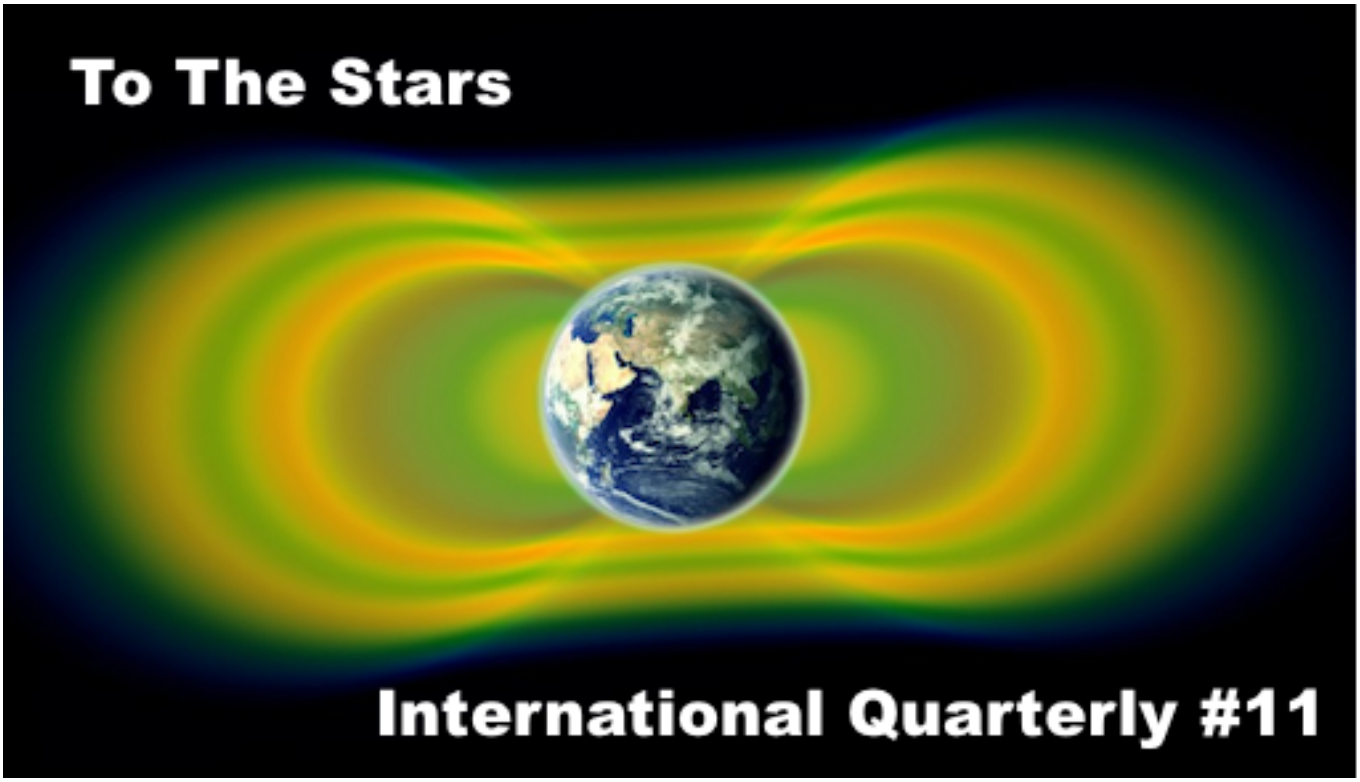


Earth's Van Allen Belts "Security Blanket" gives us protection that settlers on the Moon & Mars will not have

NDEX

TTSIQ Sponsor Organizations

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

The National Space Society was formed in March, 1987 by the merger of the former 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 annual International Space Development Conference in May each year at varing 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 our society, providing room and resources for the growth of the human race without despoiling Earth, and 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 which promotes the exploration and development of space by educating people about the benefits of space, through a network of interested students, providing an opportunity

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

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

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

[The articles below have been bullet-summarized by the editor. For the full text, see the links cited.]

ANALOG FACILITY TRAINING

SPACEPORT NEWS

COMMERCIAL SPACECRAFT

Private Dream Chaser Space Plane Keeps Marching Toward Flight

JAN. 9, 2015 – www.space.com/28203-**dream-chaser-space-plane-propulsion-milestone**.html

Dream Chaser could be one of two "shuttle-type" crew transfer vehicle available to NASA
The other being XCor's Lynx – www.xcor.com/**lynx**/

Even though NASA did not select the private vehicle to ferry astronauts to and from the International Space Statiton, the **Dream Chaser space plane** continues to take steps toward flight. Its builder, Sierra Nevada Corporation, recently checked off a milestone laid out in the company's last commercial-crew contract with NASA, signed in 2012.

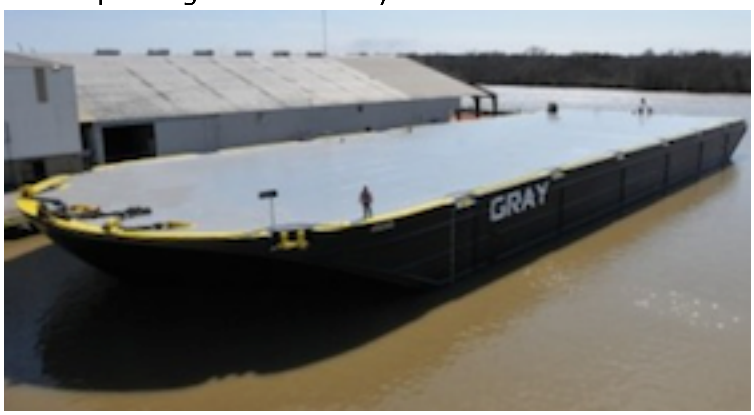
- It showed that Dream Chaser's reaction control system can operate in a vacuum chamber characterized by some of the conditions found in space. The system is supposed to help Dream Chaser maneuver in orbit, and also guide it to landings on runways.
- Sierra Nevada and NASA agreed to the optional milestone in 2013 under the company's existing Commercial Crew Integrated Capability (CCiCap) contract.
- The company now has achieved all but one of 13 miletones outlined in the contract. The work should be useful for future crewed and uncrewed missions using the spacecraft,.
- The goal of the Commercial Crew Program is to restart launches of astronauts from U.S. soil, a practice suspended in 2011 when the space shuttle retired.
- Dream Chaser, Dragon, CST100, and Orion would carry 7 persons, able to evacuate ISS if needed. ##

Daring SpaceX Rocket Landing Test Crashes after Successful Cargo Launch

JAN. 10, 2015 – www.space.com/28173-**spacex-reusable-rocket-test-dragon-launch**.html

A commercial Falcon 9 rocket built by SpaceX successfully launched a Dragon cargo ship toward the International Space Station early Saturday, Jan. 10, kicking off SpaceX's fifth unmanned cargo mission to ISS after a four-day delay.

