony). Here then is the logical formula for giving industrial muscle to the early settlement still too small to diversify into a maze of subcontracting establishments. It is a path that has been trod before. It plays on the strengths of the lunar situation and relies on the early basic industries: lunacrete, iron-steel, ceramic, and glass-glass composites (glax). And not surprisingly, it is the path of lunar development that will produce the most in exports to LEO, GEO, L5 (?), and even Mars.

This "strategy" is a 'wish list guide" for settlers in choosing what to manufacturer for both use on the Moon and for "downport" to GEO, LEO and other in-space markets, and what to "upport" from Earth. Its all about the all too real "up and down."

The goal, of course, is to reach and maintain a positive trade balance with Earth, thus keeping "the books" of the lunar economy in the black, or as close to it as possible. For lunar settlements, nothing could be more threatening to long term security than a mounting debt with Earth, leading eventually to abandonment and a set of "ghost towns" on the Moon. PK

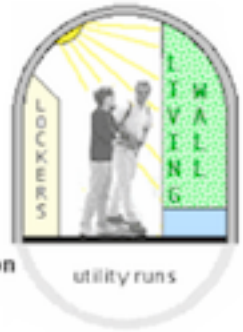
Biospheric Technologies needed on the Moon – and on Earth

By Peter Kokh

There is no air – or free flowing water – or plant life on the Moon. Just vacuum and radiation bombardment. But we can learn to life safely, and stay healthy in those conditions in properly shielded structures with inter-connected common space full of vegetation.

Modularity creates options – opportunity to experiment with different systems

Living Wall installation, Baltimore, MD. This 110 sq ft (10 sq m) wall filters all the air for its 7,500 sf office building



If we continue to think in terms of floor space then we will be put in competition with the plants we depend on – *not a prescription for success*

But plant areas can make use of otherwise empty wall space.

The challenge is in keeping both air and water fresh. We will live in self-contained settlements, "downwind and downstream from ourselves." If we pollute this environment, we all die. That means changing countless generations of bad habits learned worldwide, because "we can get away with it."

One bad habit we have, putting all wastes in one drainage system, was invented in Mohenho-Daro on the Indus River in the India-Pakistan area some four and a half thousand years B.C./B.C.E. We live like "monotremes" – animals in which the cloaca and urethra are one and the same.

We need to develop **"Tri-treme" plumbing**. That will help keep our closed biopsheres clean. In MMM #49, we wrote an article about this," CLOACAL VS. TRITREME PLUMBING" – republished in this theme issue.http://www.moonsociety.org/publications/mmm_themes/mmmt_EdenOnLuna.pdf

1 Side-flush toilet

2 blackwater tank with microbes to break down solids & destroy all pathogens

3 inert filter with irrigated soil

4 plants with roots in wet soil mixture

5 effluent water is 95% treated, ready to water plans in greenhouse and elsewhete

This and other "adjustments" to the way we live in our "throwaway" culture, in which wind and water carry our pollutants "downwind" and "downstream" to our hapless neighbors, passing on the bad habits and bad air and water which had been given us by our own neighbors upstream and upwind.

Multiple Modules in the Analog "Settlement" allow us to experiment with

- Alternative Black>Graywater systems i each module with a toilet
- Alternative Living Wall Systems in each corridor
- Alternative Plant bedding/watering/fertilizing systems in the Greenhouses and Living Wall units
- Alternative Plant Irrigation & Nutrition systems
- Alternative nightspan Plant Lighting Schedules

We will be learning many ways to "treat" our problems rather than to "pass them on."

Now if we can pre-develop the needed systems before we get to the Moon, we will help keep Mother Earth as clean as she deserves to be, and make money doing it.

The point is that these closed biospheric technologies can be pre-developed for a profit here and now so that they are ready at no extra cost when the doors to settlement are open.

Will NASA do this? No! It's up to us. PK

Recommended Reading:

http://www.moonsociety.org/publications/mmm_themes/mmmt_**EdenOnLuna**.pdf

We Need More Good & Realistic Moon & Mars Outpost & Settlement Art

By Peter Kokh

There is all too much artwork out there depicting Moon and/or Mars outposts in which habitat and activity structures are shown in the open, unprotected from cosmic radiation and meteorite rain, exposed to temperature extremes. This continues to reinforce false impressions of Lunar and Martian environments.

We need to show structures covered with several meters of shielding – moondust or marsdust either directly or indirectly: (the habitat structures are within/under a shielded "hangar" so that their interconnections can be rearranged and so that access to external fittings is easy.

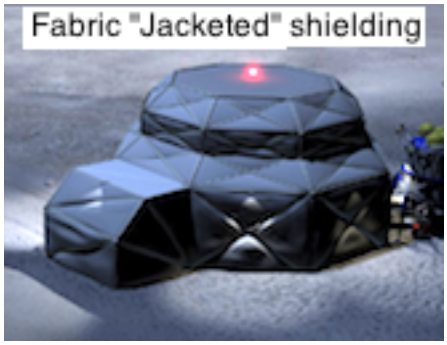
Bad Examples: habitat structures siting "naked" on the surface – no shielding

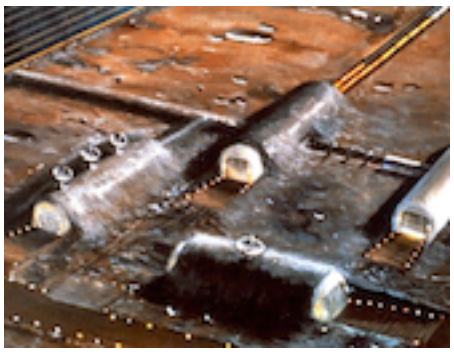
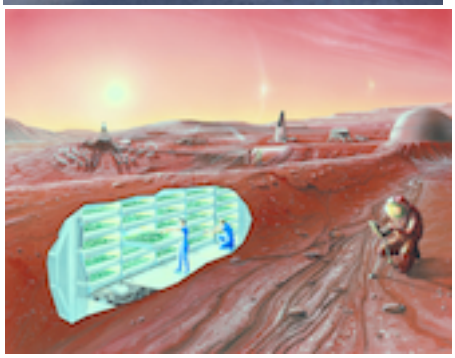




Good Examples: shielding applied in various methods





We propose that the Moon Society and National Space Society hold an art contest with attractive prizes. Submitted Art work to be shown at ISDC 2015 Toronto, May 20–25, 2015

SHIELDING: ~~"The Good, the Bad, the Ugly"~~ > "The Drab, the Nice, the Beautiful"

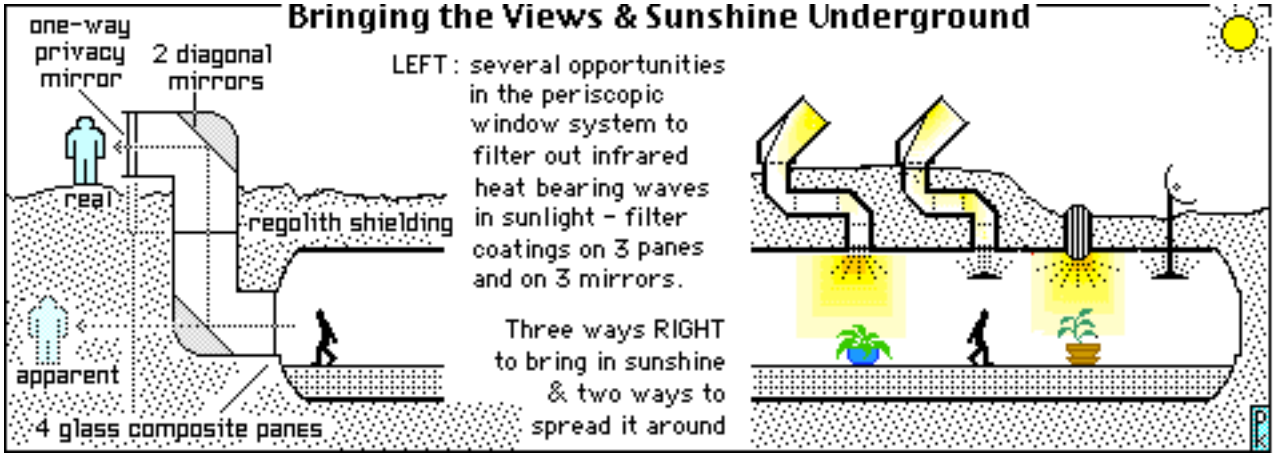
By Peter Kokh

Moon dust Shielding" against cosmic radiation and hot/cold thermal extremes need not be boring

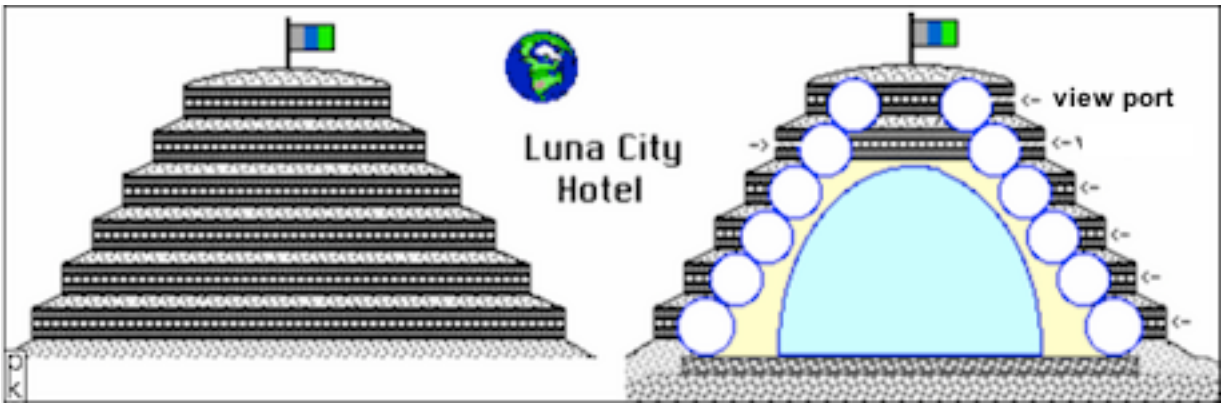
- Landscape architects" will have plenty of leeway for a homeowner that wants his/her abode to stand out and be distinctive, or who just wants to be able to spot it from outside.
- Moondust from other areas may have various shades and tones
- Moondust piles can be "**retained**" and/or shaped by retaining walls of various kinds
- Retaining walls can mirror the architecture of the covered residence or other type of building
- The top cover can be **adorned** – "finished" in various ways:
- **Stones, broken glass or ceramic**s – be inventive.
- Using regolith "**soils**" from various locations can provide various tints and shadings
- Areas around the base can be kept natural, or "Zen raked," or "paved," or decorated with sculptures.
- The **underlying architecture** of the modules being shielded – habitats, corridors, pressurized streets, parks, etc. will add design and pattern automatically
- There is plenty of room to express individuality, personal tastes, period styles, etc.
- New ways to personalized shielding mounds will be pioneered by individuals and by "mound-scaping" companies

Future Lunar and Martian "Shielding Engineers and Architects"
will be more inventive than these sketches by the editor indicate
But we hope you can see from the illustrations below that
lunar settlements will look much more interesting than a "maze of molehills!"

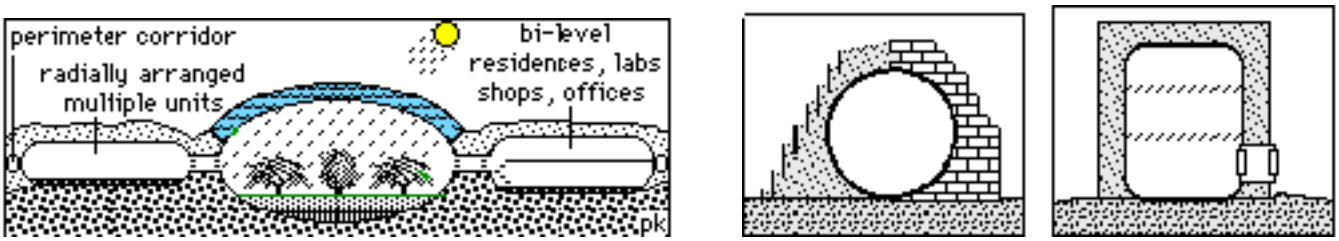
Having to live "underground" does not mean that you cannot see outside
or that you cannot enjoy the sunshine!



A shielded home can still have access to the view outside and to sunlight

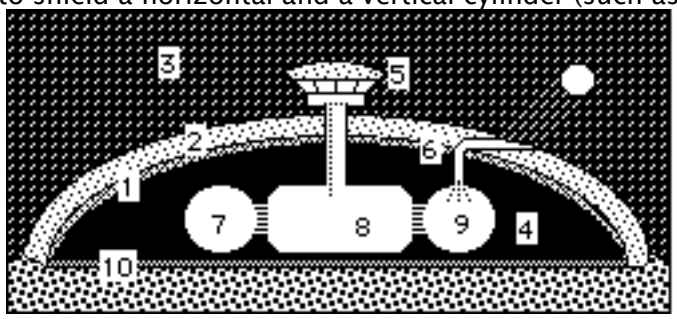


The hotel proper consists of a stack of increasingly smaller pressurized torus levels. Exterior shielding is restrained by cast cement or basalt walls. The interior space is a tree, plant, and wildlife park.



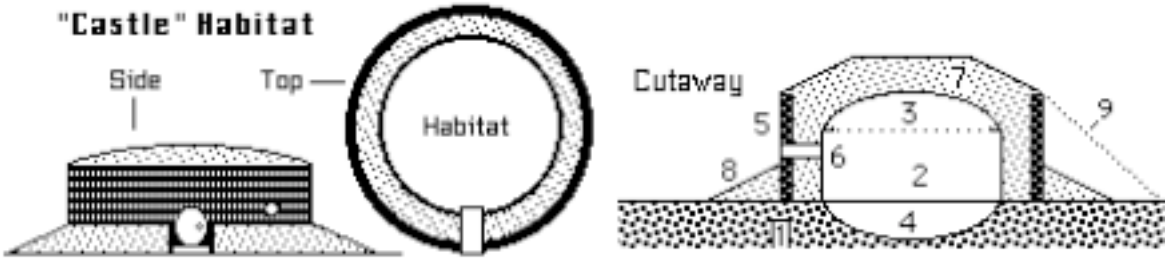
Left: Water makes excellent shielding but it will take constant circulation to keep the water from freezing in nightspan and from boiling in dayspan. Glass dome needs to have "sacrificial replaceable outer panes" less micrometeorites eventually break through and the atmosphere rushes out into the vacuum

Left: Various simple ways to shield a horizontal and a vertical cylinder (such as MDRS)

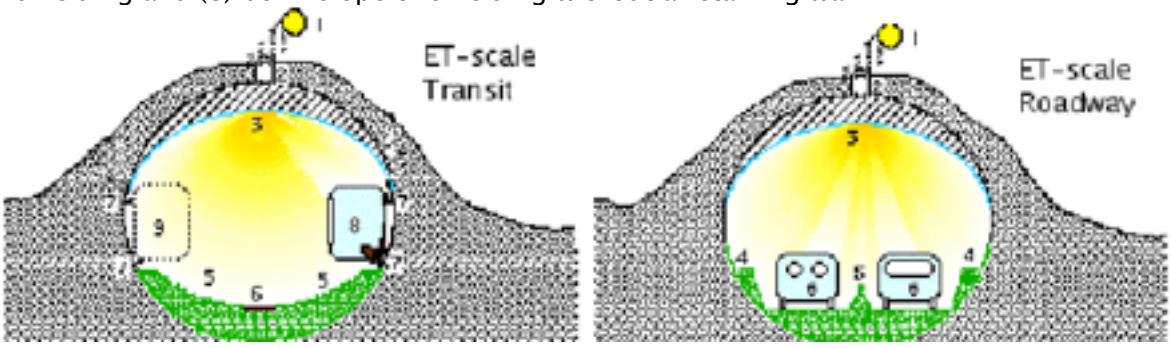


A shielded but unpressurized hangar allows pressurized modules below to be rearranged and/or replaced with ease.

KEY: (1) Space Frame Arch, Fabric Cover; (2) 20 cm or more regolith dust shielding; (3) exposed vacuum, radiation, micro-meteorites, UV, solar flares; (4) protected lee vacuum area; (5) observation cupola with ladder shaft to habitat space below (7, 8, 9); (6) broken-path solar access via heliostat & fresnel lens diffuser; (10) compacted, sintered hangar apron



KEY: (1) surface, minimally excavated to nest the rounded bottom of habitat hull; (2) Habitat Hull, in this case a squat vertical cylinder with round end caps; (3) vaulted, cove-lit ceiling; (4) "basement" area for utilities and systems and extra storage; (5) the "castle" rampart retaining wall; (6)shaft for "window"; (7) regolith shielding and (8) berm slope of shielding without a retaining wall



LEFT KEY: (1, 2, 3, 5, 6) as above. (7) wall-mount rail suspension system, (8, 9) bench seat transit car.

RIGHT KEY: (1, 2, 3) as above. (4) living wall / hanging garden, (5) planter-topped divider, (6) vehicles.

Conclusion: We should not expect that the need for shielding from cosmic rays, and thermal extremes will mean settlement exteriors will be boring. There are so many ways to achieve this need that lunar and Martian settlements, as seen from the outside will be varied and interesting. PK

Fun Time About Names: "Sun" "Earth" "Moon"

By Peter Kokh

"The Sun" vs. "Copernicus" reserving "Copernica" for the Solar System

Human civilization has been slowly "growing up" the past ten thousand years or so. But in many respects we are still in the "**Daddy" and "Mommy" stage. "Sun,"** it turns out, is **a role name**, yes, like Mother and Father. Our Sun shines on us, creating our day and night as Earth rotates "below" it.

We've always known about the stars, of course. But it was a while before we realized that "The Sun" too was a star. Although many writers so suspected, it is just recently dawning on us, that almost all stars are "suns" shining on a family of planets, many of them with one or more "moons."

"Sun" is "a family role": It is our solar system's "daddy/father" or "mommy/mother" depending on your gender preference. "Sol" and "Helios" are just "Daddy Sun" or "Mommy Sun" in other languages.

How do we give our sun a proper name?

Is it important? Yes, as we become more and more conscious that most if not all stars are "suns" and we dignify all the others with names, be it Sirius or Wolf 359 or BD+56°2783.

We could hold a contest, of course. Or we could let "leading astronomers" nominate names and then have "the public" (worldwide) choose. This "political" method would leave few happy.