- On return to Earth, it apparently impacted its target ocean platform during a dramatic and highly anticipated landing test in the Atlantic.
- The aim was to bring the Falcon 9 first stage down for a precision landing on an "autonomous spaceport drone ship" in the Atlantic Ocean.
- The rocket stage apparently hit its target, but a bit too hard.
- Musk's ever-positive emarks: "Rocket made it to drone spaceport ship, but landed hard. Close, but no cigar this time. Bodes well for the future tho."
- "Ship itself is fine. Some of the support equipment on the deck will need to be replaced. "Didn't get good landing/impact video. Pitch dark and foggy. Will piece it together from telemetry and ... actual pieces."
- The drone-ship test is part of SpaceX's effort to develop fully and rapidly reusable rocket technology which could cut the cost of spaceflight dramatically.



The Space-X Dragon booster landing platform, shown in dock

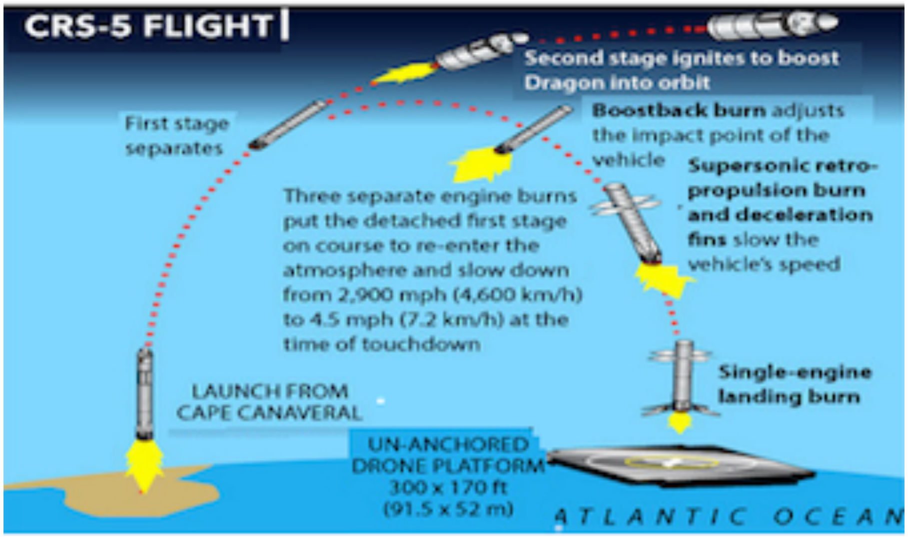
- Musk repeatedly stressed that the odds of successfully landing the Falcon 9 rocket stage on the ocean platform were relatively low because of the unprecedented nature of the technology test.
- SpaceX successfully soft-landed a Falcon 9 first stage in the ocean twice in 2014 — but just in the water, not on a floating platform.
- Saturday's attempt required a big step up in touchdown precision; the drone ship measures just 300 feet long by 170 feet wide (91 by 52 meters) with its "wings" extended, and the rocket stage targeted it after attaining a maximum altitude of 150 miles (240 kilometers) or so.
- Getting Dragon to orbit was the launch's chief objective. The capsule should arrive at the station early Monday (Jan. 12), at which point astronauts will grapple it using the orbiting lab's huge robotic arm.
- Dragon was loaded with more than 2,270 kg (5,000 lbs) of food, scientific experiments and spare parts on this journey. ##

SpaceX: "Rocket Landing Test Ran Out of Hydraulic Fluid"

JAN. 12, 2015 – www.space.com/28236-**spacex-rocket-landing-hydraulic-fluid**.html
www.space.com/28167-**spacex-risky-reusable-rocket-landing-infographic**.html

After successfully launching an uncrewed Dragon capsule with cargo moduleloaded down with supplies on a trip to the Space Station\, SpaceX attempted to land a stage of its Falcon 9 rocket on a drone ship in the Atlantic Ocean for the first time. The rocket impactinged the platform during he test.

"Rocket made it to drone spaceport ship, but landed hard," Musk wrote on Twitter on Jan. 10. "Close, but no cigar this time. Bodes well for the future tho."



Space-X engineers are still trying to piece together what went wrong with a reusable rocket test, but company founder Elon Musk said Sunday, Jan. 11th, that **the rocket's steering fins ran out of hydraulic fluid** during the attempt. Knowing the source of the problem, there is a better chance of a successful landing during a future test. ##

SpaceX Gets US $1 Billion from Google and Fidelity

JAN. 20, 2015 – http://www.space.com/28316-**spacex-elon-musk-google-fidelity-investment**.html

- Google and Fidelity Investments have invested $1 billion in Space..
- Together they own about 10 % of Space-X, run by billionaire entrepreneur Elon Musk. Other SpaceX investors are **Founders Fund**, **Draper Fisher Jurvetson**, **Valor Equity Partners** and **Capricorn,**.
- The cash infusion could help SpaceX get its **bold new satellite program** off the ground.
- SpaceX plans to build and launch 4,000 satellites to low-Earth orbit to provide cheap Internet access to people around the world.
- While low-cost Internet access is a significant end in itself, the ever-ambitious Musk wants the satel-lite program to lead to something bigger.
- The **goal is to generate a significant amount of revenue to help fund a city on Mars**
- Muskfounded SpaceX in 2002 primarily to help humanity become **a multiplanet species**.
- The cost of spaceflight must get low enough to make a permanent Mars colony economically feasible.
- Key to lowering the cost of spaceflight is developing fully and rapidly reusable rockets. ##

Private Space-X & Boeing Space Taxis on Track to Fly in 2017

JAN. 26, 2015 – www.space.com/28372-**spacex-boeing-astronaut-taxis-2017**.html

Representatives of both private spaceflight companies Boeing and SpaceX are on track to start launching NASA astronauts to the International Space Station by 2017, firms said Monday (Jan. 26).

- In September 2014, SpaceX and Boeing were awarded contracts under NASA's commercial crew program to help them start flying astronauts to the space station from U.S. spaceports in the next few years. Both companies are planning to launch a series of tests of their spaceship capsules **Dragon V2** and the **CST-100**, respectively, from this year through 2017.
- Tests will insure that the launch systems are ready to carry their first passngers to and from ISS.
- Seats aboard Dragon and the CST-100 will be less expensive than the current $70 million per seat on Russian Soyuz spacecraft to deliver astronauts to ISS since the space shuttle program ended in 2011.
- NASA requires that commercial providers meet or go below a $58 million average price per seat.

Budgets and contracts

- SpaceX is receiving $2.6 billion of the $6.8 billion contract; Boeing awarded the other $4.2 billion.
- NASA is "optimistic that Congress will accept the President's proposal for commercial crew for 2016."

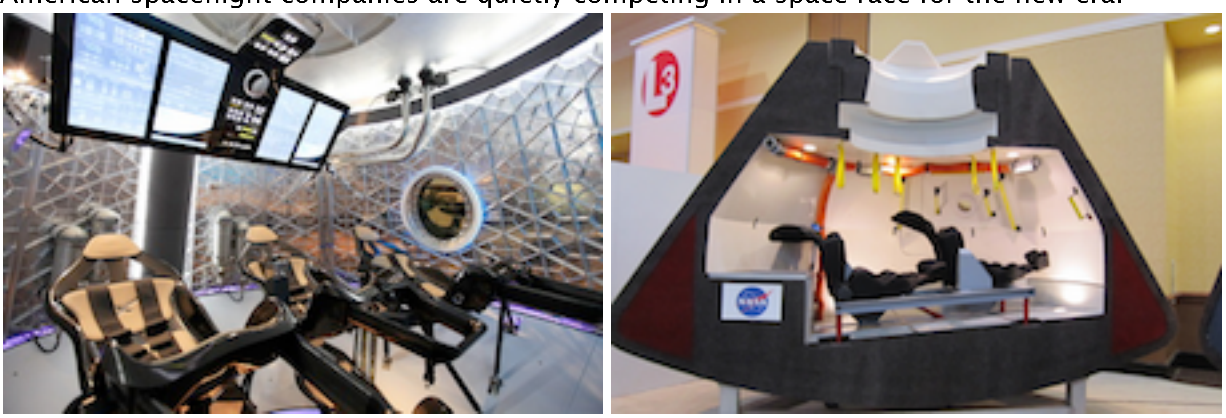
SpaceX getting ready to fly

- SpaceX's plans under the commercial crew program are expected to heat up this year. The company plans to launch its first "abort test" for Dragon "in the next month or so." \The company is then expected to perform a second abort test later in 2015.
- Those two tests are designed to show how Dragon V2 would respond in the event of a problem during liftoff— SpaceX hopes to launch an uncrewed test flight with its Falcon 9 rocket in late 2016, with its first crewed mission using the launch system coming shortly after that, in early 2017. ##

NASA's Next Space Race: SpaceX vs. Boeing

JAN. 30, 2015 - www.space.com/28411-**spacex-boeing-nasa-space-race**.html
www.nasa.gov/content/**nasa-boeing-spacex-outline-objectives-to-station-flights**/index.html

Two American spaceflight companies are quietly competing in a space race for the new era.



Inside Space-X capsule left and Boeing crew capsule right

- SpaceX and Boeing are vying to become the first private firms to fly astronauts to the International Space Station for NASA sometime in 2017.
- NASA chose both companies as part of the agency's commercial crew program, which may end NASA's current sole reliance on Russian vehicles to get astronauts to and from the space station.
- NASA has purchased expensive seats for astronauts on Russian Soyuz spacecraft since the end of the space shuttle program in 2011
- Hitching rides on SpaceX's manned Dragon capsule and Boeing's CST-100 spacecraft could make spaceflight significantly cheaper for NASA. than the approximately $70 million ride on a Soyuz.
- Both companies are currently moving toward launching in 2017. Boeing is targeting the end of 2017 for its first crewed flight to the station, but SpaceX might make it there before then.
- Astronauts who flew on the final space shuttle flight to the space station in 2011 left a special American flag on the orbiting outpost for the first commercial crew vehicle to fly a mission to the station.
- NASA is providing funds to develop both spacecraft. SpaceX will receive $2.6 billion of the $6.8 billion total in the contract, and Boeing will get $4.2 billion.

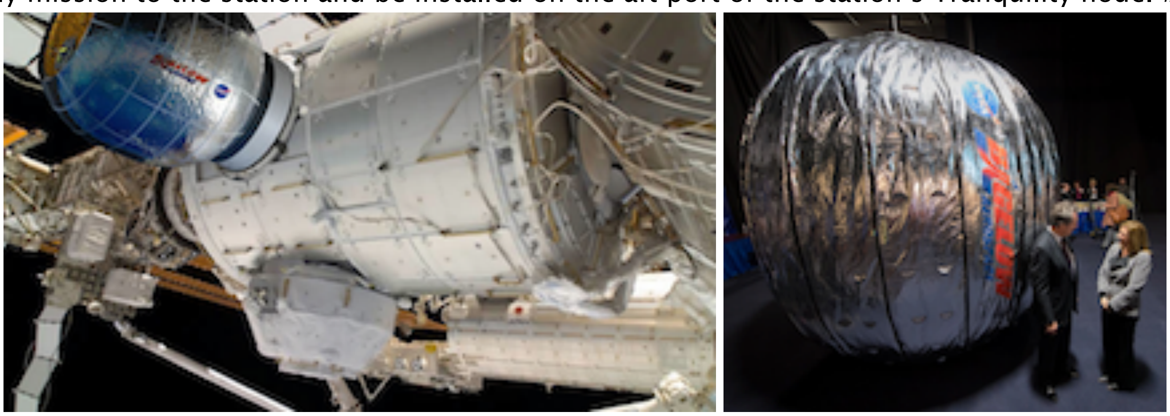
- SpaceX is planning to perform the first abort system test to get astronauts out of harm's way should something go wrong during a launch — this year, with another abort test expected later in 2015. In 2016, the company is expected to launch an uncrewed Dragon to the space station atop the Falcon 9 rocket. SpaceX representatives hope to launch a crewed mission shortly after that, in 2017.
- Boeing is planning on launching its uncrewed and first crewed missions to the space station in 2017. A Boeing pilot and NASA astronaut will be aboard for the first flight.
- Once flying, the Commercial Crew Program will actually make the space station more productive.
- Both Dragon and CST-100 are designed to carry seven space flyers to orbit, which means that **the station will play host to seven productive crewmembers instead of six.** ##

Media Preview of Bigelow BEAM Module Ahead of Shipment to NASA

www.nasa.gov/press/2015/march/**media-invited-to-see-bigelow-expandable-space-station-module-ahead-of-shipment-to/**

MAR. 3, 2015 - NASA and Bigelow Aerospace invited the media to a photo and interview on Thursday, March 12, at Bigelow Aerospace's North Las Vegas facility to mark the completion of all major milestones on the Bigelow Expandable Activity Module (BEAM).

- This was an opportunity for reporters to see and photograph the BEAM before it's shipped to to Florida for launch to the Station later this year.
- The demonstration of expandable space habitat technology supports NASA's long-term exploration goals on its journey to Mars, for which the agency will need to develop a deep space habitat for human missions beyond Earth orbit.
- The BEAM is scheduled to launch in the second half of this year aboard the eighth SpaceX cargo resupply mission to the station and be installed on the aft port of the station's Tranquility node. ##



Left: artist concept of the **B**igelow **E**xpandable **A**ctivity **M**odule (**BEAM**), constructed by Bigelow Aerospace, attached to the Space Station. BEAM will be launched to the station later this year.

Right: Robert Bigelow shows BEAM mockup to then NASA deputy administrator Lori Garver

NON-COMMERCIAL SPACECRAFT

European Mini-Space Shuttle Aces 1st Test Flight

FEB. 11, 2015 - www.space.com/28520-**europe-launches-mini-shuttle**-ixv.html

www.space.com/21679-**europe-ixv-reentry-vehicle-photos**.html

/www.space.com/28456-**how-european-ixv-space-plane-works-infographic**.html

A European mini-space shuttle prototype launched Vehicle (IXV) blasted off atop a Vega rocket from the European Spaceport in French Guiana Wednesday morning.

- The craft came back to Earth about 100 minutes after launch, making a parachute-assisted splashdown in the mid-Pacific Ocean. A recovery ship was stationed near the splashdown zone.
- The successful flight will be followed by analysis of all the data collected throughout the flight.