We have another suggestion. **Copernicus was first to realize that "the Sun" did not revolve around Earth which from time immemorial thought to be the center of the universe, nd that Earth too, was a "wanderer" or "planet" all of which revolved around the Sun.**

I suggest we name our Sun, **Copernicus**, our Solar System **Copernica**, ourselves "**Copernicans**"

"The Moon" vs. "Luna" vs. "SELENE"

"The Moon" is "Luna" meaning "the Moon" in the ancient Roman Latin language and in most languages descended from Latin: French, Spanish, Portuguese, Italian, Rumanian, etc.)

The Moon was always a proper name until we discovered "moons' around other planets. That discovery does not demote "Moon" to a common noun that should not be capitalized any more. Once Julius Caesar was followed by other Roman Emperors, who adopted "Caesar" as a title, we did not demote Julius to "Julius caesar" lower case. The haughty "keepers" of the English language are off base. **We insist on capitalizing "Moon" when it refers to Earth's satellite.**

Read why www.moonsociety.org/info/**capiltal-M-for-Moon**.html

But if you want to use Luna, go ahead, although following the historical path, we could call satellites of other planets "lunas" – plural, lower case. I think what will happen is that in time, there will be an autonomous lunar government and what they want to call 'their moon" will stick, and be capitalized. **The Lunar Republic**? **Luna**? **Selene**? Luna does have the advantage of being used in many languages, including English, even some languages not descended from Roman Latin. Of alternatives from other languages, **Selene**, Green for The Moon, stands out. "Selenology" (the study of the Moon) is gaining currency. My call? "**Selene**" – adjective "**Selenian**"

"Earth" vs "Magellana" or "EarthSea" or "Terramar" or "Tellus" or "TERRESTRA"

Our home planet has a global ocean with major "continental" Islands. **Earth**, or **Terra**, in Latin and languages descended from that ancient Roman tongue, means **land**. Most planets are all land, or all ice. Thus "Earth" does not do our world justice. Latin Terra, and Greek **Gaia** mean land also, although of late, Gaia has come to stand for the Living Earth, our biosphere, or to Earth-Life as a living complex. This is a hard call. **Terrestra** is one possibility, as is **Tellus, the Roman Goddess of the Earth.**

Right now, as mild mannered a person as I am, I want to strangle astronomers who call rocky worlds "Earthlike." No! "ocean-**and**-continent" worlds are "Earthlike!"

A word that parsed as "**EarthSea**" would be perfect. In Latin that might be **Terramar**.

A fresh new suggestion would be "**Magellan**" after the first person to lead an oceanic expedition to circumnavigate our planet. Hmm? Who was the first person to realize that Earth was not the back of some gigantic turtle?

Tradition here is strong, and I expect we will call our planet "Earth" for a long long time. But how come we don't follow the precedent "Moon" and "moons" – i.e. why don't we call other planets "earths?" The answer is simple. We've always been aware of "planets" in our system: Mercury, Venus, Mars, Jupiter, Saturn named after ancient gods, and among them, Earth" is very, very special. My call? **Terrestra as "Terrestrial" is already in common use. PK**

Meeting the Threat of Orbital Debris

Authors: Al Anzaldua and David Dunlop December 2014

Summary

There are over 21,000 Earth-orbiting objects larger than a softball (10 cm) and 500,000 shrapnel fragments between 1 and 10 cm. The number of shrapnel smaller than 1 cm exceeds 100 million. The debris is an ever-growing hazard to the International Space Station, future spacecraft, and the approximately 1,100 operational satellites, which represent only about 7 percent of the large objects in orbit. Orbital debris threatens our modern telecommunications life-style, a $320 billion annual space economy, and future plans for the utilization of space.

To address the threat of orbital debris, we support mandatory debris mitigation for all future launches with no 25 year "free parking" in orbit for spacecraft that are no longer functioning. We also urge that funding project involves be found for the development of remediation strategies and technologies to 1) deorbit dangerous space debris, beginning with spent upper stages; 2) recycle metal from debris for cislunar construction; 3) repurpose satellite parts to create new working satellites at a fraction of the cost of building and launching new ones; and 4) rehabilitate satellites by refueling or repairing them.

Before orbital debris can be remediated, it must be detected and tracked in real time and down to a size that cannot be practically shielded against. The longer the space community waits to address the danger of orbital debris, the more expensive it will be. Therefore, we supports the immediate development and implementation of international, transparent, civil and commercial detection and tracking systems able to detect in real time both ton-class and cm-class debris. We also support the immediate development and implementation of a bounty system (funded by orbital "parking" fees or a Pigovian tax on launches) to spur private competition to clean up our Earth orbital space environment.

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1.0 The Threat

Orbital debris threatens our modern telecommunications life-style, a $320 billion annual space economy, and future plans for the utilization of space. Those future plans include space tourism, solar system development for resources, and human expansion to Mars, orbiting mini-biospheric habitats, and beyond.

According to NASA, there are over 21,000 Earth-orbiting objects larger than a softball (10 cm) and 500,000 shrapnel fragments between 1 and 10 cm. The number of shrapnel smaller than 1 cm exceeds 100 million.[1]

The length of time that orbital debris persists depends on its altitude: a few days if under 200 km (125 mi); a few years if between 200 km and 600 km (370 mi); decades if the debris is between 600 km and 800 km (500 mi); centuries if over 800 km.[2]

Because of their high relative velocity on impact, typically 10 km per second or 22, 000 miles per hour in Low Earth Orbit (LEO), orbiting shrapnel as small as .5 cm can disable a spacecraft.[3] The debris is an ever-growing hazard to the International Space Station, future spacecraft, and the approximately 1,100 operational satellites, which represent only about 7 percent of the large objects in orbit.[4] Jer-Chyi Liou, Chief Scientist for NASA's Orbital Debris Program Office, using estimates drawn from six space agencies, recently declared that even without a new catastrophic collision or explosion in orbit, and with 90% compliance with the 25-year deorbiting-after-use guideline, debris will continue to grow over the next 200 years.[5] Moreover, it seems reasonable to expect that the increase in debris, by knocking out stationkeeping capabilities of impacted satellites, will worsen Liou's current estimate that there will likely be a major catastrophic collision every 5 – 9 years.[6]

Although most of the tracked[7] debris is in LEO, with the greatest concentration found between 750 – 1100 km altitude,[8] there is also debris in Medium Earth Orbit (MEO) and Geosynchronous/ Geostationary Orbit (GEO).[9] While it is still a minority opinion within the space community, some believe that within two LEO altitude bands, the density needed to initiate the "Kessler Syndrome,"[10] i.e., a

cascading chain-reaction of collisions leading to uncontrollable growth of debris, may have already been reached.[11] At any rate, debris in LEO has reached a level dangerous to current and future spacecraft, and the debris in GEO is steadily becoming dangerous as well. Because citizens in industrialized societies receive services such as global positioning, cell phone communications, weather forecasting, satellite TV and radio, and military protection – orbital debris is ultimately threatening our modern way of life.

2.0 Dealing with the Threat: Mitigation vs. Remediation

Strategies or technologies to prevent the creation of more debris, such as evacuating fuel from spent rocket stages, directing spacecraft into lower orbits to increase atmospheric air drag, or equipping spacecraft with shielding and automatic-release drag tethers, solar sails, or ballutes to deorbit them after use are potentially important mitigation measures.[12] Mitigation alone is not sufficient to remove the threat of the orbital debris already in orbit, however. For this reason, the National Space Society also recommends the development of active debris strategies and technologies to remove the threat of orbital debris i.e. orbital debris remediation.

Many technologies have been proposed for orbital debris remediation, including those using lasers, harpoons, nets, electron beaming, electrostatic manipulators, grappler-satellites and others.[13] The idea behind these proposed technologies is either to remove debris, repurpose defunct satellite parts, recycle debris metal, or rehabilitate defunct satellites by refueling or repair. Because orbital debris objects have a range of societal, economic, political, and geophysical sensitivities, however, the best remedies to carry out these processes will differ with the debris object's altitude, size, type, and ownership. For this reason, we endorse studying a wide range of debris management technologies and strategies, then developing the most promising ones to determine their competitiveness.

Several of the more promising debris remediation technologies and practices described below include:

1) Propellantless electrodynamic vehicles to capture (for deorbit or salvage) large debris objects;
2) Ground-based pulsed-laser systems to nudge large debris objects for collision avoidance or to deorbit small debris objects (shrapnel);
3) Space-based electron beaming to deorbit medium to large debris by electromagnetic deflection;
4) Low-power space-based pulsed laser ablation to deorbit small debris objects;
5) Multilateral, civil and commercial, real-time debris detecting and tracking systems;
6) An open, competitive bounty system for remediation funded by satellite "parking" fees or Pigovian[14] launch taxes.

Finally, we recommend working within current political and geopolitical systems to initiate orbital debris remediation as soon as possible.

3.0 The Satellite & Debris Scenario

It is helpful to review the satellites, services, and industries threatened by orbital debris by orbital categories and to similarly address recommendations for mitigation and remediation.

3.1 Satellites in LEO

Just in LEO (<2000 km) there are about 554 operational satellites, providing mostly communecation (voice, data, and messaging) services over global regions. Examples include Motorola's Iridium constellation of 66 satellites orbiting at an altitude of about 781 km,[15] 50 Orbcomm satellites operating at 775 km,[16] and 52 Globalstar satellites at 1440 km.[17] Also in this group are several polar-orbiting weather satellites at 850 km and a number of military satellites.

3.2 Orbital Debris in LEO

Tracked debris larger than 10 cm in diameter can range in size all the way up to 9-ton rocket bodies and 5-ton satellites. Most tracked LEO objects >1 kg are defunct but intact satellites or rocket stages. ¾ of the total mass of these objects consists of objects >ton. Therefore ton-class bodies (roughly half satellites and half rocket bodies) make up the most of the mass of approximately 2200 tons in Low Earth Orbit (LEO), leaving another 4100 tons of debris in higher orbits. As a rough rule of thumb, one can consider tracked LEO objects as "cars and their hubcaps." Although only the collision of "cars" with one another could initiate a Kessler cascade, "hubcaps" and much smaller fragments remain dangerous to spacecraft.[18]

Although explosions caused by unused fuel in rocket bodies was once the main source of shrapnel fragments, collisions among ton-class bodies have become the principle source of millions of shrapnel fragments. For example, China in 2007 intentionally destroyed its Fengyun-1C weather satellite, and in 2009 a non-functioning Russian Cosmos 2251 satellite collided with an U.S. Iridium 33 satellite. Over half of the catalogued fragments in LEO, and likely far larger fraction of the millions of untracked mm and cm-class fragments, can be traced to just these two collisions.[19]

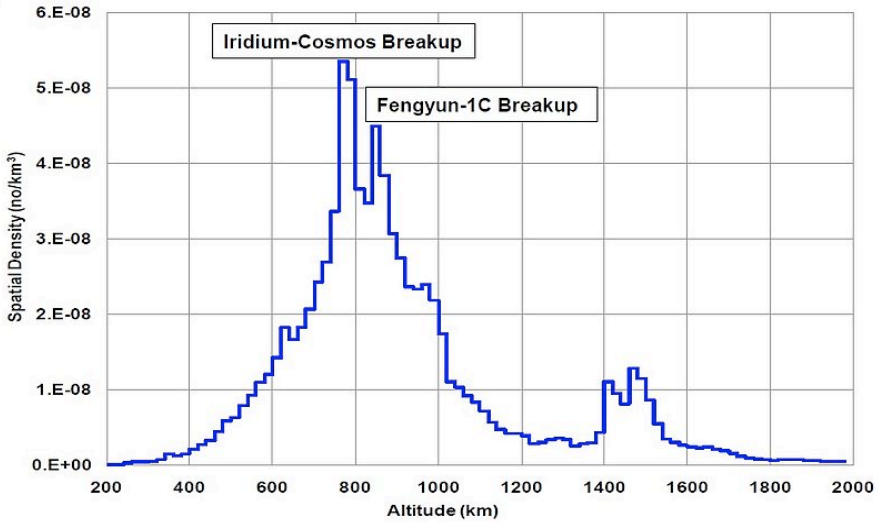


Figure 1: Spatial density of LEO space debris by altitude. NASA report to UNOOSA 2011.

Orbital shrapnel smaller than 10 cm is currently untrackable, and because of their high collisional velocity of around 22,000 mph in LEO, even shrapnel as small as .5 cm can take out a spacecraft.[20] Any effective remediation strategy for debris in LEO will have to take into account the size and mass of debris objects.

3.2.1 Large (ton-class) Objects Make Shrapnel in LEO

Removing orbital shrapnel in LEO without addressing the source of such shrapnel, i.e. collisions between large orbiting objects, would be like bailing water out of a boat without repairing the hole in its hull. A consensus is building among persons studying the orbital debris problem that the greatest danger will come from inevitable (without active intervention) catastrophic collisions between ton-class passive debris objects, producing both immediate and subsequent financial loss due to untrackable shrapnel. And because the subsequent financial loss will dwarf the immediate loss, Jerome Pearson and his colleagues Joe Carroll and Eugene Levin in a recent article argued strenuously for dealing with such large objects as soon as possible. [21]

3.3 Economic, Political, Geopolitical Impediments to Cleanup in LEO

Incentivizing cleanup in LEO is difficult, however, for two reasons. First, most of the economic and social value currently derived from LEO is either from satellites owned and operated by governments or services bought by governments from privately owned satellites. Publically 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. Second, governments, especially their military agencies, are not as open as civil and commercial operators to mutually agreed-upon regulation of the LEO commons.

Indeed, it is difficult to get them even to talk among themselves. As a case in point, NASA and the White House Office of Science and Technology Policy (OSTP) are not allowed to talk with their Chinese counterparts. For all these reasons, LEO is currently a poor candidate for economic or other policies aimed as incentivizing behavior,[22] except possibly under an open bounty competition, financially supported by the fee collection system explained below.

This publicly supported aspect of this picture in LEO could eventually change, however, if launch prices to LEO with fully and rapidly reusable launchers eventually fall much below the $1000/lb predicted by Elon Musk for Space X's Falcon Heavy.[23] In such a case, commercial activities beyond

sub-orbital could become profitable and available to large numbers of people, and companies like Bigelow Aerospace may very well succeed in establishing a tourism businesses in orbit.[24] Under such a situation, much economic value in LEO could eventually be derived from privately owned and operated habitats and other spacecraft, creating market incentives for debris remediation. Such commercial days are a ways off, however, so incentives at this juncture must be created by joint action.

Even before a commercial business surge in LEO, however, drastically lower launch costs would have a positive economic impact in Middle Earth Orbit (MEO), Geosynchronous or Geostationary Orbit (GEO), cislunar orbits, and finally, the lunar surface. The Earth's econosphere, which extends from the Earth's surface outward to LEO, MEO, GEO, and Highly Eccentric/Elliptical Earth Orbit (HEEO) amounts to over $200 billion in commercial activity annually. Even during the great economic slowdown in Europe and North America, the commercial space sector maintained a positive growth rate.

The challenge of protecting this growing market from space debris has not yet been met with much in proactive governmental or commercial response. Another major collision, however, would likely create a crisis in space access and incentivize national and international efforts to preserve this growing commercial sector "the hard way." We wish to highlight technical and policy options, both national and international, for debris clean-up that could protect access to space and future spaceflight before such a crisis occurs.

3.4 Remediation of >1 kg Objects in LEO

Leaving aside for the moment the matter of remediation funding, and given the above social/ governmental and economic context, which large debris objects should be the priority and what might be the incentives for dealing with the debris? And what technologies should be used for debris removal?

3.4.1 Ownership of Orbital Debris in LEO

Let's start with which type of large debris object should be the priority. 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 the much less sensitive, but still dangerous, upper stages (i.e. basically 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.

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. More than 70% of the mass in LEO is Russian, however, much of it rocket bodies clustered in altitude and inclination. Therefore, removing (for deorbit or salvage) only Russian rocket bodies from LEO could reduce shrapnel creation by nearly 62%![25]

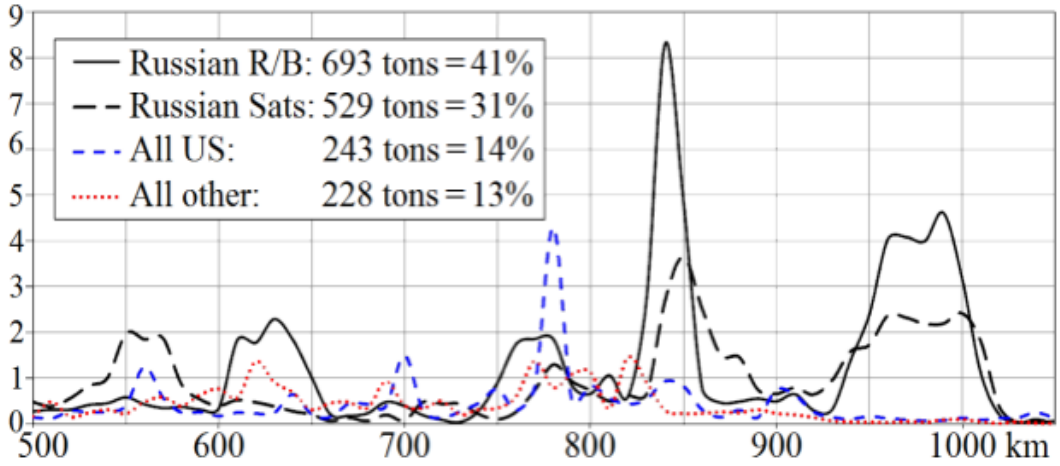


Figure 2. LEO Mass Ownership, Tons/Km Altitude. Carroll, "Can Pulsed Laser…," 2014. (Endnote 3x.)

3.4.2 Technologies for Removing/Moving Objects >1 kg Objects

3.4.2 EDDE in LEO

NASA JSC has proposed minimizing the LEO debris count of objects larger than 10 cm by removing 5 – 10 of the most threatening multi-ton objects per year.[26] Doing this with rockets lifting

single-use grasp-and-deorbit or grasp-and-rehabilitate vehicles could cost $1billion per year and would need to be continued indefinitely.[27]

A vehicle being developed called the ElectroDynamicDebrisEliminator (EDDE) is a persistently maneuverable propellantless "taxi" vehicle for LEO altitudes and a potentially affordable way to remove most potential shrapnel-generating mass (multi-ton bodies), as well as smaller kg-class bodies from LEO.[28] EDDE and similar propellantless vehicles are likely to be the only large debris removal options for LEO whose costs are just a few percent of original launch costs. Even considering learning curves, ion rockets will likely be around 6 times as costly as EDDE and chemical rockets about 20 times as costly. Conceivably, sixteen EDDE vehicles launched as secondary payloads could affordably remove 2000 tons of large debris from LEO in about 9 years, which would reduce future collisional shrapnel in LEO by more than 97%. A lesser effort using 10 EDDE vehicles and 7 years could theoretically remove 1000 tones of upper stages, reducing future collisional shrapnel by 79%.