- The experimental vehicle is a wingless "lifting body" rather than a true space plane.
- It measures 5 by 1.5 by 2.2 meters (16.4 ft long by 4.9 ft high by 7.2 ft wide and weighs 1,814 kg (2 tons) when fully fueled.
- The European Space Agency's small Intermediate eXperimental Vehicle could pave the way for future orbital space planes.
- During the suborbital flight, the IXV reached a maximum altitude of 420 km (261 mi), then barrelled back into the atmosphere at a speed of 27,037 km/h (16,800 mph).
- The vehicle was designed to use an advanced infrared camera and more than 300 other sensors to assess how its thermal protection, guidance and other key systems perform during re-entry.
- IXV is an important step towards mastering autonomous, controlled re-entry technology, essential for developing a wide range of space transportation applications, including space planes, reusable launcher stages, planetary probes and sample return, cargo and crew transport vehicles.
- Mastery of re-entry technology could also be useful in innovative future missions for Earth observation, microgravity experimentation, high-altitude atmospheric research and servicing and disposing of future-generation satellites.
- IXV precedes an envisioned space plane project called PRIDE (Program for Reusable In-orbit Demonstrator for Europe) which will be similar to, but smaller and cheaper than, the U.S.'s X-37B operated by the United States Air Force.
- IXV was originally supposed to launch in November, but the mission was postponed to perform further safety analyses of the flight path, which was a novel one for the rocket. ##

ORBITAL SPACE DEBRIS PROBLEM

U.S. Air Force turns a keen eye on Space Junk

JAN. 9, 2015 - **www.sciencemag.org/content/347/6218/115.full**

[unabridged introduction]

- An estimated 500,000 pieces of space junk—old satellites, rocket parts, debris from collisions - swarm in orbit around Earth. Much of it is potentially deadly:
- Anything larger than 1 centimeter in diameter poses a threat to the International Space Station.
- But current tracking systems can generally only watch objects 10 cm or larger, and the U.S. government currently follows less than 5% of space hazards—just 23,000 objects.
- That should change with the addition of a powerful new Air Force radar system, scheduled to break ground this month on Kwajalein Atoll in the Marshall Islands. When it comes online in 2019, the flood of information passed along to nonmilitary spacecraft operators will bring reassurance—but also some wrenching choices about which hazards to ignore. ##

Dealing with Space Junk: The Rocky Road Ahead

Jan. 16, 2015 - www.space.com/28288-**space-junk-problem-conference**.html

www.space.com/9818-**expanding-danger-space-debris-fragmentation**.html (**Video**)

Earth is encircled by an orbiting junkyard.

- After 50 years of space exploration and utilization, more than 22,000 pieces of space junk at least 10 cm (4 inc) wide are now being tracked in Earth's orbit.
- Hundreds of thousands to millions of fast-moving bits of space flotsam are too small to be spotted with current tracking capabilities but arecapable of crippling or taking out a spacecraft.
- In October, the International Space Station had to be maneuvered via Europe's Automated Transfer Vehicle (ATV) to avoid a hand-size piece of Russia's Cosmos2251 satellite which had broken up after colliding with another satellite in 2009.
- Any cleanup program will take decades to carry out. Space junk is an international concern and will be the topic of many high-level discussions in 2015 and beyond.

Domino effect

- The U. of Maryland's Center for Orbital Debris Education and Research (CODER) held an Orbital Debris Workshop over three days this past November to discuss.a number of space-junk issues, including intersections with space policy and national security, as well as treaty and legal concerns.
- Also detailed were entrepreneurial opportunities, as well as debris tracking, modeling and simulation technologies.
- In the 1970s, Donald Kessler, NASA's first senior scientist for orbital debris, proposed that space-junk collisions could have a dramatic cascading effect, eventually generating so much debris that the flotsam could threaten space exploration and satellite operations.
- This troubling snowball effect is now known as the "Kessler syndrome."

Sustainable space environment

- Legal issues and outdated policy could discourage the financial incentives necessary to solve the technical issues and make them operational.
- There is a critical need for government, commercial and legal communities to work together "to develop a realistic long-term space management policy that leads to a sustainable space environment."

Technological fixes

- While there is a policy problem to be solved, there seems to be no serious effort underway — not even modest rules of the road — that will solve this problem.
- Engineers are focused on technological fixes: some of their proposed solutions might actually work, but they also raise more policy issues which no one seems to know how to fix.

Lasers in the jungle

- The use of lasers to de-clutter space was championed by some during the meeting. But the use of such a potential "weapon" raises alarms.
- Orbital debris is a 21st century problem of the community of nations, and it will have to be solved in an international setting.
- The increasing number of tiny Cubesats could create large additional debris fields.

Technical problem

- Dennis Wingo, CEO of Skycorp Inc., said "The principal problem with low-Earth orbit orbital debris is that the Russians own most of it and will allow nothing to be done, until a disaster happens and everyone is forced into it."
- His view is that there's a fundamental technical problem: the amount of energy that it takes to move from one piece of debris to the next. "Electrodynamic tethers are the only realistic means of dealing with the problem," using Earth's magnetic-field forces to hasten the orbital decay of a satellite.

Making a business case

- Experts at the CODER meeting also focused on ways to make taking out space junk profitable. But "due to energies required to move from orbit to orbit, it is almost impossible to make a business case for commercial LEO orbital debris removal," Wingo said.

The situation at the higher-up geosynchronous orbit (GEO)

- Here, where many communications and weather satellites lie, is a different story. Most debris in GEO is co-orbital — two or more objects share, or almost share, an orbit.
- In GEO, we cannot wait until a disaster, due to the enormous financial consequences involved in a single collision. Yet neither the operators nor the insurance underwriters seem to have any sense of urgency on the matter," says Wingo.

The first step is to admit we have a problem.

- The people at the workshop at least recognize the problem. Many others may not. ##

LOW EARTH ORBIT

Introducing “FireFly” Micro Satellite Systems

/www.**fireflyspace**.com – Firefly Alpha – http://www.fireflyspace.com/vehicles/firefly-a

- Firefly Alpha is a revolution in light satellite launch design, the first vehicle in a scalable family of launchers specifically designed for the needs of the light satellite (less than 1,000kg) community.
- Featuring an aerospike engine and the lowest launch cost in its class, this all-composite launch vehicle is set to completely transform the entire industry.

Left.Right: aerospike engine; propulsion nozzles, combuster, launch vehicle

- When we first set out to design Firefly Alpha, we did so with one goal in mind: create the lowest cost vehicle with the highest performance possible.
- In order to achieve that, we designed a vehicle that is both innovative and simple. The results speak for themselves. ##

SPACE STATION NEWS

NASA Gearing Up to Reassemble the Space Station

http://news.discovery.com/space/private-spaceflight/**nasa-is-gearing-up-to-reassemble-the-space-station**-150218.htm

FEB. 19, 2015 – NASA will reconfigure the docking ports for Boeing’s CST-100 and SpaceX’s Dragon capsules, that will be delivering cargo and crew to the orbiting outpost.

- NASA began work to reassemble parts of ISS to create parking spots for two commercial space taxis.
- The reconfigurationis expected to be finished before the end of the year
- This is the first major overhaul of the station, since its completion in 2011, after which NASA retired its space shuttle fleet and turned to Russia for crew ferry flights
- NASA, which hopes to end its reliance on Russia before the end of 2017, as Space-X and Boeing crew capsules begin serving the station.
- Reconfiguring ISS will open docking ports for Boeing’s CST-100 and SpaceX’s Dragon capsules.
- One berthing slip will be at the front end of the Harmony connecting node, where the space shuttles used to dock.
- The other will be on Harmony’s zenith, or up-facing, port.
- The visiting ships also will need docking targets, communications systems and other gear, all of which will be installed during seven spacewalks planned for this year.
- Two new International Docking Adapters, fto which the space taxis will attacht, are due to arrive aboard SpaceX Dragon cargo flights later this year
- Several pieces of the station need to be rearranged before then.
- The biggest change will be the relocation of the Leonardo multipurpose module from the Unity to the Tranquility connection nodes
- This operation that will be tackled robotically via ground control,.

- NASA plans to fly four astronauts at a time on the new vehicles, one more than the number currently flown on Russia's Soyuz.
- That will allow the **station's crew to expand from six to seven**.
- SpaceX' upgraded Dragon V2 passenger ship should be ready for an unmanned debut test flight to the station in late 2016 and a crewed test flight in early 2017.
- Boeing's plan is to make an unmanned CST-100 test flight to the station in April 2017, followed by a crewed flight in July 2017. ##

Spectacular Time-Lapse Video Shows Earth Through Astronaut's Eyes

JAN. 11, 2015 – www.space.com/28176-**amazing-earth-from-space-astronaut-video.**html

Watch auroras glitter, clouds ebb and flow, and lightning flash over the Earth's surface in an incredible time-lapse video of the planet taken from aboard the International Space Station.

European Astronaut Alexander Gersttook over 12,000 photographss during his six-month stay on the space station, and the photos were stitched together into the spectacular video of Earth from space. The 6-minute video captures brilliant sunrises, sparkling cities at night and the thin strip of at-mosphere that coats the Earth in a protective layer that blocks dangerous solar radiation from reaching the surface.

Several artistic effects were used in putting the time-lapse video together. The result includes dancing auroras and stunning light trails created by superimposing images and tweaking the fade-in and fade-out timing.

Gerst set up cameras that automatically snapped photos of the Earth at regular time intervals. These sequences were used to create the unique perspective of time-lapses of stars, oceans, weather, and surrounding spacecraft, all from the perspective of the space station's windows.

The video also reveals some of the intricacies of the space station. Two satellites are also launched during the time-lapse video.

The time-lapses are part of Gerst's "Blue Dot" mission, after Carl Sagan's famous description of Earth as a "pale blue dot" as seen from space. inspired by a picture captured by NASA's Voyager space-craft when it was over 6 billion km (3.7 billion mi) away from Earth.

Gerst's Blue Dot mission also included several biology and human physiology experiments; the astronaut is still wrapping up some of the experiments. ##

SpaceX Dragon Capsule Delivers Fresh Supplies to Space Station

JAN. 12, 2015 – www.space.com/28229-**spacex-dragon-capsule-arrives-space-station**.html

SpaceX's robotic Dragon resupply spacecraft arrived at the International Space Station after a two-day orbital chase. Astronaut Barry "Butch" Wilmore, commander of the station's current Expedition 42, grappled Dragon using the orbiting outpost's huge robotic arm. The capsule was then installed on the Earth-facing port of the station's Harmony module three hours later.

Top: Dragon Capsule and Cargo Module docked at the Station

- The astronauts offloaded 2,360 kg (5,200 lbs) of food, spare parts and scientific experiments
- This was the 5th of 12 unmanned cargo flights SpaceX will fly to ISS in a $1.6 billion deal with NASA.

- Dragon was grappled by the station's huge robotic arm and installed on the Earth-facing port of the station's Harmony module
- The 2,360 kgs (5,200 lbs) of food, spare parts and scientific experiments were unloaded.
- This was the fifth of 12 unmanned cargo flights SpaceX plans to fly to the space station under a $1.6 billion deal with NASA. ##

NASA, Boeing, SpaceX Discuss Plan for Launching American Astronauts from U.S. in 2017

http://www.nasa.gov/press/2015/january/**nasa-boeing-spacex-discuss-plan-for-launching-american-astronauts-from-us-in-2017**

JAN. 26, 2015 – NASA, Boeing and SpaceX held a news briefing on NASA Television at the agency's Johnson Space Center in Houston at noon Monday, Jan. 26, to highlight key development activities, test plans and objectives for achieving certification of two American crew transportation systems.

Under Commercial Crew Transportation Capability (CCtCap) contracts for NASA's Launch America initiative, Boeing and SpaceX will develop safe reliable crew transportation to and from ISS on American spacecraft launched from the U.S., returning American industry to the front of human exploration technology and operations and ends NASA's sole reliance on Russia for crew transportation to ISS.

The panelists were:

- NASA Administrator Charles Bolden
- Johnson Space Center Director Ellen Ochoa
- Commercial Crew Program Manager Kathy Lueders
- Vice President and General Manager of Boeing Space Exploration John Elbon
- President and Chief Operating Officer of SpaceX Gwynne Shotwell
- NASA astronaut Mike Fincke

Mock Mars Mission Crew Tests 'Smart Shirt' for Astronauts

MAR. 27, 2015 – www.space.com/28945-**mock-mars-mission-hexoskin-shirt.**html

An astronaut "smart shirt" — one that could someday **beam biometric information back to ground controllers to keep an eye on a spacefarer's health** — is now on a space mission of sorts.

The crew now conducting a mock Mars mission at the Hawaii Space Exploration Analog and Simulation (HI-SEAS) facility uses **Hexoskin** frequently to look at how well crewmembers are coping in the harsh, high-altitude environment.

HI-SEAS Mission III crewmembers posing after a workout in Hexoskin biometric shirts.

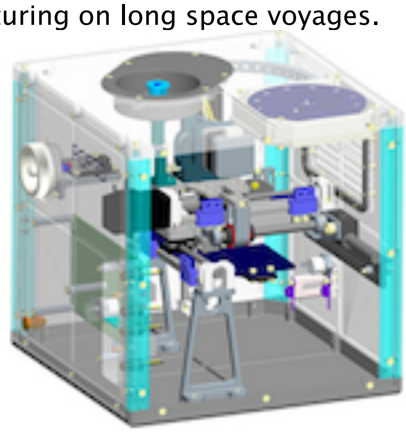
- Crewmembers have used Hexoskin to track performance in EVAs [extravehicular activities] while exploring the geology of the surrounding volcanic terrain (on Hawaii Island)
- During EVAs and workouts, crewmembers monitor heart and respiratory rates_on their Hexoskin applications and applaud each other for reaching new maximum levelsl.