EDDE consists of a multi-kilometer reinforced aluminum tape that collects and conducts electrons, plus solar arrays to drive the current. Hot wires emit electrons back into the ambient plasma, allowing external closure of the current loop. EDDE's maneuver force comes from current in the tape thrusting against geomagnetic fields. Slow end-over-end rotation allows persistent directional net thrust even in polar orbit, and also keeps the tape extended under tension. EDDE is limited to LEO by its dependence on the Earth's magnetic field and ionosphere. Because its sustained maneuvering ability greatly exceeds the needs of any currently plausible single assignment, an EDDE vehicle could handle tasks serially. Such serial tasking, however, involves EDDE to rendezvous and capture its tumbling payloads with expendable gossamer nets. Because EDDE is modular and may typically range from 20 to 80 kg for different missions, even if it is severed, it's parts can still maneuver independently.

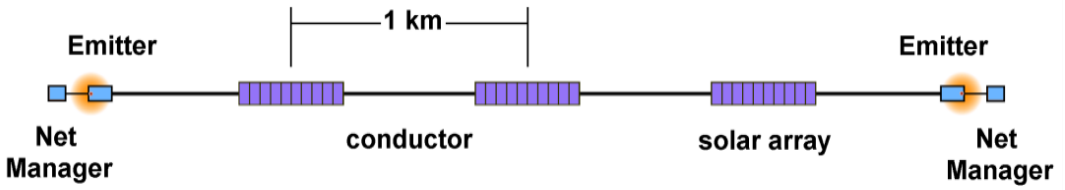


Figure 3: EDDE Vehicle Schematic, Showing Arrays, Conductor, Emitters, and Net Managers. Pearson, et al. "EDDE Spacecraft Development…," 2014. (Endnote 28.)

As explained above, EDDE potentially offers an affordable technology for the wholesale removal of large LEO debris, preventing collisions that are otherwise likely to be the main future source of untracked debris lethal to spacecraft. EDDE could also distribute secondary payloads to custom orbits, and deliver service modules to spacecraft throughout LEO. After completing payload deliveries, EDDEs could capture and remove ton-class debris, while 12U-size cubesat EDDEs do inspections and possibly capture and remove debris under 100 kg. [29]

To avoid collisions with other spacecraft that could create even more debris, EDDE vehicles operators would have to propose several trajectory options to an authorizing authority, publically post the approved one, and have the EDDE vehicle actively maneuver around other objects while staying within a defined maneuver volume centered on the posted trajectory. If an EDDE is severed, each resulting piece can keep actively avoiding all operating satellites and other large objects while it autonomously spirals down to a prompt reentry.

NASA's only debris removal program thus far has been an EDDE component development program, a phase III Small Business Innovation Research (SBIR) project that ended last May.[30] The US Government should continue funding EDDE and other propellantless debris cleanup initiatives because it faces a pay-now or pay-more-later situation that will result from inevitable ton-class collisions. Taking prompt proactive action now to develop propellantless cleanup technologies might jump-start international commercial investments and contracting in similar technologies. Russia, for example, might wish to take a major position in such a company as a way to limit its liabilities and profit from its own materials in orbit. (More on the Russian stake below.)

POINTS TO PONDER

- The direct cost of debris is from infrequent satellite failure from impact, mostly by untracked cm-class debris.
- The main future source of cm-class debris is likely to be occasional collisions of ton-class passive objects.
- Most of the mass in orbit is in passive ton-class objects. In LEO, there are >1000 tons *each* of spent rockets and satellites.
- Russia owns >70% of the mass of LEO, and the US over half of the rest. Remaining countries own around 13%.

3.4.3 Electromagnetic Deflection of Debris in LEO

Another potentially affordable way to clean up LEO, and perhaps some low MEO orbits as well, is by deflecting debris objects by means of a space-based electron gun or beam emitter.[31] The emitter would function by generating an electron beam at a debris object, thus remotely imparting an electric charge on the object as it crosses the Earth's magnetic field lines. Over time, the object's orbit would become highly elliptical and would intersect the upper atmosphere, thusly deorbiting from atmospheric drag. Because electron beam technology is very mature, and the energy needed to generate the electron beam orders of magnitude lower than high power lasers, this technology could offer low cost feasibility. Electromagnetic deflection is likely to be low risk as well, because the electron emitter spacecraft would cause deflection without physical contact on the targeted object. The exact size range of debris amenable to this treatment is unknowable at this time, but might include kg-class to ton-class objects.

Because the International Space Station (ISS) has a large power-generation capacity and is already in LEO, an electron beam device could be integrated thereon for testing and deployment as add-on module, avoiding the need to develop and launch a new spacecraft. Moreover, since electromagnetic deflection could not directly damage of destroy an spacecraft, it would likely be readily accepted by the international community. Electromagnetic deflection technology would best be implemented as an international program, managed and coordinated by the space agencies of several countries. Here again, testing and deployment on the ISS would facilitate this process.

3.4.4 Ground-Based Pulsed-Lasers for Large Debris

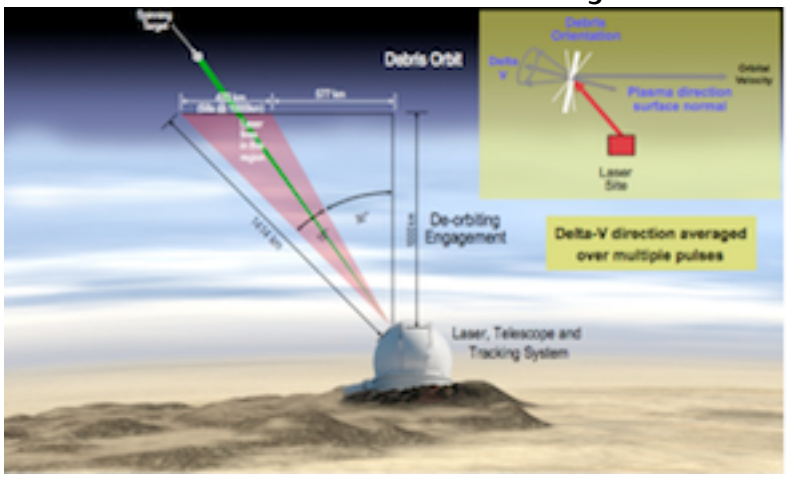


Figure 4. Phipps et al. 2011 LODR Concept.

Another proposed way to deal with large debris objects is simply to nudge them with ground-based pulsed-lasers to prevent collisions. This strategy could work for deorbiting small debris objects in the 1-10 cm range,[32] but would be much more expensive than space-based electromagnetic deflection or EDDE systems for removing or moving ton-class objects. Simply nudging large objects to avoid collisions would also leave the objects mostly intact and possibly dangerous on other occasions. If it

turns out that ground-based lasers are the only feasible way to deal with the millions of fragments under 10 cm, however, nudging large debris objects to avoid collisions might not add much cost.

Theoretically, pulsed lasers could also deorbit a ton-class debris object. But while nudging may only take about 10 pulses, deorbiting a ton-class object may take 200,000 times as many pulses delivered over many years. For this reason, deorbiting multi-ton debris objects with ground-based lasers is not practical. Small kg-class objects could become feasible targets, however.

3.4.5 Space-Based Pulsed-Lasers for Large Debris

Because the issue of space-based lasers for large debris removal is very geopolitically contentious and such systems very costly, the NSS does not at this time promote their use. However, low power space-based lasers to remove small debris objects might be affordable[33] and also acceptable all around if such systems are transparently operated, civilian-based, and international.

3.4.6 Rocket-Propelled "Catcher" Spacecraft

Various rocket-propelled "catcher" spacecraft have also been proposed, including those with nets, balloons, and robotic grapplers.[34] To be useful, however, such rocket-propelled spacecraft would have to be carry enough fuel to repeatedly and precisely match the speed and direction of the target debris moving at different speeds, orbits, and altitudes. The cost of designing, developing, testing, and launching such a spacecraft does not appear to be economically feasible.[35]

START HERE

4.0 Considerations for Large Debris Metal Recycling

4.1 Affordable Salvage of Large Debris in LEO

Even if Space X does manage to get the payload price to LEO down to $1000/lb using the Falcon Heavy and eventually half that cost with routine first-stage reuse, debris removal from LEO and higher for salvage using only propellant-dependent spacecraft would still remain prohibitively expensive. As mentioned above, using EDDEs or other non-propellant using vehicles to carry out the removal of 1000 tons of upper stages from LEO for whatever reason could make a noticeable difference at a reasonable cost. To be more exact, such removal by EDDEs in seven years would also remove 79% of the collision-generated debris potential at a projected average cost of less than $500 per kg and an average annual cost of about $70 million. Part of the cost savings comes from the fact that EDDEs could be launched as secondary payloads.[36]

4.2 Salvaged Raw Materials & Their Market Value

To the above economic considerations, we must add the salvage value of 2000 mt of refined metal. Aluminum scrap on Earth is currently around $1730 per mt.[37] So, at a minimum, large debris in LEO represents at least $3, 460,000 in raw materials. Finished products would have many multiples of that value in orbit. However, manufacturing finished products in orbit from raw metal could involve heavy production costs – or would it?

One possible way to cut such costs is though the emergent "SpiderFab™" on-orbit additive manufacturing and robotic assembly technology. SpiderFab technology would radically change the way we build and deploy spacecraft parts, such as antennas, booms, trusses, RF apertures, solar panels, optics, solar concentrators, and other multifunctional structures by escaping the size constraints and cost scaling of current space systems, which currently require ground-based construction of such structures and their subsequent crammed stowage into launch shrouds.[38]

This technology would enable the use of small, low-cost launch vehicles to deploy systems dramatically larger than possible with current technologies, leading to the acquisition and distribution of a variety of forms of data at higher resolution, higher bandwidth, higher signal-to-noise, and lower life-cycle cost. Under a NASA /Langley Research Center (LaRC) Phase I SBIR contract, Tethers Unlimited, Inc. is currently implementing the first step in SpiderFab architecture, i.e. a machine that uses 3D printing techniques and robotic assembly to fabricate long, high-performance truss structures. This "Trusselator" device will enable the construction of large support structures for systems such as multi-hundred-kilowatt solar arrays, large solar sails, and football-field sized antennas.[39] Unfortunately, such large structures would also offer much bigger targets to orbital debris, one more reason that the space industry must address debris remediation as soon as possible.

4.3 Production Cost for Value-Added End Products

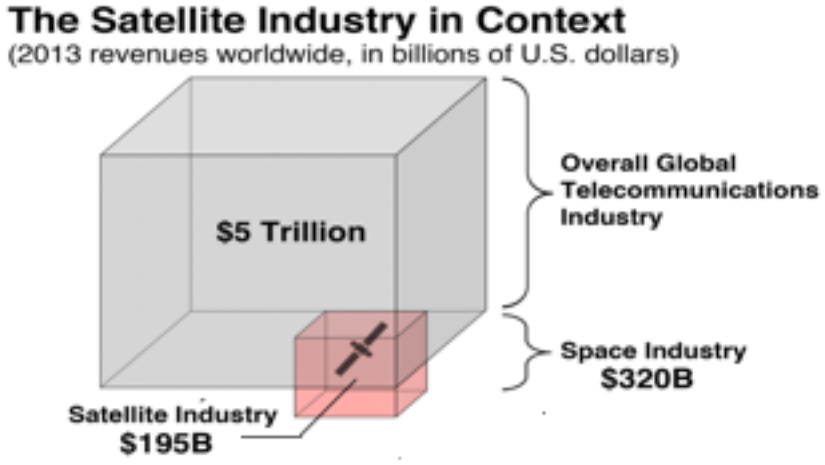
4.3.1 The Salvage-Market Model

Salvaged metal can only be worth something to a company ready and able to process it into new tools, devices, or spacecraft – for a profit. To get that profit, the potential buying company will have to figure in capitalization costs necessary to transform the metal into final products. Then, the buyer of salvage must either sell the new tools, devices, or spacecraft or use them to provide a service for which there is demand. All these actions within the cislunar market will determine the actual value of the salvaged metal to the first buyer. Keep in mind that it is unlikely that all those tons of salvaged metal will be bought for space construction in the foreseeable future; a good number of the smaller upper stages and "zombie" satellites will likely be deorbited, limiting the amount of salvaged material available.

Beyond these preliminary market figures and considerations, on-orbit recycling of materials for construction and manufacturing would counteract the throwaway culture that has made space operations largely beyond the reach of the commercial economy, with the exception of commercial communications and GPS satellites. Currently GEO is limited by treaty to only 180 stations 2° apart.[40] If its economy is going to continue to grow, it may be necessary to build large cross-truss platforms, one at each station, each able to host a number of satellites, and eventually providing station -keeping, power, and tele-robotics repair. Rather than bring the material up from Earth or the Moon to build these platforms, it may be less expensive to have EDDEs bring salvaged aluminum-alloy tanks to a construction site to provide the raw metal for SpiderFab-type construction. Moreover, if SpiderFab robotic and additive construction were to use aluminum-alloy tanks as feedstock, salvaged upper stages would suddenly grow in value, surpassing the value of such on Earth.

4.3.2 The Risk-Reduction Quantification Model

On the other hand, simply lowering or removing the odds of large debris collisions greatly threatening an annual $200 billion satellite industry, a $320 billion space industry, and to a lesser extent, a $5 trillion telecommunications industry[41] is a valuable service that should be quantified. The community of satellite users must remove large debris objects safely and thus lower the risk of catastrophic collisions, or face customer anger and loss, coupled with much higher costs for satellite replacement. Retiring this risk of collision soon will avoid much larger losses later.[42] Salvage market quantification and lower cost insurance based on risk reduction could be used to provide incentives to remove, reuse, or recycle space debris, and thus protect the above industries.



Sources: "TIA 2014 Playbook," Telecommunications Industry Association; "GNSS Market Report (October 2013)," European GNSS Agency; Commercial Spaceflight Federation; Missile Defense Agency, NASA, and Space News .

4.3.3 Large Space Debris and Cislunar Orbital Mechanics

Serious thought should be given to where orbiting scrapyards would best be located and what sorts of vehicles should emplace them. Most orbital debris resides within 1500 km of the Earth's surface, although there is a significant band of large debris around GEO. Depending on the exact alti-

tude, scrapyards orbiting below 500 km would degrade because of atmospheric drag and de-orbit within a year to several months.

At around 575 km altitude, however, orbital debris is still relatively sparse[43] and scrapyards there would need only infrequent boosting to maintain altitude. EDDE vehicles could therefore carry large debris objects to cross-truss scrapyards at that altitude. Also, carrying defunct upper stages to 575 km for collection would make the raw aluminum-alloy more accessible for subsequent construction in LEO and would be quicker than carrying them to deorbiting altitudes.

Orbiting scrapyards could also be located within other sparse debris bands in MEO, HEO, or even around Earth-Moon Lagrange points. Scrapyards embedded in cross-frames built from scrapped aluminum alloy in meta-stable halo orbits near Earth-Moon L1/L2 (E-M L1/ L2), with a little station-keeping, could serve as a SpiderFab metal-resource sites and a nexus for cis-lunar infrastructure, facilitating the later growth of staging sites, fuel depots, spacecraft construction sites, comsats, and habitats with telerobotic capabilities.

Keep in mind that it takes a bit less chemical propellant from LEO to reach E-M L1 or L2, than to reach and circularize on orbit in GEO.[44] On the other hand, in comparison to going to GEO, reaching E-M L4 or L5 would take a little more chemical propellant. Scrapyards in these latter locations, however, could remain in stable-bean shaped orbits without stationkeeping for many years. When dealing with low-thrust Solar Electric Power (SEP) from LEO to Lagrange orbits instead of GEO, the propellant cost is not as favorable.[45] With SEP, however, we would be dealing with much less propellant in the first place.

Every proposed salvage operation should entail reducing the risk of orbital-debris collisions, not increasing it. The act of grappling, controlling, or moving debris should therefore be carried out carefully. In this regard, beyond technical strategies, any international system monitoring such salvage operations should operate transparently and give notice of voluntary space "clean up" activities by sovereign nations or parties registered with those countries to do business. Opportunities for third-party review, comments, filing of objections, and unilateral “holds” should all be part of the process. Finally, liability assignment under various scenarios will have to be agreed upon by all parties before orbital remediation can begin.

5.0 Large Debris Mitigation in LEO

The space community has used light “Whipple” shielding for on-orbit spacecraft for many years.[46] The weight of any more effective shielding, however, would cause launches to not be economically viable. We are therefore left with other mitigation options.

Pop-out gossamer solar sails for deorbiting debris by atmospheric drag would need to be large to be useful. This, unfortunately, increases their collision potential with other debris objects. Although they would be relatively simple and would not need propellant, another downside is their lack of nimbleness; using photons to maneuver while dragging objects down to lower altitudes for deorbiting would take time.[47]

On the other hand, pop-out electrodynamic drag tethers are small, lightweight systems that use passive drag against the Earth’s magnetic field to rapidly deorbit spacecraft from low Earth orbit.[48] Studies of the application of electrodynamic drag to the deorbit of constellation satellites indicate that launching satellites and other spacecraft with pop-out electrodynamic drag tethers that automatically deploy at the end of a spacecraft’s useful life would offer significant mass savings compared to conventional rocket-based deorbit systems. Moreover, because the system uses passive electrodynamic drag to achieve deorbit, it can deorbit the spacecraft even if the host has lost power and control functions.

Numerical analyses of the performance of the Terminator Tether™, for example, indicate that a 5 to 10 km long conducting tether weighing only 2% of the host spacecraft mass can deorbit a typical constellation satellite within a few months.[49] Although such tethers would increase the total collision cross-sectional area of the satellite system during the deorbit phase, the electrodynamic drag is so many times greater than atmospheric drag at LEO altitudes that the tether can reduce the collisional Area-Time product for the satellite by several orders of magnitude. Electrodynamic drag tethers therefore offer the possibility of providing a low-cost and reliable method of mitigating the growth of debris in valuable constellation orbits. The most rational application of this technology, however, would be in its

deployment immediately upon the termination of the useful life of the connected spacecraft. Any delay in deployment increases the possibility of catastrophic collision.

6.0 Pulsed-Laser Removal of Shrapnel in LEO

There is currently no feasible way to reuse or repurpose debris objects smaller than about a meter in diameter. Removal, therefore, remains the only current option.

6.1 Ground-based Laser Removal of Shrapnel in LEO

To remove shrapnel, pulsed laser ablation ("laser nudging") by ground-based lasers appears to be the most viable option. In this concept, a powerful ground-based laser would ablate the front surface off a debris target to slow and thereby deorbit it.[50]

Because only 6% of future shrapnel in LEO is likely to come from multi-ton collisions over 1000 km in altitude, nudging debris only up to 1000 km should suffice for the immediate future. Over 2/3 of the LEO debris mass at 500 – 1000 km is less than 10° from polar orbit. Although one laser near 70 ° North or South latitude could theoretically be sufficient (if the site has superb weather and seeing affording very frequent daytime nudging), a diversity of simply adequate sites, coordinating their nudging under international civilian control, would outperform any single site.[51] Such a cooperating consortium could also lead to more international cooperation in general, possibly facilitating the solution of other international issues.

When it comes to shrapnel in LEO, however, we are still left with a problem: As mentioned above, shrapnel as small as .5 cm can take out a satellite and ground-based lasers will only be able to take out what specialized telescopes can track. The affordable lower size limit for detection and regular tracking of small debris is likely to be around 1 cm at 700 km altitude and ever-larger cm-sizes as we move towards at 1000 km altitude.[52]

So how can we deal with the extremely dangerous LEO debris from .5 cm to 10 cm that spreads within each breakup cascade? As mentioned above, the space community has proposed various "catcher" spacecraft, both for shrapnel and larger debris objects. These include giant balloons, nets, or blocks of aerogel or Styrofoam, none of which appear to be economically viable if carried by rocket-propelled spacecraft due to cost of designing, developing, testing, and launching such spacecraft with sufficient fuel to repeatedly intercept multiple debris fragments at different speeds, orbits, and altitudes.[53]

6.2 Space-Based Laser Removal of Shrapnel in LEO

Because of their enormous number and diminutive nature, debris as small as .5 cm will be very difficult to detect and track, much less remediate. It may turn out that debris this small will simply have to be dealt with through more sophisticated shielding, which will likely increase shielding mass and add to launch costs. But a new pulsed ultraviolet-laser technology being developed by Claude Phipps may provide an affordable way to deal at least with debris from 1 – 10 cm and larger cm-scale.[54] This technology would consist of active small debris removal using laser ablation directed from a spacecraft such as the ISS. This new system would use head-on, interaction on debris objects with 20 – 40 kw bursts of UV pulses from a 1.5 meter diameter aperture to clear out small debris in a 400-km thick LEO band.

Cost analysis by Phipps estimates a cost of less than $1000 to deorbit each small object within a few months – not exactly cheap, but likely to be much less expensive than other technologies for removing this dangerous threat. Any space-based laser system is bound to raise contentious geopolitical issues. Such issues could be ameliorated, however, by keeping such systems internationally multilateral, transparent with veto power, and civilian-based.

Whether lasers or other technologies are used to deorbit small shrapnel, much better detecting and tracking systems must be created for these technologies to be effective. This issue will be addressed below.

7.0 MEO Challenges

Above them in MEO (2000 – 35,586 km) are 87 satellites used for navigation, polar communication, and geodetic/space environment science. Included in this group are 64 U.S. Global Positioning System (GPS) satellites orbiting at 20,200 km, 24 Russian Glosnass satellites at 19,100 km, 14 Chinese COMPASS satellites at 21,150 km, and 4 European Galileo satellites at 23,222 km.

7.1 Overview of Debris in MEO

The volume of the MEO region is 150 times that of the LEO and GEO regions combined. (Remember than GEO is in effect a skinny orbital "tube" at 35,786 km and thus contains little volume.) For this reason, the orbital debris in MEO presents perhaps the least urgent situation.[55] This does not mean, however, that MEO is completely unthreatened by debris. Historically a small minority of spacecraft have operated in MEO, the number of such satellites residing in or routinely transiting the zone is increasing. MEO is mostly used for global navigation satellite networks, the most common altitude for which is around 22,200 km. Defunct global positioning satellites (GPS) are usually disposed of by maneuvering to slightly higher altitudes.

Until recently no rocket stages were left permanently near the GPS altitude regime. Beginning in 2010, however, GPS satellites were deployed with the help of larger launch vehicles, whose stages were left in orbits above the GPS constellations in the vicinity of decommissioned GPS spacecraft.[56] This does not completely remove them as a danger, however, because lack of stationkeeping will allow these large objects to drift in unpredictable ways.

Worse yet, GLONASS satellites are typically abandoned in place. This policy, coupled with a relatively short operational lifetime has led to a sharp increase in spatial density at around 19,100 km. Now approximately 140 large derelict objects mingle with fewer than two dozen operational spacecraft.[57]

Because the Earth's magnetic field becomes attenuated above 2000 km altitude, EDDE or other electrodynamic debris remediation technologies will not work effectively above that altitude. Specifically, because electron-beam electrostatic deflection also needs the Earth's magnetic field to work, that technology cannot be used. Debris orbiting at MEO altitudes are also out of the effective reach of ground-based lasers. The technologies remaining consist of physically grappling or containing MEO debris through the various means described above, using electrostatic "tractor beam" capture to maneuver the debris, or repurposing via cellularization (both described in GEO section below). However, because the debris in MEO is likely to be more spread out than in GEO, even repurposing does not appear to be economically viable at this time.

8.0 GEO Challenges

Next are around 450 operational satellites in GEO at an altitude of 35,786 km. The GEO band includes all television and radio broadcasting satellites, some weather satellites, and civilian and military communication satellites.

8.1 Orbital Debris Environment in GEO

As mentioned earlier, the impact velocities of orbital debris in GEO generally are relatively low (1.5 km/sec) compared to those in LEO (10 km/sec). Satellites and spent boosters in crossing orbits, however, especially those left stranded in geostationary transfer orbits (GTO), have much higher velocities relative to other GEO objects.[58] Moreover, when stationkeeping ceases or a spacecraft suffers a collision from whatever cause, orbital perturbations in GEO become significant, ending with the longitudinal drift, precession, and tumbling of large structures.[59] Unless something is done about these crossing and tumbling ton+ debris objects, however, solar power satellites and other large spacecraft will certainly suffer major collisions.[60]

In reaction to these dangers, the ITU has placed increasingly strict requirements on the stationkeeping ability of new satellites and demands that satellite owners guarantee their ability to safely move the satellites out of their orbital slots and into parking orbits at the end of their lifetime. Unfortunately, evidence is mounting that these new ITU requirements are insufficient to have a major effect on collisional frequency, estimated currently to be one approach within 50 meters per year.[61]

In fact, a debris-spacecraft collision in GEO may have already taken place. In March 2006, the Russian Express-AM11 comsat was struck by an unknown object and rendered inoperable, but engineers had enough time in contact with the spacecraft to send it into a parking orbit out of GEO.[62]

8.1.1 The Importance of Debris Remediation in GEO

Solar power satellites and other large structures such as cross-truss platforms for telecommunications in GEO will likely become the main driver of the Earth-Moon economy later in this century because they will address the exploding demand for clean energy for Earth's growing population. In particular, reliance by future millions of people on solar power satellites for energy, whether they are in

GEO or in lower orbits, will require high reliability. Therefore, the detection, tracking, and remediation of ton-scale space debris in GEO, which could cause catastrophic damage to spacecraft despite lower impact velocities, will be crucial to the future economic development of space.

8.2 Large Debris Remediation in GEO

8.2.1 Cellularization in GEO

The DoD's Defense Advanced Research Projects Agency (DARPA), under a demonstration project called Phoenix, is teaming up with the private sector to harvest and "repurpose" still functional components of nonworking satellites in GEO to create new space systems at greatly reduced cost. Beginning in 2016, the project proposes to attach nano-satellites to parts of retired U.S. government and commercial satellites, making the debris a resource. In a process called, "cellularization," nanospacecraft separately carrying out functions such as power, communications, attitude control would be launched into orbit as secondary payloads. A service-tender spacecraft would then be telerobotically directed to attach such miniature devices to large antennas or other large parts of dead satellites to produce working satellites at a fraction of the cost of new ones launched from Earth.[63]

8.2.2 Satellite Rehabilitation by Refueling/Servicing in GEO

Another way that defunct satellites in GEO can be rehabilitated, if not already too damaged by orbital debris, is through refueling. The Canadian company MacDonald, Detwiller, and Associates (MDA) 2010 Space Infrastructure Services (SIS) project envisioned both refueling and otherwise servicing satellites in orbit telerobotically. Although MDA and Intellsat in 2012 cancelled their collaborative agreement in which MDA was to develop a satellite capable of servicing Intelsat's 50 operating satellites, MDA remains interested in the concept and is waiting for a possible DARPA contract.[64]

In this connection, it is important to note that in May 2013, NASA carried out a series of telerobotically operated "propellant transfer experiments" on an exposed platform of the International Space Station (ISS).[65] Although the ISS is in LEO, the refueling technology being developed is intended for use in GEO.

The impact of cellularization, refueling, and other satellite rehabilitation schemes on the commercial satellite industry is difficult to forecast when such capabilities have not yet been demonstrated. In theory, rehabilitating defunct satellites could suppress the demand for larger or truss-connected communication satellites. What is clear is that defunct but potentially redeemable satellites and satellite parts face the same threat from space debris as do those currently active.

8.2.3 "Tractor Beam" Disposal of Large Debris in GEO

There are more than 1200 large objects in GEO, but fewer than a third are functioning. The rest are dead communications and Earth-observing satellites or spent rocket bodies. Even though the collisional velocity of such objects would be much lower than in LEO, they remain dangerous to working satellites and to potential remediating spacecraft because of their high mass. Worse yet, such objects are usually tumbling. So approaching them is risky.

While other ideas for remediating this debris involve physical contact with the object, of r example, netting, grasping, harpooning, etc, aerospace engineers Schuab and Sternovsky have devised a touchless process using induced electrostatic forces to move defunct satellites and spent rocket bodies into disposal orbits, 250 – 300 km above the geosynchronous zone.[66] In this process, a space tug employs continuous electron emission to raise its own potential to a positive value of 10s of kilovolts, while the electron emission is directed at the space debris object to yield a negative potential. Once the initiating electron "tractor beam" has resulted in a sufficiently high electrostatic tractor (ET), low-thrust inertial thrusters are employed on the tug to raise the two-vehicle system altitude.

The big advantage of this method is that the tug spacecraft can operate with a separation distance of multiple craft radii, thus greatly reducing the risk of collision, even though the target object is tumbling. The disadvantage is that the "disposal" orbits" envisioned would not in fact remove the debris from the cislunar econosphere, and such tumbling debris could therefore create a danger to future highly eccentric/elliptical Earth orbiting spacecraft.On the other hand, if such objects can be detumbled using de-spinning tethers, pulsed-laser application, or other technologies, they might become available as feedstock for space construction in GEO by SpiderFab-like techniques.

8.2.4 Small Debris Remediation in GEO?

Based on estimates drawn from the historical record of known collisions, there is much less small debris in GEO than in LEO. Moreover, the potential impact velocity is so much lower than in LEO (1.5 km/sec v. 10 km/sec), shrapnel <10 cm cannot be as dangerous. At any rate, GEO orbit is too distant to make accurate measurements of debris under 1 meter.[67] For all these reasons, small debris remediation in GEO is not practical or feasible at this time, but should be evaluated in the future. As mentioned above, however, it is urgent to track and remediate large debris objects in GEO.

9.0 HEO Challenges

There are only around 23 operational satellites in High Earth Orbit (HEO) at 37,500 – 50,000 km.[68] Many HEO satellites monitor solar activity (space weather). Ground based lasers would not be effective in such high orbits. Other remediation techniques, such as tractor-beam electrostatic disposal could theoretically be used, but would entail high costs. Orbital debris, which is very difficult to detect and track at these altitudes, although presumably growing slowly, is not likely to have reached crisis levels. For now, the mitigation technologies mentioned above are crucial to keeping debris in HEO at a minimum level. As new detection, tracking, and remediation technologies are being developed, however, more attention should be given to the possibility of debris remediation in HEO.

10.0 HEEO Challenges, Present & Future

Finally, there are several satellites in HEEO, which range from 1000 km to 35,786 km in altitude. Such extremely elongated orbits have the advantage of long dwell times at a point in the sky during the approach to, and descent from, apogee -- thus giving them more time over target areas of the Earth's surface and less time over non-target areas. Sirius Satellite Radio, for example, uses HEEO orbits to keep two satellites positioned above North America while another satellite quickly sweeps through the southern part of its 24-hour orbit.[69]

Because the most immediate threat from orbital debris comes to spacecraft operating within the LEO and GEO bands, the priority is to deal with those bands first. As described above for the situation in HEO, for now HEEO orbits only require attentive monitoring for future debris issues.

10.1 Enter Cislunar Cycling HEEOs

Another aspect of the upper volume of cislunar space beyond GEO is its potential use by spacecraft in an Earth-Moon supply chain of varied cycling orbits as has been long proposed by Apollo Astronaut Buzz Aldrin and John S. Lewis.[70] Such orbits would connect the upper volume of cislunar space to lower levels. For example a 2:1 Heppenheimer Resonant orbit would have an apogee of 200,00o miles and a perigee of 100,000 miles.[71] John S. Lewis sees potential in cycling HEEOs with perigees as low as 1000 km and perigees reaching in excess of 300,000 km, or nearly to the Moon's orbit.[72]

Such cycling orbits might become useful for infrared telescopes detecting and tracking potentially exploitable mini-moons entering and departing the Earth-Moon system, for example. Larger near-Earth asteroids, which present a challenge for planetary protection and an opportunity for mining, might also be detected by infrared telescopes in HEEO cycling orbits. Cycling orbits might also eventually connect freighter and tanker spacecraft to orbits in LEO, MEO, GEO, EML1/2 and further solar system destinations on the Interplanetary Transport Network.[73] Clearing debris from Earth orbits will be particularly important for the safe passage of spacecraft using HEEO cycling orbits with perigees that pass through LEOs.

11.0 Geopolitical Considerations for Debris Cleanup

We have seen above that removing (for deorbit or salvage) only Russian rocket bodies from LEO could reduce future shrapnel creation by nearly 62%. 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 multilateral 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 a new nadir, there is a shared interest in and responsibility for ensuring that the space environment is safe and sustainable. Indeed, 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 US of other countries do.

First, those Russian debris pieces, large and small, carry with them liability under the 1972 Liability Convention. Second, the debris represents enormous potential value in an emerging economic model for space debris clean-up, both as already emplaced highly refined metal and potential targets for satellite rehabilitation. Third, if Russia turned down a chance to collaborate with the US to remediate orbital debris, it would suffer a double opportunity cost: a) Russia would lose a chance to advance its own space technology and industries, while keeping an eye on the advancement of space technology (including laser) of other countries and b) Russia would also remain at odds politically with the US and other Western countries, which would likely have negative economic consequences. Through collaboration, however, Russia could enhance its overall technological capacity and prestige as a space-faring nation, which should play very well at home.

A recent event has made talks between Russia and the US on the range of space operations and safety considerations a more urgent consideration. A Russian rocket launch last May to add three Rodnik comsats to an existing military constellation also put into orbit an object that was originally classed as space debris and given the label Object 2014-28E (Norad designation 39765).[74] Amateur astronomers and satellite-trackers in the West and Russia have since noted unusual maneuvers by object, including precise self-propelled moves towards other Russian space objects. Speculation is rife that the object is either a project to deal with orbital debris, an anti-satellite test, or both.

Although Russia officially decommissioned its anti-satellite program after the fall of the iron curtain, its expertise in that area has not disappeared. Moreover, military officials have publicly stated that they would restart anti-satellite research in the event of a deterioration of relations with the US over anti-missile defense treaties. Such a deterioration has occurred, and Russian efforts to try to secure an international treaty to prevent weapons being deployed in space have been futile.[75]

In a sign that international sensitivities are rising over anti-satellite technologies, a recent Chinese missile test drew condemnation from both the US and EU. US authorities said they had “high confidence” that the July launch was a test for a ground-based weapon to strike a satellite, and accused the Chinese of “destabilizing actions.”[76] The time for outreach to the Russian Federation is therefore more than ripe, and there could be a grave opportunity cost if not undertaken. Russian collaboration to deal with orbital debris might also bring China to the table and encourage other spacefaring states or state entities, such as the European Union and India also to collaborate with the US and others in such activities. Wise US and Russian public/private cleanup endeavors would also facilitate the growth of commercial space missions in both countries.

Using lasers to clean up orbital debris is a particularly thorny issue. To remove the political-military element, any laser-nudging debris collision avoidance system or small debris removal regimen would have to be ground-based, transparent, and under international civilian control. Under such a regimen, civilian consensus would be needed to select targets and timing for deorbiting. Military entities may insist on observer status along with veto power, however. Likewise, any effective system for the active removal or salvage of large debris objects, other than those systems gained through bilateral or multilateral government treaties, would also have to be transparent and under civilian control.

12.0 Funding Debris Cleanup

A bounty system could also be used to facilitate commercial participation so that the consortium members need not pay for complex and expensive development project, or for failures, but only for results. A system paying bounties for results could also be used to facilitate the removal of large debris through other means. Along with property rights in space, international laws and treaties touching on the delicate issue of lasers impinging space objects will have to be modified, or elaborated from whole cloth.

But from where would a bounty system get its funds? Two possible fee schemes seem feasible: Parking fees and partially returnable deposits on launch. Right now all the users of LEO are contributing to its general degradation. Current rules for LEO are equivalent to 25 years of free parking after the mission ends.[77] In crowded cities, to pay for street upkeep and to maintain reasonable traffic flow, parking fees start when you arrive, and vary with congestion and vehicle size.[78] It may be necessary for

LEO users to start paying "parking fees" upon reaching working orbit. But what entity should collect such fees?

If the voluntary "seed money" regimens are not instituted, it might fall to the international space-users communThTheity to empower the International Telecommunications Satellite Organization (ITSO) to collect universal and mandatory fees on satellite launches to finance bounties to be paid to commercial entities for successful orbital-debris remediation. Such a fee would in effect be a type of "Pigovian tax," i.e. a tax applied to market activity generating negative externalities (costs for someone else).

In the case of a deposit instead of a fee, a portion of the deposit could be returned in the event that the launched spacecraft is deorbited safely.[79] For any fee or deposit plan to work, all satellite-service providers would have to contribute (i.e. no "free riders"), so that no competitive advantage would exist from non-compliance.

If the above internationally instigated solution is not quickly begun, a nationally coordinated public-private orbital debris remediation effort should be undertaken as soon as possible. Under Article VI of the Outer Space Treaty, the US Government has agreed to authorize and continuously supervise the space activities of both government and other US entities.[80] In compliance with the Outer Space Treaty, a public-private program could be administered by a suitably authorized and funded regulatory program such as the FAA or FCC, which would also coordinate with the ITSO, International Telecommunication Union (ITU), UN Office for Outer Space Affairs (UNOOSA), and other international space players.