- Living in the confinement of the HI-SEAS dome, the crew improves their physical health with workouts ranging from yoga to plyometrics to resistance-band strength training to kickboxing to cardio work-outs on the treadmill and stationary bike.
- Most of the crew feels that they are in better physical health now compared to before the mission."
- Hexoskin is the commercial version of a prototype shirt called **Astroskin**, which was tested last year during a 45-day mission in Antarctica. The Canadian Space Agency (CSA) hopes to fly a version of this shirt in space, although a flight date has not been set.
- The data for Hexoskin can be downloaded to various types of software.
- NASA wants people to conduct research in a real-life context instead of doing health research in a clinical environment, a controlled environment, such as making people run on treadmills. "We want to know what happens to people when they climb mountains, what happens to people when they take walks around the city, when they stay at home, when they sleep at home."
- Besides its possible space applications, the technology has been touted as a tool to help monitor the health of residents in remote communities.
- Hexoskin and the Canadiaan Space Agebcy are also looking at how the health of seniors relates to the health of astronauts, as many effects of aging are observed in orbit: bone loss, muscle weakness and blood-flow changes, to name a few. Path to Mars
- HI-SEAS will be a help to Hexoskin generally because "there have been very few missions that lasted that long to simulate extraterrestrial environments."
- Crewmembers began their eight-month mission in mid-October 2014; scheduled to end in June. ##

Europe's 1st Zero-Gravity 3D Printer Headed for Space

www.space.com/28418-**european-3d-printer-in-space**.html

JAN. 30, 2015 - Europe is set to send its first 3D printer to the Space Station by the end of June to experiment with zero-gravity manufacturing on long space voyages.



- The European Space Agency plans to deliver its new Portable On-Board 3D Printer
- “POP3D” will be the second 3D printer aboard ISS.
- A cube just under 25 cm (10 in) per side, it requires small amount of power and crew time to operate.
- The machine uses a heat-based printing method and a harmless, biodegradable plastic.
- Made In Space's 3D-printed objects, as well as anything POP3D produces, will eventually be returned to Earth and compared with identical items made with 3D printers on the ground to help scientists determine whether 3D printed objects made in space work as well as they do on Earth. ##

Next Generation of ESA Space Station Experiments

www.esa.int/Our_Activities/Human_Spaceflight/Research/**The_next_generation_of_Space_Station_experiments**

MAR. 20, 2015 - From how astronauts perceive time to whether parts of their brains shrink in space, the next round of experiments to be performed on the International Space Station has been chosen from more than 200 proposals.

- ESA received more applications than all other Space Station partners combined, showing a high level of European interest in space research.
- Following a February 2014 call for proposals, an independent peer-review process in coordination with NASA looked at each experiment in terms of scientific significance, feasibility and whether the Station is essential to test the hypotheses.
- The proposals were then assessed for practical and financial restraints such as the time and equip-ment needed to run the experiment.
- Thirty-one projects have been selected for further study.

Changing Astrtonauts

- Some experiments will continue research that warrants more investigation, such as monitoring lung health will continue after crew changes.
- The next step, after a chrew change, will add helium to the mix to help understand why astronauts in space breathe out more nitric oxide than normal.
- Another experiment will look at astronauts' hippocampi, a part of the brain that processes informa-tion for navigation and storing memories. Will the hippocampus shrink in space and want to run brain scans before and after flight?
- The same region in our brain is the first to suffer damage in Alzheimer patients, so the research will be of interest for understanding this disease.
- A more subjective experiment will look at how astronauts perceive time. Using existing hardware, in-cluding a head-mounted display and headphones, astronauts will be regularly asked to estimate time and will chart any changes during their time in weightlessness.

Biology, Processing Human Waste, Immune systems

- In biology, experiments will support research for ESA's Melissa project on creating a self-sustained ecosystem to provide food and oxygen to astronauts from waste.
- ESA will continue its pioneering research into exobiology by putting micro-organisms and chemicals on CubeSats attached to the Station's exterior before returning to Earth, to test theories of how life could have developed and spread through the Galaxy and even how they might evolve to adapt to the harsh vacuum of space.
- Many experiments will look at how cells cope on a molecular level with the stress of weightlessness and space radiation. ##

Russia Will Spin-Off ISS Parts for New Space Station, starting 2024

MAR. 2, 2015 – www.space.com/28687-**russia-space-station-parts-plan**.html

- Roscosmos will support U.S. plans to keep the outpost operating through 2024
- Russia will then split off 3 still-to-be launched modules to form a new, independent orbital outpost.
- The announcement reverses previous Russian statements that it would end involvement in the 15-nation program in 2020 when current agreements expire.
- The new Russian commitment puts pressure on station partners Europe, Japan and Canada, to fund a four-year extension as well.

One-Year Crew Begins Epic Trip on International Space Station

MAR. 28, 2015 – www.space.com/28960-**one-year-space-station-trip-begins**.html

A Soyuz spacecraft launched from Kazakhstan's Baikonur Cosmodrome in central Asia March 27th.

- Three new crewmembers just arrived at the International Space Station, and two of them won't be leaving for about one year.
- NASA astronaut Scott Kelly and cosmonaut Mikhail Kornienko are expected to spend about 342 days living and working on the International Space Station — marking the orbiting outpost's first yearlong-space mission.
- Cosmonaut Gennady Padalka also made the trip with Kornienko and Kelly on the Soyuz spacecraft.

- Padalka will stay on the space station for about six months, the usual amount of time people live on the space laboratory.

NASA astronaut **Mark Kelly** and Russian cosmonaut **Mikhail Kornienko** are taking the ultimate space trip: one year in space on the International Space Station.

- For Kelly and Kornienko, the arrival at the space station marks the beginning of an unprecedented endurance space mission by NASA and Roiscosmos.
- During a live videoconnection with Russia's mission control center near Moscow, the two men said they were excited now that their journey was underway.
- They join NASA's Terry Virts, European Space Agency astronaut Samantha Cristoforetti, and Russia's Anton Shkaplerov already living onboard the station.
- NASA officials hope that the one-year space station mission will help scientists gather **data about what long-duration spaceflight does to the human body.**
- While some Soviet-era cosmonauts lived onboard the space station Mir for a year or more in the 1980s and 1990s, researchers don't have a lot of data about how people are affected by long stints in microgravity.
- Kelly and Kornienko's spaceflight will hopefully change that.
- This kind of research is important if we hope to one-day launch crewed missions to Mars on a mission that will last at least 500 days.
- So more research into the potential safety and health hazards of a long-duration spaceflight is necessary before a Mars mission can launch.
- Kelly's twin brother and former astronaut Mark Kelly will also participate in experiments on Earth to help researchers studying his brother in space.
- The identical twins will be monitored in a variety of ways throughout the mission and after Scott comes home to help scientists understand how the long-term mission might alter Scott by comparison to his brother.
- It is the availability of identicl twin astronauts that makes this mission especially valuable.
- This mission will advance our understanding of what happens when people leave the planet for a long time and help pave the way for sending people beyond low-earth orbit.
- This mission is another step toward sending humns further out in the universe. ##

Editor: This experiment may indicate whether or not we need **artificial gravity** on long duration flights.