13.0 Debris Detecting & Tracking Improvements Are Crucial

When it comes to any comprehensive and effective orbital debris program using whatever technology, beyond the daunting task of organizing a large group of spacefaring countries and getting their consensus, there remains another major problem: Small orbital debris is currently not being tracked, and even larger debris is not tracked in real-time.[81]

In particular, the most immediately dangerous shrapnel, i.e. debris between .5 – 10 cm is not being detected or tracked. Doug Beason, Senior Vice President for Special Programs at the Universities Space Research Association suggests public/private efforts to "find, fix, track, and target" orbital debris objects, so they can be engaged and that engagement later be assessed.[82] Also, because the Joint Space Operations Center is part of U.S. Strategic Command, much of its tracking technology is secret. According to Beason an international station with optical, radar, and polarization debris-tracking technologies under civilian control is urgently needed, not to find and track sensitive satellites, but to find and track in real-time, orbital debris, including shrapnel.

Tracking LEO debris is challenging because of its large populations, high velocities, and limited viewing opportunities. Radars miss a substantial fraction of debris objects in the 10 – 15 cm range and a much larger fraction of objects smaller than 10 cm. Properly designed small optical telescopes, on the other hand, using only sunlight for illumination, should be able to detect currently untracked debris fragments in the 5 – 15 cm range. Coverage will depend on the sensor capabilities and the configuration of the sensor networks. If the associated optical instruments are designed specifically for spotting and tracking orbital debris, and they are placed wisely, one spacecraft or five unmanned aerial vehicles (UAVs) can provide debris coverage comparable to a network of 30 ground sites.[83] Using 30 ground sites spread around the globe, however, would more likely induce international collaboration, leading possibly to other multilateral cooperative efforts.

Although small telescopes are adequate to find and track orbital debris, an optical system paired with a ground-based deorbiting laser would ideally use and 8.4 meter telescope with adaptive optics and "lucky imaging."[84] The laser ideally would be able to deliver 10 nsec pulses of 20 kJ energy up to 1200 km range. Although the exact lowest to highest debris size-range amenable to ground laser deorbiting is currently unknown, the above optically equipped and powered laser should be able to deorbit small objects in the 5 cm – 1 meter range. Larger objects, because of their lower surface area to mass ratios, would take longer and longer as mass increases, until deorbiting by laser becomes impractical due to cost and extended time needed for the deorbiting.[85]

13.1 Market for High Precision Debris Data to Upgrade Tracking?

Luckily, a number of new tracking methods, technologies, and systems are being developed, and new players, some commercial, are demonstrating impressive accuracies even with small telescopes.[86] Commercial and civil satellite operators need high precision debris data to accurately access conjunctions and ensure safety of their assets. Because this data is not readily available from the military space surveillance networks, however, a nascent partially commercial market for high precision debris data is emerging. Although commercial players will likely attempt to sell these new technologies and systems to their governments, debris data has a much wider potential market.

13.1.1 Potential Space Debris Data Providers & Sellers

Examples of emerging debris-data sellers include the Commercial Space Operations Center (ComSpOC) run by Analytical Graphics, Inc., currently using more than 28 optical sensors, three radio frequency interferometry sites, and one radar site to track 1880 total space objects so far.[87] Another emerging space situational awareness (SSA) seller ExoAnalytic Solutions, offering software called ExoAnalytice Space Operations Center (ESpOC)[88] that can process and interpret optical data from small telescopes in real time.[89]

Some emerging free or minimal-fee providers of orbital debris data include the USAF Academy Center for Space Situational Awareness, deploying its Falcon Telescope Network involving twelve universities around the world[90]; the International Scientific Optical Network (ISON) started by Russian astronomers in 2005, which joins 35 observation facilities with 80 telescopes in 15 countries[91]; a consortium of Lawrence Livermore National Laboratory, Naval Postgraduate School, and Texas A&M University deploying its Space-based Telescopes for the Actionable Refinement of Ephemeris (STARE), with a goal to have 18 3U Cubesats in LEO, each with a small telescope to observe objects predicted to have close conjunctions with valuable assets[92]; and the Canadian Space Agency's Near Earth Object Surveillance Satellite (NEOSSat) launched last year and carrying a 6 inch telescope in a sun-sync orbit to find and track debris in high Earth orbits as one of its missions.[93]

13.1.2 Potential Space Debris Data Buyers

On the potential buyer side of the market are large commercial operators such as Intelsat, Iridium, GlobalStar, Orbcomm, and others.[94] They may buy directly or become indirect buyers through organizations like Space Data Association or ComSpOC using the data to provide analysis for them. Small and single-satellite operators may just buy data piecemeal for their satellites. Universities may buy data for research purposes.[95] If the quality of data offered in space debris data markets is higher than that provided by military detection systems, then spacefaring governments would have a significant incentive to buy such data as well. On the other hand, the non-commercial players described above, by giving out free or minimal-fee data, might scotch or impede all but a highly specialized commercial market in debris data.

13.1.3 Characteristics of an Orbital Debris Data Marketplace

So there are potentially interested buyers and potentially capable sellers. What is missing is a debris data trading floor to facilitate buying and selling. A civilian-run and regulated Debris Data Exchange, operating like a stock exchange, could fill the bill.[96] All catalogued debris objects could be listed on such an exchange, including, ideally, defunct military stages and satellites. To avoid military concerns, operational satellites of any stripe need not be listed – unless particular satellite operators wish to list theirs. With international commercial space detection and tracking systems in place, all objects above .5 cm would ideally be tracked, improving the situational awareness and security of both military and commercial spacecraft users. Such a market could include "finder fees" for bringing new debris objects to market, paid for by small fees on the buying and selling of debris data.

A system consisting of only commercial debris data exchanges would not be viable in the long run. Especially in the aftermath of a catastrophic collision, a seller's high price for critical data could cause the seller to be seen as, in effect, withholding such data, and therefore contributing to a catastrophic collision. To advance the overall goal of preventing collisions and reducing liability for all space users, therefore, it is important that non-profit providers remain in the game. In such a case, the for-profit exchanges could offer specialized analyses and other services as a premium.

Instead of depending on military debris detection and tracking wrapped in secret capabilities and protocols, an international transparent non-military commercial tracking system is beginning to emerge.

We have transitioned from a military-only GPS system to commercial dependence on GPS tracking that now includes Russian GLONASS and European Galileo systems, in addition to Chinese and Indian positioning systems. We can make the same type of transition with orbital debris tracking systems.

14.0 Summary of Recommedations

14.1 The ISS: Ideal Test-Bed for Remediation Technologies

There are good reasons for using the ISS to test and develop potential orbital debris remediation technologies such as EDDE, electromagnetic deflection, solar electric power (SEP), electrostatic "tractor beaming," pulsed-laser, refueling, and cellularization.

In the first place, the ISS also has features that can facilitate early debris removal technology demonstrations: its own electrical power supply, a redundant international supply chain, human extravehicular capabilities, robotic grappling and docking, a Ka Band microwave transmission antenna, capacity for add-on modules, and airlock, and a potential for servicing and refueling other spacecraft. EDDE, for example, could use the NanoRacks deployer or the new NASA Cyclops satellite deployer, both of which use Japan's Kibo airlock on ISS.[97]

Second, the ISS generates ten tons of test-amenable waste annually, and money and effort is already being spent to remove it.[98] EDDE vehicles could potentially bring another 100 tons of orbital debris to the ISS for either de-orbiting, repurposing, or salvage for recycling metal.[99] Such testing and development will not only facilitate the clearing and increased safety of our orbits, but will also inform technologies that will be needed for future off-Earth ISRU and settlements.

The Naval Research Laboratory has a 3U EDDE-cubesat precursor test scheduled to deploy from the ISS in 2015. The next step is to test the actual EDDE hardware with a 12U format cubesat. Eventually EDDE vehicles should be able to scale up, extend their reach, and capture ever larger objects as well as remove old cubesats from higher orbits.[100]

As mentioned above, an electron-beaming module could also readily be added on to the ISS to test and develop "touchless" collision avoidance and deorbiting technologies, such as electromagnetic deflection and "tractor beam" electrostatic debris disposal. The ISS can also be used as a testbed for developing satellite rehabilitation techniques and technologies involving refueling and repair. As described above, such testing has in fact already begun. Finally, the ISS could become a test-bed for the development of space-based UV laser system to remove small debris of 1 – 10 cm per technology proposed by Phipps.

Once we have learned to deal with small amounts of debris in connection with the ISS, we will be better prepared to deal with the estimated 2200 tons of dangerous large debris objects in LEO and elsewhere. The ISS has occasionally to dodge space debris, and this involves moving its million-pound mass with rocket engines using chemical propellants. Perhaps the ISS-connected debris remediation demonstrations, done with free flyers operating within power beaming-distances, could evolve into technologies specifically to protect the ISS and thus obviate the need to burn precious chemical propellant.

In sum, we highly recommend that the ISS be used as a test bed for various debris remediation technologies, including those for moving for collision avoidance, deorbiting, repurposing, recycling (salvaged metal), and rehabilitating (by refueling or repairing). The costs of the ISS as an international space lab could not be better justified than by this purpose.

14.2 Beyond the ISS

We don't yet know the cost or the feasibility of the various options mentioned in the paper, although there are indications that, at least in LEO, EDDE or other possible electrodynamic vehicles [101] and energy-beaming technologies to deflect and remove debris should be the most cost-effective, simply because they would use no propellant and involve relatively low mass.

Ground-based lasers under international civilian control look like a possible option for deorbiting small debris objects, although much better tracking technology as described above and under multilateral civilian control would also have to be developed to detect and track debris as small at .5 cm in real-time.

Such multilateral detection and tracking systems could form a foundation for further international cooperation and insurance mechanisms, and at any rate, would be needed for non-laser technologies addressing larger debris objects at all altitudes.

For MEO, owners and operators of satellites should at the very least work multilaterally to avoid the creation of unnecessary debris, while coordinating the disposal of space assets through whatever feasible means, which no longer serve a purpose.

For GEO, the debris "repurposing" technology being developed by DARPA's Phoenix project looks hopeful, but not all debris will be amenable to repurposing. For this reason, electrostatic touchless technology should be further developed to tug debris into parking orbits, or much better yet, deorbit or salvage it.

As described above, we recommend internationally assessed parking fees or a Pigovian taxes to finance bounties for de-orbiting operations. The United States Government should offer a COTS-type program to start testing and developing cost-effective debris remediation technologies from the ISS as soon as possible. Work should also begin immediately on a bilateral agreement to remove US and Russian defunct rocket stages from LEO, with an eye towards developing similar agreements with China, India, and the Europeans. While extending an offer to Russia for such an agreement, the lack of such a treaty should not prevent the USG and US companies from as soon as possible developing technologies to remediate their own defunct upper stages and satellites. We urge the US Department of State to see that International Trafficking in Arms Regulations (ITAR) do not prevent such collaboration.

Whatever orbital debris remediation technologies win out in the end, however, the longer we put off testing and developing the various possible technologies for orbital debris remediation, the more costly the debris remediation will be in the long run. This will be especially true if there is another catastrophic collision in orbit, something that will certainly occur without orbital debris remediation. It's time to get moving on all fronts!

Endnotes

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3. Jer-Chyi Liou speaking at the 2014 NewSpace Conference Orbital Debris Panel on July 26
4. Jer-Chyi Liou; Ibid.
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7. There is an observation bias in assessing the amount of debris at various latitudes. US Space Command can reportedly detect and track debris >10 cm, whereas the threshold in GEO is reportedly ~1 meter.
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9. De Selding, Peter B., "Debris-control Report Card Cites Improvement by GEO Sat Owners," Space News, 25 October 2013. According to de Selding, citing the European Space Agency, 70 percent of the objects in GEO are garbage. There is a technical difference between geosynchronous orbit (GSO) and geostationary orbit (GEO), but this difference is often ignored so that the acronym GEO is used for both types of orbits. To avoid confusion, the authors will follow this convention.
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12. The Whipple shield or Whipple bumper, invented by Fred Whipple, is a type of hypervelocity impact shield used to protect spacecraft from collisions with micrometeoroids and small orbital debris. As opposed to monolithic shielding of early spacecraft, Whipple shields consist of a relatively thin outer bumper placed a certain distance off the wall of the spacecraft. There are several multi-shock variations on the simple Whipple shield. For summary of shield types, see http://swfound.org/media/50876/Jiang_DebrisShielding.pdf.
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From Power Beaming at the International Space Station To Tethered Balloons, Proposed Cubesats and a Growing Network of First Nations° Connected Organizations

Dave Dunlop, National Space Society - December 15, 2014

[° "**First Nations**" is a term adopted by Native Canadian tribes, but is now seeing some usage in the U.S.]

"You can never predict precisely where good ideas lead you." said Gary Barnhard, of XISP Corporation in Cabin John Maryland. His NASA proposal to demonstrate power beaming from the Ka-band antenna on the International Space Station caught the attention of others looking for affordable ways of engaging students and conducting space applications research.

Dan Hawk, of Hawk Consulting, a consulting firm working with the Wisconsin Space Grant organization, developed a grant proposal to use tethered balloons as platforms for experiments and environmental observation. This project will provide funded internships for students from several Wisconsin colleges to develop research projects using these tethered aerostats which some have called "poor man's satellites".

How are power beaming experiments proposed for the International Space Station connected to ground tethered aerostat platforms? The tethered balloons must comply with FAA regulation and cannot exceed 1000 ft in altitude or present a hazard to aircraft. They cannot suspend any more than 6 pounds of payload instruments in a styrofoam box. That is actually larger in volume and mass than the cubesat that would be released from the International Space Station and fly in formation some 200 meters (650ft.) above and behind the station and in view of its Ka-band antenna. Dan Hawk said, "I realized that a ground based Ka band antenna could similar provide power to a tethered balloon platform a similar distance from the ground without having to support a heavy power cord. So we could apply engineering lessons designed for the ISS to our Wisconsin Space Grant tethered balloon project."

Students at the College of Menominee Nation's Sustainability Institute are proposing to monitor the Menominee Forest with an eagle's view perspective from the tethered balloon. Monitoring the C02 levels over the forest and also tracking the patterns movement of game animals via their infrared "signature". Wisconsin Space Grant Director Dr. Kevin Crosby and Dan Hawk developed this NASA funding proposal to provide funded internship opportunities for students to utilize Science, Technology, Engineering, and Math skills in practical space related research applications. Tethered balloon platforms at 1,000 feet can be an affordable mechanism to observe perhaps 50 to 100 square miles. The view from a tethered balloon is not dissimilar from the view available to tourists visiting Chicago's John Hancock building) but tethered balloons are tools for education and science and a variety of practical applications.

Tribal governments need to monitor their lands. Perhaps spotting forest fires or measuring air quality and C02 uptake, to monitoring game or cattle are some of the early ideas that will be explored. Plotting the sensor information on maps translates the data to geo-spatial knowledge of practical use for both research and monitoring of the land. Student engagement, building and using sensors and space related technologies to address local environmental concerns brings the science and engineering applications developed on the International Space Station National Lab down to Earth where government and commercial utilization are important.

This Wisconsin Space Grant tethered balloon project was also subsequently discussed at the American Indian Science and Engineering Society Conference in November in Orlando and at Kennedy Space Center. These discussions also sparked another collaborative cubesat project.

Navaho Technical University, in Crown Point New Mexico, and Northwest Indian Indian College some 60 miles north of Seattle in Bellingham Washington, and Hawk Consulting have also expressed interest in developing a RavenSat Tribal College project. This "Raven Sat proposed project is a "1 U" cubesat (ten cm-4" inches on each which has been submitted to NASA's CubeSat Launch Initiative, The ALANA Program. It will contain a complex fractal "patch" antenna which can detect Ka band frequencies? This tiny satellite could detect signals on orbit from the new Kennedy Space Center KABOOM antenna array of three 12 meter dishes which are placed at the tips of a triangular pattern, 60 ft a part from each other. These powerful antennas are designed to detect space debris and therefore 4" Raven sat target should be easily detected. It may also be possible to not only detect these Ka band frequencies but to measure the strength of the power beam received and to capture enough power even briefly from

passing overhead to push current into a circuit that charges a small battery. So the ISS power beaming work proposed by Gary Barnhard's XISP project could be expanded in it applications to ground to satellite detection by the Raven sat proposal. Additional cube satellite work with trailing objects scaled down in size might provide a calibration target for the KABOOM array.

In addition Raven sat will carry a dosimeter (as proposed in consultation with Dwayne Free of the Space Coast Intelligent Solutions) which can measure the radiation mitigation of carbon compounds which can provide data useful in future satellite and spacecraft design. Some electronics testing for RavenSat may also involve Fond du Lac Tribal and Community College in Minnesota which has also expressed interest in participating in this project.

Flexure Engineering's Bonnie Dubrow provided an organizational forum with the Central Florida Cubesat initiative which resulted in initiating several of these collaborative relationships. including Kennedy Space Center staff Gloria Murphy and Rob Cannon, supervising the First National's Launch Funding with the Wisconsin Space Grant program, other organizational elements at KSC including the SPLITS Lab and Launch Director, and Space Coast Intelligent Solutions. The American Indian Science and Engineering Society Conference provided a follow-on context and forum for additional discussions of proposed work.

These projects are an example of how XISP's ISS solar power beaming cubesat project provided a stimulus to subsequent project ideas and the development of a network of collaborative relationships among several Tribal Colleges and businesses, NASA's First Nations Launch Program funded through Kennedy Space Center, and administered though Wisconsin's NASA Space Grant organization working with Hawk Consulting and National Space Society representative Dave Dunlop.

The Emerging Space Applications Network of Organizations Involving CubeSat and Power Beaming Projects

A brief summary of cubesat scale projects that involve power beaming proposals and the organizations proposing them, sponsoring grant or contract requests, and collaborating with each other in sharing information, collaborating on these projects, and
participating in related conferences.

I. ISS Power Beaming Demonstration CubeSat –

Project Description

The first project involves the ISS using it's KA band antenna to beam 1 watt of power to a 3U cubesat plus receiving antenna (rectenna) which is released via the Japanese Kibo airlock and handed off for robotic deployment to a co-orbiting position above and in front of the ISS but in view of one or more of the ISS Ka-band capable antennas.

Participating Organizations

1 The company proposing this is Xtraordinary Innovative Space Partnerships, Inc (XISP-Inc) of Cabin John Maryland, CEO Gary Barnhard. This project is being coordinated through NASA Headquarters with the Human Exploration and Operations, Space Technology, and Science Mission Directorates. A NASA Space Act Agreement is being developed with XISP-Inc by NASA AMES regarding related aspects of the work.

2 Deep Space Industries is a subcontractor the XISP has identified to build the cubesat used for this proposal. This company is located in the NASA AMES research park in Mountain View, CA. This project is intended to stimulate subsequent developments on the ISS.

3 Dave Dunlop, of the National Space Society BOD and Milwaukee Chapter has been an interested volunteer and a match maker to some other organizations with various connections with this project.

II. Tethered Balloon Student Research Project

Project Description

This project involves paid student internships from several colleges in Wisconsin involving the use of tethered balloons as platforms for student experiments which involve space connected technology using sensors or instruments that for example might also be provided or engineered in a cubesat scale spacecraft.

Participating Organizations

1 The second project involves a 2 year NASA Grant received by the Wisconsin Space Grant Consortium Dr. Kevin Crosby Director,

2 The subcontractor for this project is Hawk Consulting. Dan Hawk

3 Colleges involved in this project include as of 12-14-2014:

1 UW Fox Valley X

2 College of Menominee Nation X

3 Western Wisconsin Technical Institute in Lacrosse X

4 UW Sheboygan County

5 UW Washington County

6 (Potentially Lac Courte Oreilles Tribal College if they join Wisconsin Space Grant as an affiliate organization.) X?

- There will be 6 Primary Student Interns with an $ 8 K stipend.
- There will be 6 Assistant Student Interns with an $ 4 K stipend.
- The equipment budget is $13K.

5 Hawk Consulting has communicated with XISP and has expressed an interest in using a Ka-band antenna to beam power to a tethered balloon platform at approximately the same 200 meter (650 ft.) to 300 meter (975ft.) distance as that proposed for the XISP ISS power beaming project.

6 Dave Dunlop, of the National Space Society has been a contributing volunteer and "match maker" with regard to this project working with Hawk Consulting, and Flexure Engineering, and Kennedy Space Center Staff.

Project Goals and Potential

A A tethered balloon platform would provide a working prototype of this power beaming application and provide a way to provide power to the sensor platform without having a heavy power cord suspended from the balloon.

B This would also provide a prototype of a fractal antenna design which could absorb more power from the limited surface area of a cubesat scale device than just solar arrays on the 100 square cm surface of each facet of a cube satellite. So this wireless power beaming might provide a limited distance practical device of providing both operating power and power to charge batteries on small tethered balloon platforms.

This solves the problems of:

1 Having limited lift capacity from small tethered aerostats by eliminating power-cords from the design.

2 Having to include heavy batteries for longer duration power supplies. Provide a means of charging whatever battery systems that may be part of the sensor platform.

3 Providing a test-bed engineering platforms which are similar in mass and volume to those of small spacecraft which are both volume and mass power constrained.

4 Providing a test bed platform to build and test increasingly effective iterations of initial engineering designs, and experiments, and to test them easily and inexpensively under field conditions.

5 Providing a flexible system for providing student engagement in the construction, deployment, and operation of experimental and demonstration projects, of various sensors and cameras and their subsequent data analysis.

Potential Commercial Applications of this Work

6 This provides a prototype of what might be considered a **potential commercial balloon platform systems power supply system as one component of a tethered balloon platform system** as an affordable "poor man's satellite" for many potential environmental observation stations. It would on a preliminary basis seem feasible that such systems could be assembled for less than $10K. Such platforms could also be described in terms of maximum weight, volume, and power so that experiments would have to fit within these design constraints but these are also design constraints quite typical of cubesat scale projects and are a good precursor design projects leading to space hardware development.

The Tribal College Space Applications Consortium

Projects Descriptions

Several Tribal Colleges and other organizations have expressed an interest in building Cubesat projects.

Participating Organizations

1 To the best of our knowledge the first Tribal College to develop a cubesat project is the **Salish Kootenai College in Pablo, Montana**. Dr. Tim Olson is the PI for the **BisonSat project** which is funded by NASA's Alana program, which has been developed over the summers of 2013 and 2014, and which should be ready for launch in the fall of 2015. Hawk Consulting of Oneida Wisconsin was a subcontractor for this project at Salish Kootenai with funding from the Montana Space Grant organization and coordinated with Salish Kootenai College. Hawk Consulting provided assistance in the thermal design and the solar cell and power systems design for BisonSat. This satellite will provide photographs from orbit.

A precursor to this project was a NASA high altitude balloon project launched from NASA's balloon project facilities in New Mexico by Salish Kootenai's Dr. Tim Olson.

2 **The RavenSat I Project**

Project Description.

This "Raven Sat proposed project is a "1 U" cubesat (ten cm~4" inches on each side) which has been submitted to NASA's CubeSat Launch Initiative, The ALANA Program. It will contain a complex fractal "patch" antenna which can detect Ka band frequencies? This tiny satellite could detect signals on orbit from the new Kennedy Space Center KABOOM antenna array of three 12 meter dishes which are placed at the tips of a triangular pattern, 60 ft a part from each other. These powerful antennas are designed to detect space debris and therefore 4" Raven sat target should be easily detected. It may also be possible to not only detect these Ka band frequencies but to measure the strength of the power beam received and to capture enough power even briefly from passing overhead to push current into a circuit that charges a small battery. So the ISS power beaming work proposed by Gary Barnhard's XISP project could be expanded in it applications to ground to satellite detection by the Raven sat proposal. Additional cube satellite work with trailing objects scaled down in size might provide a calibration target for the KABOOM array.

In addition Raven sat will carry a dosimeter (as proposed in consultation with Dwayne Free of the Space Coast Intelligent Solutions) which can measure the radiation mitigation of carbon compounds which can provide data useful in future satellite and spacecraft design. Some electronics testing for RavenSat may also involve Fond du Lac Tribal and Community College in Minnesota which has also expressed interest in participating in this project.

A Ravensat Sat project proposal package has been submitted to NASA ALANA in November of 2014 by the following:

1 **NorthWest Indian College, of Bellingham Washington, Gary Brandt PI**,
This college has experience in building rockets and engineering payloads and prior balloon and quad-copter experience. They have previously participated in the First Nations Launch competition.

2 **Navaho Technical University, Crown Point New Mexico**, Gregory Dodge
This University has 3D printing facilities which can be used to provide preliminary structural prototypes of a Ravensat Project. They have previously participated in the

First Nations Launch Competition.

3 **Hawk Consulting, Oneida, Wisconsin**, Dan Hawk
This company has experience in payload construction and power systems design. And in pyrogenic carbon compound research.

4 **Space Coast Intelligent Solutions, Titusville, Florida**, Dwayne Free
This company has expertise in radiation dosimeters

5 **Fund du Lac Tribal & Community College, Cloquet, Minnesota**, Steve Highlandç
This college has interest in payload testing and development work and also has some experience in rocket construction and payload development, and quad-copter construction. They have previously participated in the First National Launch Program competition.

6 Dave Dunlop, of the **National Space Society** has been "a matchmaker" and contributor to proposal development, working with Hawk Consulting, Navaho Technical University, and Flexure Engineering.

7 **Flexure Engineering,** Central Florida Cubesat Community Project, Bonnie Dubrow
This organization has provided facilitation meetings with Central Florida organizations including Kennedy Space Center program staff, staff from Space Florida and other companies including Space Coast Intelligent Solutions.

A Potential RavenSat II Project

A successor project to RavenSat I would involve a larger cubesat configuration perhaps at the 6 U level (24 cm long) which would eject a cable with trailing objects scaled down in size in order provide a calibration array of targets for the KABOOM array. This satellite could confirm a Ka-band signal sweep from the ground with a "timing stamp", measure the beam strength upon intersection with the satellite, and therefore provide a calibration of the detection efficiency of reflections from the trailing objects which might include objects down to the 1 cm level. The trailing antenna would not only provide a model for calibration but would provide additional drag and an active part of the end of life model for a cube satellite. More active end of life active propulsion might also be considered with the cable providing a electro-dynamic tether application.

Potential Ravensat III project

Another successor project to RavenSat would involve a 12U configuration which would provide extensive fold-out arrays of patch antenna for power beaming reception and solar PVC for solar power power reception as well as signal detection and measurement. These extensive upgrades to power reception and production would enable trials of active propulsion system involving electrospray, and or electron-arc propulsion systems. A Raven III project might demonstrate launch from the ISS and subsequent use of its active propulsion to enter a Heppenheimer cycling orbit or simple provide a faster orbital burn-up at end of life as a starting measure of this scale of active propulsion. So a series of Ravensat follow-on projects can be easily envisioned.

Space Technology Development Connections

The work described for a Ravensat series connects with technology development applications in space power beaming including increasing the efficiency of small satellites in gaining power from both solar arrays and patch antenna for beam power reception. This works also connects to improved levels of power for propulsion and communications requirements beyond Low Earth Orbit at cislunar distances from the Earths surface.

First Nations Launch Program Growth and Future Potential

The First Nations Launch (FNL) program grew out of the Rockets For Schools and University rocket competitions program in Wisconsin initially started by the Wisconsin Space Business Roundtable with the support and collaboration of the Wisconsin Tripoli Rocketry organizations, the Sheboygan School District and a side assortment of community volunteers including this author. FNL was developed by the Wisconsin Space Grant Consortium program with Hawk Consulting and since 2007 has been funded by Kennedy Space Center. This program has recruited Native American Tribal Colleges and college level chapters of the American Indian Science and Engineering Society (AISES) in a competition requiring competitive teams to design and build high power rockets and to meet design and engineering challenges. The program has up until now provided Wisconsin based workshops and a launch site at the Bong State Park for the rocket teams with the support of the Wisconsin Tripoli Rocketry organizations for launch and range safety support functions. In 2013 some ten teams from around the United States

participated in this effort.

In the 2014-2015 academic year the number of teams will likely increase to around 13 to 14. Also with the change in administration from the University of Wisconsin Green Bay to Carthage College in Kenosha Wisconsin increased flexibility in travel for recruitment and support of the program have opened up new opportunities for the program. Dr. Kevin Crosby, physics faculty at Carthage College is now the Wisconsin Space Grant Director and Christine Thompson is the First Nations Launch Program Manager. Gloria Murphy who has had direct program responsibility for FNL at Kennedy Space has now turned this responsibility over to Rob Cannon.

National Growth Potential and Opportunities

The scope of the program as a national outreach vehicle for Science Technology Engineering Arts, and Math engagement in the native American community has only begun to be tapped. Some 38 Tribal Colleges receive Federal financial support and most of these are West of the Mississippi River. Over 60 AISES college chapters exist across the country with many in the Eastern United States. Increasing the national impact of this program model is the next challenge and several ideas are under consideration.

1 A documentary about this Program is being produced to further the national outreach and team recruitment potential and filming was occurring at the AISES Conference in November.

2 This program also can utilized the structure of other organizations which provide venues for recruitment, communication, and interaction. The National AISES Conferences which draw a couple of thousand attendees, including many of the Tribal Colleges is one venue where enhanced communications and personal access to these networks provide a significant strategic opportunity. The 2014 Fall AISES Conference was a stimulus for further recruitment and project ideas and organizational collaboration and developments.

3 Another similar venue is the American Indian Higher Education Conference in the Spring which similarly draws many of the Tribal Colleges.

These venues provide a potential program rhythm for the academic years where both a Fall and Spring events provide a opportunity to leverage the resources of pre-existing networks where Tribal organizations are already participating.

Regional Launch Initiatives and Opportunities

Customer convenience and the expense and time commitments of travel to Wisconsin are and have been practical barriers to participation in this Wisconsin based program. The model in Wisconsin has been based in one of the 53 NASA State Space Grant organizations and this program model has the potential for collaboration and regionalization between other State Space Grant organizations. The State Space Grants administer several funding categories including faculty grants, undergraduate, and graduate student grants, and grants for women and minority participation which have the potential to tie into First Nations Launch program initiatives and engineering challenges and other NASA connected opportunities such as NASA Center internships.

A Unconnected to FNL in Wisconsin but somewhat parallel in concept with origins in the mid 1990's has been a student high power rocket launch program aimed at high schools started by the New Mexico Space Grant organization also with the collaboration of local Tripoli Rocketry Association groups. Perhaps Tribal Colleges in the SouthWest, and perhaps the Arizona, and New Mexico Space Grants might collaborate in a regional launch initiative maybe even with the new New Mexico Spaceport America organization and its commercial space occupants Virgin Galactic.

B Southwest Indian College in Bellingham Washington has developed is own launch facilities and equipment. There are some 29 Tribal entities in the State of Washington and there is the potential to increase the connections between these groups, AISES chapters, and the State Space Grant in expanded participation in the State of Washington.

C Similarly, Montana has a variety of Tribal Entities and colleges, a State Space Grant which works with these programs and a similar potential for a Montana launch site initiative and network.

D A similar potential for a regional launch network exists in the North and South Dakota with several tribal entities, Tribal Colleges, and AISES chapters, and the State Space Grant organization.

E The Kennedy Space Center also provide a national launch site for NASA and its contractors and planning of incorporation of a summer launch program into the “Rocket University” program model developed at Kennedy is an early new consideration. An invitation to KSC and special tours of its facilities are also a potential incentive for winning teams which participate in the FNL program.

F Dr. Kevin Crosby has identified a potential collaborative opportunity at the **Yerkes Observatory** in Williams Bay, Wisconsin, an Astronomical Observatory long operated by the University of Chicago but whose telescope is now compromised by the light pollution of the Chicago Metropolitan region. This historic facility is well positioned as a point for collaborative science education and outreach because it is within a 2 hour drive from the metropolitan areas of Milwaukee Wisconsin, Chicago, Illinois, and the Northwest, Indiana metropolitan region. Perhaps some collaboration between State Space Grant organizations in Wisconsin, Illinois, Indian and the Yerkes Observatory can provide a foundation for additional regional and national educational outreach initiatives.

National Outreach Potential

As a national program model the FNL is a gateway program for STEAM engagement in the native American Community at the college level. It also has similar potential for STEAM engagement at the high school level if a truly regional structure of launch sites and support facilities can be developed so that the travel costs and time commitments are within the grasp of secondary schools. The national robotics competition, First Robotics, is evidence that such a structure can be successful.

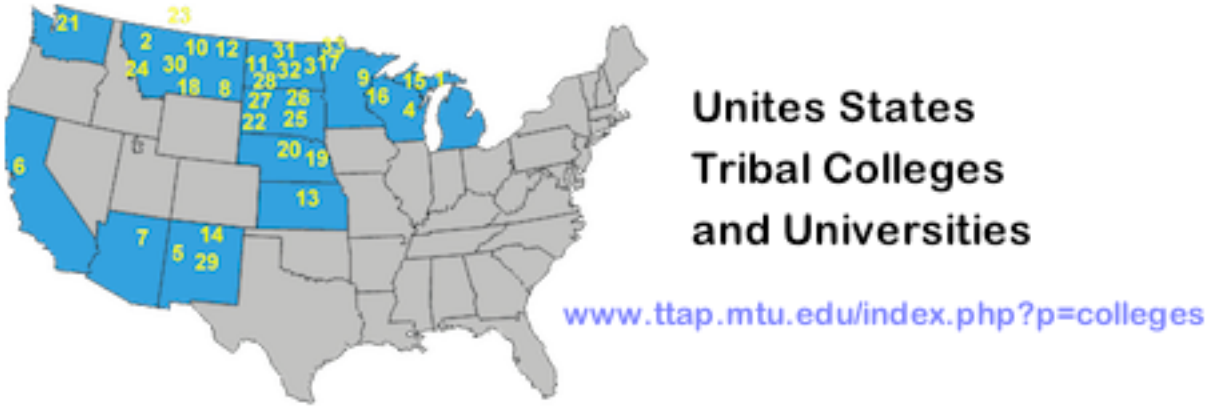
There is also the potential for some program synergies between rocket-based competitions, and those that involve a wider scope of balloon, small satellite, robotics, and electronics and programming activities.

NASA's Federal funding opportunities in education and outreach have been declining over the last several years so this expanded program model must depend on a wide range of additional resources based in local colleges, and universities, community organizations such as Tripoli Rocketry Chapters, AISES chapters, and other potential commercial organizations.

FNL launch has provided a successful model of student team engagement with a variety of roles and responsibilities that are well aligned with the educational and learning objectives of our modern science and technology dominated culture. The national program potential of FNL as a Gateway program to both NASA's and the commercial space industry and professional space science engineering communities has only begun to be realized. DD

Yerkes Observatory and the 40 inch (1.061 m) refractor, the largest ever built

http://astro.uchicago.edu/**yerkes**/



The Emerging Lunar Reconvergence

By David Dunlop - October 29, 2014

The Lunar Tide Has Been Running Out for NASA's US Lunar Program For Awhile

NASA's retreat from a vigorous lunar program with new missions already in the pipeline has been discouraging for those who advocate the settlement of both the Moon and those more distant locations, for which the Moon is the obvious and natural stepping stone, and for the rapid development of the Earth-Moon econosphere and the access to both the energy and material resources that such an econosphere can provide to terrestrial civilization.

The Obama administration's shift from the Constellation program's strategic direction back to a permanent human presence on the lunar surface to an Asteroids and Mars First priority has, it can be persuasively argued, been a disaster for the US position of international leadership in space (or perhaps not by counter arguments).

To its credit the Obama program did keep funding and provided completion of the LCROSS, GRAIL, and LADEE missions, and also provided extended funding of the Artemis 4 and 5 Lunar Mission, and for the Flagship LRO mission which will remain in orbit for another 8 years. These missions have revolutionized our knowledge of the Moon and those of the other space faring nations. These missions represent expenditures of perhaps $1.5-$2 Billion in their development and implementation in the period since the Obama administration has been in office. Clearly the US has done a significant share of the scientific heavy lifting in this lunar revolution.

The Bad News

What has caused heartburn and malaise in the scientific community of lunar interest, however, has been:

1. The elimination of the Lunar Quest Line Item in the Science Mission Directorate Budget,
2. The politicization of the Decadal survey process which had more lunar papers than Mars papers but which has lunar mission priorities that diminished the chances of their being funded.
3. Lunar Mission proposals for New Frontier and Discovery Missions have not been awarded.
4. No significant new lunar missions in the pipeline have been approved . The “Resolve Mission” which was included in early version of the Global Exploration Roadmap was announced as cancelled by the White House in he fall of 2013 at the LEAG meeting. Subsequently it was kept on life support renamed as a Lunar Prospector with a Lunar Catalyst program announcement with no funds allocated (and the hope of a foreign or commercial sponsor.)
5. The US has worked with the International **Space Exploration Coordinating Group (ISECG)** of 12 space faring nations including most o it ISS partners to issue a non-binding **Global Exploration Roadmap** where the US priority on Mars and the Asteroid does not synchronized well with the lunar priorities of the other countries. The Obama Administration apparently does not “play well with the other children” in contrast to its position of leadership back to the Moon under the Constellation initiative. It has demonstrated serious questions as to its reliability as an international partner in this regard.