MISSION TO PLANET EARTH

NASA Has Big Plans for Tiny CubeSats

DEC. 30, 2014 – www.space.com/28124-**nasa-cubesats-icecube-exploration.**html

Tiny CubeSats promise big savings in development and launch costs

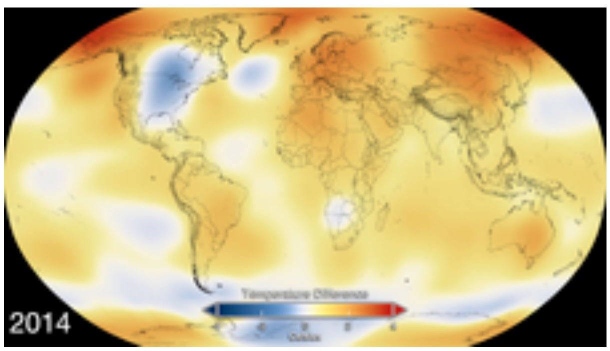
- Cubesats can deliver sizable scientific returns with less investment of time and money.
- NASA to one of these tiny probes, the "IceCube," in 2016 to test a radiometer for a big space mission
- Climate scientists have never used this frequency to measure cloud ice from space before.

- A CubeSat, 'Dellingr' to be launched March 2015, will have a magnetometer to help us understand how Earth's magnetic field fluctuates, and the effect of solar flares and other space weather on Earth.
- CubeSats aren't the answer for every mission,. While mobile phone technology has shrunk the power requirements for these tiny satellites, they don't have the juice to run more powerful instruments.
- As small and relatively "cheap" spacecraft can be launched in bunches, multiple copies of an instrument can be tested at a low cost, so scientists can collect data from several satellites not just one. ##

2014 Was Earth's Hottest Year On Record, NASA Says

JAN. 16, 2015 – www.space.com/28297-**2014-earths-hottest-year**.html
www.space.com/28293-**2014-was-warmest-year-ever-recorded-video**.html
www.nasa.gov/press/2015/january/**nasa-determines-2014-warmest-year-in-modern-record/**
www.space.com/28264-**arctic-sea-ice-has-declined-steeply-since-1979-video**.html

- The year 2014 ranks as Earth's warmest since 1880, according to two separate analyses by NASA and National Oceanic and Atmospheric Administration (NOAA) scientists.
- The 10 warmest years in the instrumental record, with the exception of 1998, have now occurred since 2000. This trend continues a long-term warming of the planet, according to an analysis of surface temperature measurements by scientists at NASA's Goddard Institute of Space Studies (GISS) in New York.
- In an independent analysis of the raw data, also released Friday, NOAA scientists also found 2014 to be the warmest on record.



This color-coded map displays global temperature anomaly data from 2014.
Image Credit: NASA's Goddard Space Flight Center
Additional related visuals: http://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=4255

"The observed long-term warming trend and the ranking of 2014 as the warmest year on record reinforces the importance for NASA to study Earth as a complete system, and particularly to understand the role and impacts of human activity."

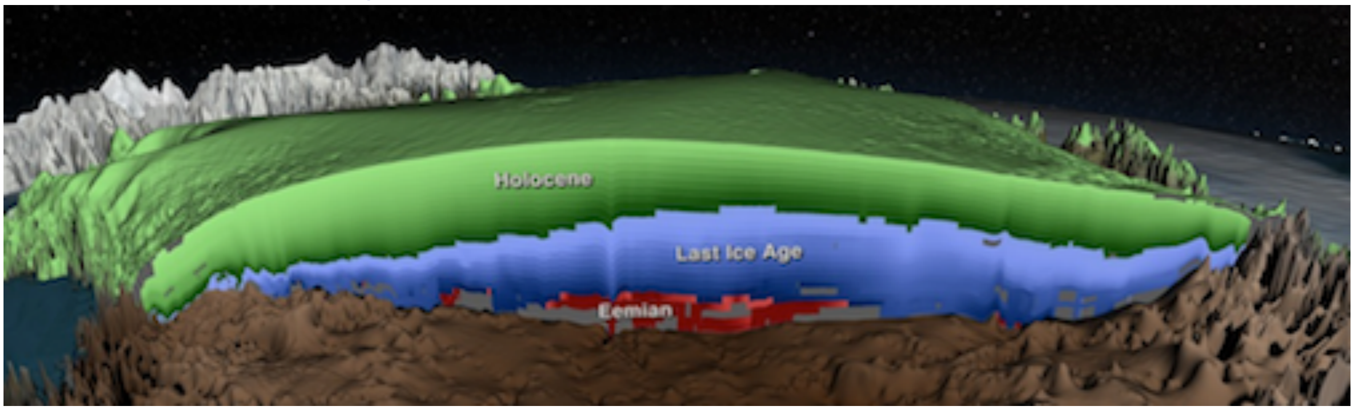
- Since 1880, Earth's average surface temperature has warmed by about 0.8 °C (1.4 °F) , a trend largely driven by the increase in carbon dioxide and other human emissions into the planet's atmosphere.
- The majority of that warming has occurred in the past three decades.
- While the ranking of individual years can be affected by chaotic weather patterns, the long-term trends are attributable to drivers of climate change that right now are dominated by human emissions of greenhouse gases.
- Scientists still expect to see year-to-year fluctuations in average global temperature caused by phenomena such as El Niño or La Niña, that warm or cool the tropical Pacific and are thought to have played a role in the flattening of the long-term warming trend over the past 15 years.
- However, 2014's record warmth occurred during an El Niño-neutral year.
- Regional differences in temperature are more strongly affected by weather dynamics than the global mean. Parts of the U.S. Midwest and East Coast were unusually cool, while Alaska and three western states – California, Arizona and Nevada – experienced their warmest year on record.
- The GISS analysis incorporates surface temperature measurements from 6,300 weather stations, ship- and buoy-based observations of sea surface temperatures, and temperature measurements from Antarctic research stations.

- This raw data is analyzed using an algorithm that takes into account the varied spacing of temperature stations around the globe and urban heating effects that could skew the calculation.
- The result estimates the global average temperature difference from a baseline period of 1951-1980.
- NOAA scientists used much of the same raw temperature data, but a different baseline period. They also employ their own methods to estimate global temperatures.
- NASA monitors Earth's vital signs from land, air and space with a fleet of satellites, as well as 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.

Related story: www.space.com/28264-arctic-sea-ice-has-declined-steeply-since-1979-video.html

Greenland Ice In 3D Reveals 3 Distinct Climate Periods | Video

www.space.com/28361-**greenland-ice-in-3d-reveals-3-distinct-climate-periods-video**.html



Three periods: Holocene, Last Ice Age, Eemian

NASA Launches Groundbreaking Soil Moisture Mapping Satellite

www.nasa.gov/press/2015/january/**nasa-launches-groundbreaking-soil-moisture-mapping-satellite/**

www.space.com/28399-nasa-launches-earth-dirt-satellite.html

www.space.com/28427-**blast-off-nasa-soil-tracking-mission-launches-from-california-video**.html

JAN. 31, 2015 - NASA successfully launched its first Earth satellite designed to collect global observations of the vital soil moisture hidden just beneath our feet.

- The Soil Moisture Active Passive (SMAP) observatory, lifted off Saturday from Vandenberg Air Force Base, California, on a United Launch Alliance Delta II rocket.
- It will monitor Earth's soil moisture for 3 years.