The Good News

To dispel this negative litany NASA has just approved a lunar cubesat mission, Lunar Flashlight for 2018.

NASA has also announced that it well provide several additional slots for cubesats on the Orion Unmanned test mission of 2018 which will be sent to the Earth-Moon Lagrange 2 location. So Lunar Flashlight may have some company if additional Lunar Cubesat Missions are approved.

The Lunar Tide Running in for the Rest of the Space Faring Nations

The other major space faring powers have sent a flotilla of lunar mission also launched during the first decade of this century which included SMART I from ESA, Chang'e I, II and III from China, Chandrayaan I from ISRO, and Kaguya from Japan. A Russian Instrument LEND is on the LRO. And NASA's Moon Mineralogy Mapper and Mini-SAR radar were on the Chandrayaan I mission. These have contributed and confirmed the revolution in knowledge of the Moon's potential for further human exploration and economic development.

The great preponderance of the other major space faring powers, Russia, The European Union, Japan, India, and China have significant lunar missions if not entire programs in development that focus on the Moon.

Some 15 lunar missions are in development by these nations:

• **Lunar Missions in Development**		**Mission Count**
• China	Chang"e , IV, V, IV	3
• India	Chandrayaan II	1
• Japan	Selene II, III, X	3
• Korea	Orbiter, II Impactor, III Lander	3
• Russia	Luna 25, 26, 27, 28	5
• **Foreign**	**Subtotals**	**15**
• US-CA	Resolve Lunar Prospector	1
• US	Lunar(Cube) Flashlight +	1
	11 More CubesSat slots on Orion E-M 1 Mission	
• **Total**		**17**

The Global Phenomenon of the Google Lunar X Prize

The Moon Missions and Momentum story is not complete however without mentioning the Google Lunar X-Prize Competition which is scheduled to end on December 31, 2015. There are rumors that the competition will be extended into 2016 no doubt because the prospect of no team meeting this deadline are very great. There is a natural great incentive to insure that the competition will not be a bust and that there will be some tangible launch attempts and hopefully teams landing on the lunar surface, moving 1500 meters, and sending live HDTV images as evidence of meeting the First Prize objectives. There are very mature initiatives taking place and evidence by Astronautic and Moon-X has been evident in conference appearances and presentations in the US in my own experience.

The Astrobotic team has announced that it will sponsor rideshare opportunities to the lunar surface for some of its competitor teams on its lander and provide a uniform start time for the contest to move 1500 meters with HD TV documentation be willing to split the Google Lunar X-Prize. I am not aware of what teams have been offered this opportunity or how many may have accepted.

The Moon-X team has also announced rideshare customers for its flights. Several teams were awarded milestone prizes if they could meet certain objectives by the fall of 2015. Team Space IL scored a $16.5 M bequest from a generous benefactor. The Penn State Lunar Lions have announced the launch on a mission developed by the Phoenix Company which has like Astrobotic functioned as a "launch aggregator" to spread the financial burdens among a variety of customers.

Moving the Goalposts Again

This is not the first time theX-prize Foundation has moved the goal posts during this competition as the first deadline was at the end of 2012. This perhaps reflects the hubris of the initial start of the GLXP which occurred before the 2008 economic collapse in the US and Europe. This also reflects that fact that getting to the Moon is not and never was an easy or inexpensive accomplishment even when it was done for the first time by both the US and Soviet Union during the 1960's at a time when they were the largest military and economic superpowers.

The accomplishments of forty years ago might seem trivial to those of this generation until they face the realities of duplicating these feats. The advantages of prior knowledge, much better computers, the world wide web in accessing information and making communications both cheap and easy, of better materials, and of compact electronics have provided capabilities that make this ambition seem not only feasible but "easy" for small teams.

Oh yes, and there is the little factor of raising money. The financial endeavors of these teams are not public information but the efforts of Astrobotic and Moon-X no doubt have long ago crossed the $100 M threshold for the scale of their projects. Team Space IL has indicated that their mission costs for a follow-up commercial repeat mission for their micro-lander would be $40M to bring a 4 kg payload to the lunar surface.

This author has attempted to glean information from time to time from the GLXP Team web-sites but admittedly this has not been my full time vocation, nor do I claim complete knowledge as of October 30. 2014. The following teams to the best of my knowledge have made substantial efforts to produce some tangible engineering initiatives in getting to the surface. Some have announced launch providers, Some have shown or displayed landers or lunar surface rovers.

Some Google Lunar X-Prize Team Prospects

• Astrobotic	US	1	1
• Barcelona Moon Team	Spain	1	
• Hakuto	Japan	1	
• Moon-X	US	1	1
• Part-Time Scientists	Germany	1	
• Penn State Lunar Lions	US	1	
• Team Indus	India	1	
• TeamSpace IL	Israel	1	1
	Subtotal	8	3

Evidence of Growing Momentum

There might be teams on the Astrobotic rideshare not listed above and I might also have missed another team with launch prospects in Brazil on this listing. This list may account for another 11 lunar mission attempts within the next two to four years. So if these are added to those of the national space agencies **there are some 26 lunar mission initiatives within the next decade, mostly before 2020, representing 10 different countries.**

From a Global perspective it would seem that lunar mission initiatives are at a recent record high even if the climate in the US on the NASA side holds only a few glimmers of light.

But can more be accomplished in this globally positive context? I think the answer is clearly "yes."

Providing a "Scientific Bandwagon" with an International Lunar Geophysical "Year" Campaign

This author and some colleagues have been promoting the idea of an International Lunar Geophysical Year campaign beginning in 2017 on the 60th anniversary of the IGY of 1957-58 not so much directed at the major space faring nations which already made substantial lunar mission commitments and plans, but at additional small countries that could now afford lunar mission initiatives because of the advent of commercial access to the lunar surface via Astrobotic, Moon-X, and even Space IL's micro-lander system, and rideshare providers such as Phoenix and the large launch companies such as ULA, Space System Loral, and Space-X. These rideshare opportunities will lower the mission costs for secondary payloads.

The lunar cubesat paradigm may well bring cubesat and cubelab missions to near Moon space and the lunar surface into the single digit million dollar price range. Some early examples such as Lunar Flashlight and the Lunar Swirls Mission are under $20M.

t is therefore economically feasible to imagine that everyone of the G-20 nations could participate in an International Lunar Geophysical campaign lasting until 2024. This price range should also be within the reach of many other countries and justified because of the salutary impact on the educational and university systems, and not only because of those scientific results for planetary sciences.

If there are now only 3 flags on the Moon we ask why not 33 flags on the Moon? This is not an impossible stretch as an international initiative. Such initiatives might also be energizing for the movement to create a Pan African Space Agency as several African countries are now advocating. Something similar might also inspire similar collaborative international activities in South America. **This is something I hope can be further promoted at the ILEWG meeting in Istanbul in 2016.** A similar but independent appeal for a lunar decade is also being presented at the Next Great Leap Conference in Hawaii in November 2014. The case was also presented at the IAC Toronto meeting.

GLXP Teams as Critical Demonstrators

We will see within the next year or two how well the small team paradigm represented by the GLXP teams fares in meeting the challenges of landing on the Moon, and operating within a mile or so or perhaps as much as 3 miles from the initial landing site. If a number of teams succeed this will "buy down the risk" of others either duplicating this feat or more likely using the commercial operators to get their flags and science payloads on the lunar surface.

We have also strongly suggested to both the GLXP organization and SSERVI that the GLXP team community represents engineering capabilities that can be employed to meet scientific objectives, It seems important that the network of international science teams represented by the NASA's Solar System Exploration Research Virtual Institute can utilize these capabilities in meeting scientific objectives in near Moon space and on the lunar surface.

The international nodes of SSERVI represent Canada, Germany, Israel, Italy, Korea, the Netherlands,Saudi Arabia, and the United Kingdom. I am informed by SSERVI staff that one more nation, not publicly identified, is about to join this international network.

Hopefully the Moon 2.0 Campaign that is the GLXP can morph into a Moon 3.0 International Geophysical campaign that creates an international market place that supports sustained lunar access and extends lunar exploration and scientific understanding by engaging the most economically advantaged and technically advantaged nations.

Industrial Convergence on the Moon

But beyond this upbeat scenario are other initiatives that reinforce my optimism about the resurgence of interest and activities on the Moon. I recently attend the International Astronautical Conference in Toronto, Canada in early October 2014 and learned by attending a session that in addition to the ISECG group of national space agencies that major international space contractor companies have a lunar planning and coordination group that has developed scenarios for a return to the lunar surface.

These companies are the prime contractors for their national space agencies and therefore have a significant stake in the future planning and coordination activities of their national funding contractees. These companies include such well known names as Lockheed Martin, Boeing, EADS, and Mitsubishi.

These industrial complexes represent economic and political constituencies that also look to future opportunities for economic growth and sustainable markets for their products and workforce. This lunar orientation also bodes well for a growing international consensus about returning to the Moon to expand the economy from the realm of GEO out to the orbit of the Moon and the Moon's surface.

The demands for clean energy and minerals for the continued growth of the terrestrial economy cannot be met with the resources on the Earth's surface, and the global recognition of these limitations is driving this new consensus. So the industrial establishments of the major powers are engaged in this planning.

Entrepreneurial Convergence on the Moon

In addition to the existing industrial paradigm are a host of entrepreneurial initiatives directed at creating a new industrial paradigm. They hope to introduce disruptive technologies into the existing market places which will permit a rapid expansion of these market and a high rate of growth by lowering prices. These new ventures are also interacting and looking for collaborative and complimentary investment models that use in situ resources to produce a market sustainable rather than a government subsided space industries.

There is a low cost lunar base initiative that is based on a private capitalization model now in development. The forces of technology development and entrepreneurial initiatives are therefore also driving a return to the Moon. A Paul Spudis and Tony Lavoie paper on using Local resources to establish a Moon base provided what NASA would call a baseline reference model for such development given a range of variables that govern political bureaucracies such as NASA. Without the political constraints this type of extended and incremental implementation schedule might be greatly accelerated and much lower cost.

The Counter Argument in support of NASA's Stepping back from the Moon

From a conservative political and economic perspective perhaps the US government's step back from leading the charge back to the Moon at the head of a number of vertically organized national space bureaucracies monopolies is in fact a good thing. Perhaps the US leadership provided should be exactly in doing by private initiative and private capital what the government no longer needs to subsidize. If government should provide what the people on their own cannot provide then perhaps we have reached the point where "the people" can do space with their own private resources. There is no doubt that NASA's lunar withdrawal has slowed the pace of government subsidized research and development and exploration for the last several years. The GLXP is one way that vacuum has been filled.

Science has many times been the handmaiden of commerce and this may in fact become the new paradigm on the Moon. If commercial space tourism, space mining, and oxygen production become established industries then the access to the Moon for scientists will be much easier and less expensive and frequent than they dream of now. Hopefully in twenty years the ideas of paying a billion dollars for a few kg of new rock samples from the Moon will seem as ridiculous as paying a billion dollars for rock samples from Wyoming. Investing a few billion in changed changed infrastructure and a market driven model of operations may open a flood gate of lower cost scientific opportunities for continued and extensive global exploration of the Moon and along with industrial development. NASA has for decades

operated as a giant monopoly with status quo Centers system and associated contractor establishments. New Commercial contracting for ISS cargo delivery, commercial crew systems, and even innovative lunar data demonstration contracts, have open the door to genuinely competitive and disruptive technology developments.

Summary

I am for one more of an optimist than I have been in more than forty years of waiting to see humans and industry established on the Moon. I believe that the reconvergence on the Moon of other global space faring nations, the coordinated exploration perspectives of the ISECG and it's industrial counterpart, and the new entrepreneurs working collaboratively on a new low cost affordable model of space access and operations will in combination be able to storm “the beaches” of the Moon.

They will stay to make a living with local resources as humans have always done in establishing themselves in a new environmental niche throughout the long trail of human evolution. The Moon is the gateway and training ground for the harsh and stark environments waiting in the rest of the solar system. It is not an easy place to occupy, no where near as friendly as the Antarctic temperatures of Mars, but it is a good place to learn how to live and work on other airless bodies and with both extreme hot and cryogenic environments far beyond the range of terrestrial experience and engineering.

On the Moon we can learn how to engineer our survival in the cryosphere that constitutes the majority of our solar system and the cold reaches of the Kuiper belt and Oort Cloud. With the mastery of these challenges it offers new riches and opportunities to both save the Earth's environment and to pass our species intelligence test in both preserving our home planet and acquiring a living on others. As a multi-planet species with our eggs in more baskets, the Moon will teach us how to fully use the resources of our star system. That is why there must be a lunar reconvergence. DDp

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]

Mars Comet Shames Earth Dithering

http://spectrum.ieee.org/tech-talk/aerospace/astrophysics/**mars-comet-shames-earth-dithering**

By **James Oberg** - Posted OCT. 17, 2014 - reprinted in its entirety - unabridged

Comet Siding Spring will make a spectacular fly-past of the planet Mars on 20 October. Among the observers will be seven robotic space probes sent from Earth.

Only discovered less than two years ago, the newborn comet, fresh from the Oort Cloud nursery far beyond Pluto, probably carries secrets of the origins of the solar system. Its arrival was so sudden and unexpected that no Earthborn probe could have been built and launched in time to intercept it. Instead, by the most freakish of improbabilities, it fell directly into range of a space fleet that had assembled for an entirely different reason.

On Sunday the comet is to flash through the Mars-and-moonlets system, traveling south-to-north nearly perpendicular to their orbital plane. It'll miss Phobos and Deimos by 112,000 kilometers, and skate by Mars by about the same. When its potentially dangerous dust trail follows, four of the five orbiting probes will be snuggling safely behind the planet's bulk. The two surface rovers will be protected by the Martian atmosphere. The aged Opportunity will look for the comet in pre-dawn twilight, and the more-recently-arrived Curiosity, on the opposite side of the planet, will be in evening twilight.

Besides carrying cosmic secrets, the comet is also carrying a question. Why aren't there people out there front-row-center for what might have been the greatest solar system spectacle of all human history? Where are the human eyeballs and human souls that should have been rising from the Martian surface at this marvel. The sight would likely have been a literally astronomical reward for the boldness and ingenuity that had placed humans there?

Fifty years ago, during the heyday of the Apollo Program development, the issue of human flight to Mars wasn't even open to doubt or debate – the only issue was the time frame. Could it be done within 20 years of a Moon landing, as optimists hoped? Or would it take 30, or 40, as the realists expected?

True, these visions rested on the wispy foundations of imaginary engineering breakthroughs and in blissful ignorance of the real challenges of long-term space operations and human physiology. The maturity of the independently-developed technologies that when harnessed together in the 1960s enabled — barely enabled — brief lunar surface sorties by astronauts, also misled futurists into thinking a new crop of advanced engineering capabilities could easily be mustered.

In hindsight, sophisticated reliability assessments, which properly assessed Apollo mission success at 80 percent and crew survival at 95 percent, when applied to even the best humans-to-Mars strategies, gave the likelihood of success at less than 5 percent and of crew survival as less than 50 percent. We didn't even know how much we didn't know.

But was that really an excuse for not even seriously trying? It's not as if we couldn't have afforded it. Did not trying to get humans to Mars really saved the world's governments any serious money?

So instead of on-site living eyewitnesses to this spectacle, we've sent R2D2, and been lucky at that. The robots will perform just fine, and it will still be an amazing event. Yet it can also serve as a slap-in-the-face reminder that just as on Earth, "fortune favors the bold." It would have vastly increased human culture if bold humans now on Mars— and the bold societies that might have existed to send them— would be justifiably exulting in this unexpected reward from the inanimate Universe, seen first-hand instead of through robot eyes.

There are more glorious surprises in the infinite "Out There," waiting to be stumbled across and recognized. Let's not be caught flat-footed like this again. ##

[Opinions expressed are those of the author, not IEEE Spectrum, the IEEE, or its organizational units.}

A Decade into a New Spaceflight Era, a Mixture of Frustration & Optimism

OCT. 22, 2014 - http://www.space.com/27501-**commercial-spaceflight-era-frustration**.html

By Jeff Faust

LAS CRUCES, N.M. — Ten years after the completion of the Ansari X Prize appeared to open a new era of commercial human spaceflight, company executives and government officials at a commercial space conference expressed a mixture of optimism about the future of the industry and impatience at the perceived lack of progress over the last decade.

"I'm actually quite frustrated with the pace of commercial space," said Brett Alexander, director of business development and strategy for Blue Origin, the privately funded spaceflight company led by Amazon.com founder Jeff Bezos.

"It really has been frustrating to be 10 years into commercial space, 10 years from the X Prize, and not see a proliferation of activity, of people flying regularly," he said in a presentation at the International Symposium for Personal and Commercial Spaceflight (ISPCS) here Oct. 15.

Alexander was referring to the flights of SpaceShipOne on Sept. 29 and Oct. 4, 2004, that won the $10 million Ansari X Prize for vehicle developer Scaled Composites and the project's financial backer, Microsoft co-founder Paul Allen. At the time, those flights appeared to signal the beginning of a major expansion of commercial space activities, including suborbital space tourism.

The company most closely linked to that vision of commercial spaceflight has been Virgin Galactic, which announced its plans to partner with Scaled Composites on what would become SpaceShipTwo shortly before those X Prize flights. At the time of the original announcement, Virgin Galactic proposed starting commercial service as soon as late 2007. Those flights are still at least several months in the future.

In an Oct. 15 ISPCS speech, Virgin Galactic Chief Executive George Whitesides said the company had just completed ground qualification tests of a new hybrid rocket motor for SpaceShipTwo. "We expect to get back into powered test flight quite soon," he said.

As is customary for the company, Whitesides did not give a schedule for when commercial SpaceShipTwo flights would begin, although the company's founder, Sir Richard Branson, said in September that he expected to be on the first commercial flight in February or March of 2015. "I, personally, am incredibly excited about the next six months," Whitesides said.

The ISPCS, marking its 10th year, is itself an outgrowth of the X Prize. The conference started in 2005 as the International Symposium for Personal Spaceflight, a one-day event held on the New Mexico

State University campus here just before the X Prize Cup, a space-themed airshow held at the local airport. While the X Prize Foundation ended the X Prize Cup after the 2007 event, the conference has continued, diversifying into other aspects of commercial spaceflight.

That diversification has included a greater presence by U.S. government officials in their roles of both regulating and incentivizing commercial space efforts. At this year's conference, they argued that the growing capabilities of the commercial space industry are becoming increasingly critical to civil and military space efforts, and overall national space power.

"I see a collision coming between commercial space and defense space needs," Douglas Loverro, deputy assistant secretary of defense for space policy, said in an Oct. 15 speech here. That intersection of needs and requirements, he said, could mitigate reductions in government spending by allowing agencies to make greater use of commercial capabilities. "This is the way the U.S. will stay ahead of others in space," he said.

One way the Defense Department is supporting that intersection is through the Experimental Spaceplane 1 (XS-1) program at the Defense Advanced Research Projects Agency. Three companies — Boeing, Masten Space Systems and Northrop Grumman — received phase one contracts this year to begin initial design work on a reusable lower stage that could be used to place satellites weighing up to 2,250 kilograms into orbit for less than $5 million per launch.

"We are trying to build a capability that is useful to the military, but do it on the backs of commercial space," Jess Sponable, DARPA XS-1 program manager, said Oct. 16. "If you can do that, we have a sustainable solution. If we can't, then we're just another space program.

In an Oct. 16 speech here, George Nield, associate administrator for commercial space transportation at the Federal Aviation Administration, outlined a dozen "mission areas" where industry is playing, or plans to play, a major role, from launching satellites to space tourism to space-based resource extraction. That, he said, is a major change from 10 to 20 years ago, when commercial space activities were largely limited to the construction, launch and operation of communications satellites.

"I find the depth and breadth of the things being worked on right now in the commercial sector to be really exciting, and they frankly give me hope for the nation's future in space," he said.

Much of that hope is pinned to the future of the International Space Station, including both commercial transportation to and from the ISS and commercial research performed there. That near-term work on the ISS may be critical in developing demand for future commercial space stations, said William Gerstenmaier, NASA associate administrator for human exploration and operations.

"The question is, can we use the space station as a government entity to show others that there is a market out there that is independent of the government and is worth their investment?" he asked.

Some of those partnerships have moved faster than even Alexander expected. "Who would have thought 10 years ago that we'd be talking about NASA funding two commercial crew providers, flying their own astronauts on privately owned and operated vehicles?" he said. "I thought then it would take a lot longer than that.

"This progression that we've had over the last decade from fully government activities to hybrid government-commercial activities to now some fully commercial activities has been exciting to watch," Alexander said, "but the pace of it has been a little bit frustrating."

Other thought-provoking articles from Space Review

Disruption and destruction in the launch business

Space-X Quest for "Reusability" - http://www.thespacereview.com/article/2628/1

One of the most popular business buzzwords today is "disruption"; does it apply to the launch business? Jeff Foust reports on the effect one company is having on the business and what its quest for reusability could mean for the industry.

The Space Pioneer Act - http://www.thespacereview.com/article/2627/1

Advanced in commercial space ventures have raised new questions about the need for property rights and ownership of resources in space. Wayne White makes the case for legislation that could accomplish this within the limitations of current treaties.

Lessons from Apollo for Mars One - http://www.thespacereview.com/article/2625/1

The Mars One plan to send people to Mars one-way has attracted its share of attention and criticism. James C. McLane III examines what Mars One could learn from the challenges faced by Apollo.

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://isdc.nss.org

The Moon Society – http://www.moonsociety.org – TMS
The Moon Society has informal relationships with the Calgary Space Workers, Calgary, Alberta, Canada and with 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, Philippines**, 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.

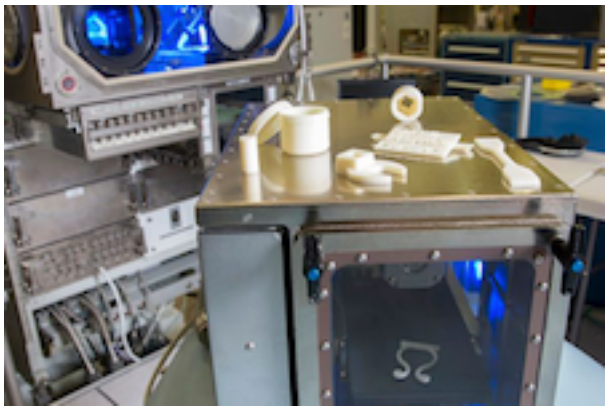
STEM – The STEM Academy – http://www.stem101.org/about.asp
[STEM: an acronym for **Science**, **Technology**, **Engineering**, and **Math**]
The STEM Academy, Inc. is a national non-profit status organization dedicated to advancing economic development by improving STEM literacy for all students. State 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

NASA Launches Student Contest for 3D-Printed Astronaut Tools

Oct 2, 2014 - http://www.space.com/27311-**nasa-3d-printing-student-contest.html**
https://www.youtube.com/watch?v=zZCvEOEd30c

You don't have to become an astronaut to use the I Space Station's new 3D printer.NASA has challenged students, ages 5-19, to design first 3D printed tools that could be made in microgravity.

The first 3D printer to fly in space arrived at the astronaut outpost in September 2014 aboard a SpaceX Dragon capsule - along with more than 2,268 kg (5,000 lbs) of cargo on Space-X' fourth resupply mission to the space station for NASA.



Made in Space's 3D printer will churn out the first 3D-printed tools on the International Space Station

- The printer was built by the California-based company Made in Space, which plans to create simple plastic parts at first, to test whether 3D printing is viable in the final frontier.
- Now, students will have a chance to take part in that experiment.
- NASA and the American Society of Mechanical Engineers Foundation launched a set of "Future Engineers" 3D Space Challenges on Sept. 21. The contest asks students in grades K-12 to create and submit a digital 3D model of a tool that they think astronauts will need in space.

"To be able to make parts on demand will forever change everthing."

- Entries, which are due by Dec. 15, will be judged for their creativity, usefulness and adherence to design guidelines. Semifinalists will be announced in mid-January and winners revealed on Jan. 30.
- The grand prize for the winning teen entrant (13-19) includes a trip to NASA's Payload Operations in Huntsville, Alabama, where the student will watch his or her print made live on the space station.
- The winner in the 5- to 12-year-old set will get a 3D printer for his or her school.
- Learn more about the contest and how to participate here: http://www.futureengineers.org/ ##

Contestant Gets to Name a new Space Station Droid " "

NOV. 2, 2014 - http://www.space.com/27419-**nasa-space-robot-name-contest.**html

NASA asked for help to name a new space robot, and design a mission patch for, a new free-flying robot expected to launch to the International Space Station in 2017.

"**We have this new free-flying robot that we're building; We don't know what to call it**.

We don't know what to call it. 'Free-flying robot' sounds kind of boring and not all that exciting, so we're asking you to actually name the robot for us."

- The first-place winner of the challenge received US $1,000.
- 2nd place won $500, 3rd pLace and 4th place $250 each.

The robot could appear as **a small, ball-shaped droid that will use fans to move itself around the interior of the International Space Station. It is expected to be able to fly itself, or be operated by remote control.**

Other free-fliers already on the station.

- NASA's SPHERES robots (**S**ynchronized **P**osition **H**old, **E**ngage, **R**eorient, **E**xperimental **S**atellites) are already used on ISS. The program has been running for seven years, and is designed to help scientists test robotics hardware and software in microgravity.

- The SPHERES robots and the new robot should be able to move around autonomously, but humans living and working on the orbiting outpost can also control the satellites.

Controlled and autonomous robotic devices will extend the research and exploration capabilities of astronauts, as they are capable of working during off-hours and (eventually) in extreme environments. Initial designs were due on Oct. 22, Officials will announce the winners of the competition on Nov. 2..

- {Winners Announcement NOT made as of 12/31/2014.] ##

PISCES to host winning Moonbots Team

http://www.pacificspacecenter.com/wp-content/uploads/2014/10/OCT-2014-Newsletter.pdf

October 2014

> **[PISCES** = **P**acific **I**nternational **S**pace **C**enter for **E**xploration **S**ystems, based in Hawaii, which is both host and a founding sponsor.PISCES conducts conferences as well as Moon and Mars analog programs on Hawaii island on the slopes of Mauna Kea and Mauna Loa mountains. The state of Hawaii, NASA, Canada, Germany, and Japan are co-sponsors]

The Google Lunar XPRIZE has announced the winner of the **2014 MoonBots Challenge**, awarding **Team Incredibots of Columbus, Ohio** with a grand prize visit to PISCES.

The team will arrive on Hawaii Island at the end of November for a world-class exercise of their robot at a PISCES planetary analogue test site.

The MoonBots Challenge is an international online competition for youth ages 9-17 years old. It mirrors the Google Lunar XPRIZE Competition – an international contest challenging privately-funded space teams to land a spacecraft on the Moon with a lunar rover for a grand prize of $30 million.

The 2014 MoonBots Challenge began in March, attracting entries from more than 300 teams across 24 countries in the interest of promoting **STEM** (**S**cience, **T**echnology, **E**ngineering, **M**ath) education. Applicants submitted videos answering the question,

"Why should we go back to the Moon for good?"

A panel of judges selected 25 teams and tasked them with **building and programming a LEGO MINDSTORMS robot**, along with **a simulated lunar landscape for the bot to traverse**.

Congratulations **Team Incredibots** on your success! We look forward to seeing you in Hawaii!

For more information on the 2014 MoonBots Challenge, visit http://**moonbots**.org. ##

NASA Selects Student Teams for High-Powered Rocket Challenge

http://www.nasa.gov/press/2014/november/**nasa-selects-student-teams-for-high-powered-rocket-challenge/**

NOV. 20, 2014 - RELEASE 14-321 NASA has selected eight teams from middle and high schools across the country to participate in the 2014-2015 NASA Student Launch Challenge, April 7-12, organized by NASA's Marshall Space Flight Center in Huntsville, Alabama.

The Challenge

- Engage students in a research-based, experiential exploration activity.
- Design, build and launch a reusable rocket, with a scientific or engineering payload, capable of reaching an altitude of one mile.

Eligibility

- Must have successfully completed the NASA Advanced Rocketry Workshop,

- Participate either the 2012-2013 Student Launch Challenge, Team America Rocketry Challenge, or 2014 Rockets for Schools competition.

The 2014-2015 middle and high school teams who will compete are:

- Durham Area Rocketry, Durham, North Carolina
- Krueger Middle School, San Antonio, Texas
- Madison West High School (Land Imaging), Madison, Wisconsin
- Madison West High School (Muons), Madison, Wisconsin
- Plantation High School, Plantation, Florida
- Spring Grove High School, Spring Grove, Pennsylvania
- St. Vincent-St. Mary High School, Akron, Ohio
- Victory Christian Center School, Charlotte, North Carolina

Standards and Criteria

- Each team must meet rigorous standards and review processes, those applied in the NASA workplace.
- Student designs must undergo in-depth technical reviews and follow actual flight safety guidelines.
- Two target audiences – **middle and high schoo**l students, and **university and college** students.
- Programs for middle and high school students focus on advancing education in science, technology, engineering and math and exposing the students to careers in aeronautics and aerospace.

To learn more, visit: http://go.nasa.gov/1oYb7sY

Follow the Student Launch on social media for the latest news and updates:

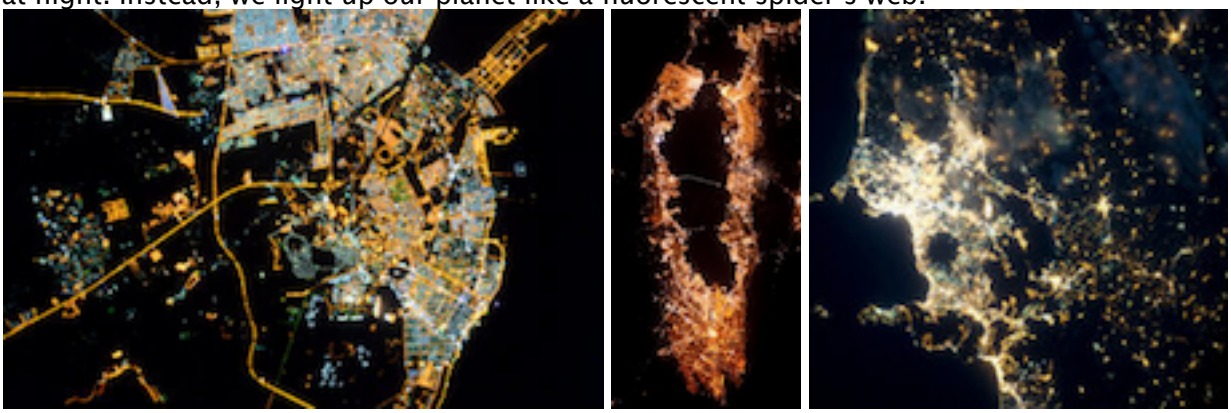
http://go.nasa.gov/1uNpJfq – https://twitter.com/NASA_Launchfest ##

The "Cities at Night Project" is asking for Your Help

http://www.esa.int/Our_Activities/Human_Spaceflight/**Research/Bright_lights_big_cities_at_night**

The Challenger Crowd-sourcing Identification

Astronauts circling our planet on the International Space Station take wonderful pictures of Earth and many are fascinated by our brightly lit cities at night. Without humans, Earth would be completely dark at night. Instead, we light up our planet like a fluorescent spider's web.



Left to Right: Liverpool UK, San Francisco Bay Area US, Naples Italy

Nearly 500 000 pictures have been taken of Earth at night by astronauts – and the number keeps growing. ESA astronaut Samantha Cristoforetti is continuing the habit during her mission on the Space Station. Not all of these pictures are identified or catalogued and this is where the Cities at Night project is asking for your help.

The project **asks you to identify and tag night-time photos of Earth**.

Recognizing a city is not as easy as it might seem. Astronauts can set their cameras to take pictures automatically while they work on scientific experiments, so they do not always know themselves – and computer programmes cannot help.

Researchers need your help to tag images, locate them on a map and provide exact references. Each task has its own web application that runs straight from your browser.

The applications have a brief tutorial to get you started. Locating cities needs the most work – so get out your atlas and start hunting.

Can you imagine what a wonderful and popular resource this would be? **You can make it real!** ##

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)

WINTER 2014

14 A Gravitational Tandem Starship: the future of interstellar travel – Alexander Kazykin
20 Making His Own Path: Richard Garriott's Entrepreneurial Space Odyssey – Clifford R. McMurray
24 Coming Home May be the Hardest Part – Paul Contoursi
28 Wrapped in Darkness and Silence – Lance Frazer
32 The Affordable Mission to Mars – Humboldt C. Mandell,. Jr., PHD
36 The Easiest Path: Michael Griffin's Strategic Vision for a Spacefaring Civilization – Clifford R. McMurray
40 Sofia: The Teacher Experience – Lynne F. Zielinski
44 The Age if in-Space Manufacturing – Michael P. Snyder

www.MMM-MoonMinersManifesto.com

OCTOBER 2014 – MMM # 279

2 In Focus: **Are we ever going to settle the Moon?** – Peter Kokh
3 **A fresh look at the idea of "Spinning-up" Industries Needed on the Moon** – Peter Kokh
4 **Exports to Earth must be less in value than imports from Earth: The "M.U.S./c.l.e." Equation** – P. Kokh
5 **Biospheric Technologies needed on the Moon – and on Earth** – Peter Kokh

NOVEMBER 2014 – MMM # 280

2 In Focus: **ISS Neglected Research: We welcome more Space Stations** by Peter Kokh
4 **We Need More Good & Realistic Moon and Mars Outpost and Settlement Art** by Peter Kokh

DECEMBER 2014 – MMM # 281 – MMM's 28th Anniversary Issue (10 issues a year since December 1986)

2 In Focus: **Tourism, not Industry, may "Kickstart" Lunar Settlement** – by Peter Kokh
3 [**Index to MMM Tourism Theme Issue]**
4 **Tourists could well lay the foundations for settlement** – by Peter Kokh
5 **The Role of Tourism in Fostering a Unique Settlement Culture** – by Peter Kokh
6 **A free "take home must" for Lunar Tourists** – by Peter Kokh
The "House on the Moon" Project – by Peter Kokh
7 Stay at Home Pioneers can and must Promote the Vision – by Peter Kokh
8 **Fun Time About "role-originated" Names: "Sun" "Earth" "Moon" "Astronaut"** – by P Kokh

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. O**ther 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.moonsocietyorg/publications/mmm_classics/

MMM Classic Theme Issues: introduced a new series to collect the same material as in the Classics, but this time organized by theme. The first MMM Classic Theme issue gathers all the **Mars** theme articles from years 1-10 in one pdf file. A second pdf file collects all the Mars Theme issues from year 11-20. The 2nd Classic Theme is "**Eden on Luna**," addressing environmental issues underlying lunar settlement. **Asteroids**, **Tourism, Research**, **Select Editorials, and Analog Programs** have been added. New Theme Issues will be coming: Lunar Building Materials, The Lunar Economy, The Lunar Homestead, Modular Architecture, Modular Biospherics, Frontier Arts & Crafts, Frontier Sports, Other Solar System Destinations, and so on.

www.moonsociety.org/publications/mmm_themes/

MMM Glossary: The publishers of MMM, the Lunar Reclamation Society, has published a new Glossary of "MMM-Speak: new words and old words with new meaning" as used in Moon Miners' Manifesto.

www.moonsociety.org/publications/m3glossary.html

The initial addition includes over 300 entries, many with illustrations. Additional entries are under construction. It is hoped that new members will consider this to be a "Read Me First" guide, not just to Moon Miners' Manifesto, but to our vision and goals.

All of these resources are available online or as free access downloads to readers. But TTSIQ does need your help!

To The Stars International Quarterly Advisors, Liaisons, Contributors, Reporters, Illustrators

If this publication is to help spread the word about Space worldwide, among the public at large, especially among the students and younger people, it must become a truly International publication. We need people from many fields and many nations to join our team.

If you can add to the usefulness and vitality of this publication, in any of the ways listed above, or in fields we had not thought of, write us at: ttsiq@moonsociety.org [This email address goes to the whole editorial team]

Tell us about yourself; your interest in space, and how you think you can make this publication of real service in the education of the public worldwide, and in the education of young people on whom our future rests.

Guidelines for Submissions TTSIQ is intended for wide public distribution to encourage support for space research and exploration and development. TTSIQ is not a scholarly review or a technical journal for professional distribution. Submissions should be short, no more than a few thousand words. Longer pieces may be serialized editorials and commentary, reports on actual developments and proposals, glimpses of life on the future space frontier, etc. Articles about launch vehicles, launch facilities, space destinations such as Earth Orbit, The Moon, Mars, the asteroids, and beyond, challenges such as moondust, radiation, reduced gravity, and more.

Help Circulate To The Stars International Quarterly

If you know someone who might enjoy reading this publication, send us their email address(es) so that they receive notice when a new issue if published. Readers are encouraged to share and to distribute these issues widely, either as email attachments, or via the direct download address (for all issues):

http://www.nss.org/tothestars/ and http://www.moonsociety.org/international/ttsiq/

To The Stars International Quarterly #10: January 2015 Index

To The Stars International Quarterly #10

Engage! And Enjoy! - published January 1, 2015