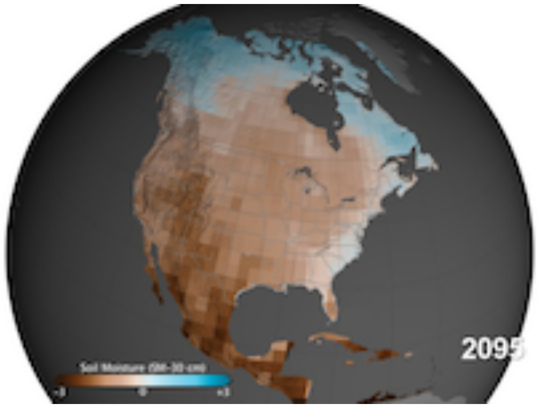
Carbon Emissions Could Dramatically Increase Risk of U.S. Megadroughts

FEB. 12, 2015 RELEASE 15-020: NASA Study

www.nasa.gov/press/2015/february/**nasa-study-finds-carbon-emissions-could-dramatically-increase-risk-of-us/** with **Videos**

- Droughts in the U.S. Southwest and Central Plains during the last half of this century could be **drier and longer** than drought conditions seen in those regions i**n the last 1,000 years**y.
- The study is based on projections from several climate models, including one sponsored by NASA.
- The research found continued increases in human-produced greenhouse gas emissions drives up the risk of severe droughts in these regions.

- Natural droughts like the 1930s Dust Bowl and the current drought in the Southwest have historically lasted maybe a decade or a little less.



2095

NASA monitors Earth's vital signs from land, air and space with a fleet of satellites and ambitious 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. The agency shares this unique knowledge with the global community and works with institutions in the United States and around the world that contribute to understanding and protecting our home planet.

- We are going to get a drought similar to those events, **but "it is probably going to last at least 30 to 35 years."**
- If greenhouse gas emissions stop increasing in the mid-21st century, Cook and his colleagues project the likelihood of megadrought to reach more than **60 percent**.
- If greenhouse gas emissions continue to increase along current trajectories throughout the 21st century, there is an **80 percent** likelihood of a **decades-long megadrought in the Southwest and Central Plains between the years 2050 and 2099.**
- The scientists analyzed a drought severity index and two soil moisture data sets from 17 climate models that were run for both emissions scenarios.

Increasing concentration of Carbon Dioxide from 400 ppm to 630 ppm, even 1,370 ppm

- In the Southwest, climate change would likely cause reduced rainfall and increased temperatures that will evaporate more water from the soil.
- In the Central Plains, drying would largely be caused by the same temperature-driven increase in evaporation.
- Much of the previous research analyzed of only one drought indicator and results from fewer climate models,
- This study also is the first to compare future drought projections directly to drought records from the last 1,000 years.
- Modern measurements of drought indicators go back about 150 years.
- Tree species like oak and bristle cone pines grow more in wet years, leaving wider rings, and vice versa for drought years. By comparing the modern drought measurements to tree rings in the 20th century for a baseline, the tree rings can be used to establish moisture conditions over the past 1,000 years.
- Some medieval megadroughts in North America between 1100 and 1300 lasted 30 to 50 years.
- When these past megadroughts are compared side-by-side with computer model projections of the 21st century, the risk of droughts lasting 30 years or longer increases significantly.
- Connecting the past, present and future in this way shows that 21st century droughts in the region are likely to be even worse than those seen in medieval times, according to Anchukaitis.
- These findings require us to think about how we would adapt if even more severe droughts lasting over a decade were to occur in our future. ##

New NASA Earth Science Missions Expand View of Our Home Planet

www.nasa.gov/press/2015/february/**new-nasa-earth-science-missions-expand-view-of-our-home-planet/**

FEB. 26, 2015 - Four new NASA Earth-observing missions are collecting data from space - with a fifth newly in orbit - after the busiest year of NASA Earth science launches in more than a decade.

NASA now has 20 Earth-observing space missions in operation.

- A year ago, on Feb. 27, 2014, **NASA** and the **Japan Aerospace Exploration Agency** (**JAXA**) launched the **Global Precipitation Measurement (GPM) Core Observatory** into space from Japan.
- Data from GPM and 3 other new missions are making observations and providing scientists with new **insights into global rain and snowfall, atmospheric carbon dioxide, ocean winds, clouds, and tiny airborne particles called aerosols.**
- Combined with data from our other Earth-observing spacecraft, these new missions will give us new insights into how Earth works as a system.
- Including two instruments mounted on the exterior of the Space Station, all this data will be freely available to the international scientific community.
- Last month, NASA released the agency's most comprehensive global rain and snowfall product to date from the GPM mission made with data from a network of 12 international satellites and the Core Observatory which acts as a tuner to bring together measurements of other satellites, providing a nearly global picture of rain and snow called the Integrated Multi-satellite Retrievals for GPM, or IMERG.
- The first global visualization of the initial IMERG data , released February 26th, gives us an unprecedented view of global precipitation every 30 minutes.
- The Orbiting Carbon Observatory-2, launched July 2, 2014, is providing preliminary global maps of carbon dioxide concentrations and a related solar-induced chlorophyll fluorescence.
- OCO-2 data will let us better understand how carbon dioxide is distributed around the globe and changes with the seasons.
- The data will be used to identify the sources and storage places, or sinks, of carbon dioxide, the most significant human-produced greenhouse gas driving global climate change.
- A preliminary global map based on observations from November and December 2014 shows carbon dioxide concentrations largely driven by the seasons, with higher levels in the northern hemisphere winter and lower in the southern hemisphere summer.
- The data show levels unprecedented in recorded history.
- The ultimate goal is to collect data to advance carbon cycle science, improve understanding of the global climate change process, and make better-informed decisions.
- NASA also deployed two Earth-observing instruments to Space Station: **ISS-RapidScat**, a scatterometer that **measures wind speeds and direction over the ocean**
- The Cloud-Aerosol Transport System (CATS) measures the altitude of clouds and airborne particles.
- The ISS-RapidScat team also uses the wind measurements to better understand how ocean winds differ, on average, during the day and night.
- CATS, launched to ISS on Jan. 10, has released its first data image: a slice of the atmosphere over Africa showing clouds and dust particles on Feb. 11.

Clouds & aerosols remain two big question marks in terms of impact on future climate change.

- NASA's new Soil Moisture Active Passive (SMAP), was launched Jan. 31 to map global soil moisture and detect whether soils are frozen or thawed. ##

Surprise! Quebec Double Crater Formed by 2 Separate Impact Events

MAR. 14, 2015 - www.space.com/28822-**double-crater-two-asteroid-impacts**.html

An asteroid smashing into a planet can dramatically alter the planet's habitability by setting back evolution or even encouraging biodiversity. To understand how cosmic impacts influence life and the environment, scientists study the craters left behind.

- Some of these impact craters come in pairs, most likely caused by binary asteroids, composed of two asteroids torbiting each other.
- The Clearwater lakes in Canada are a double crater, but some geologists, now believe that the craters were formed in two separate events.

√ West Clearwater Lake has a diameter of 36 km (22.5 mi) – The East crater is 10 km (6 mi) smaller

√ There is evidence that the asteroid that formed the East crater impacted a marine environment, which would place the impact during the Ordovician period.

√ The West crater was created in the Permian period and impacted the landmass Pangaea.

√ Maps at center and right shows lakes (in circle) well north of Quebec City and Montreal

Crater Doublets

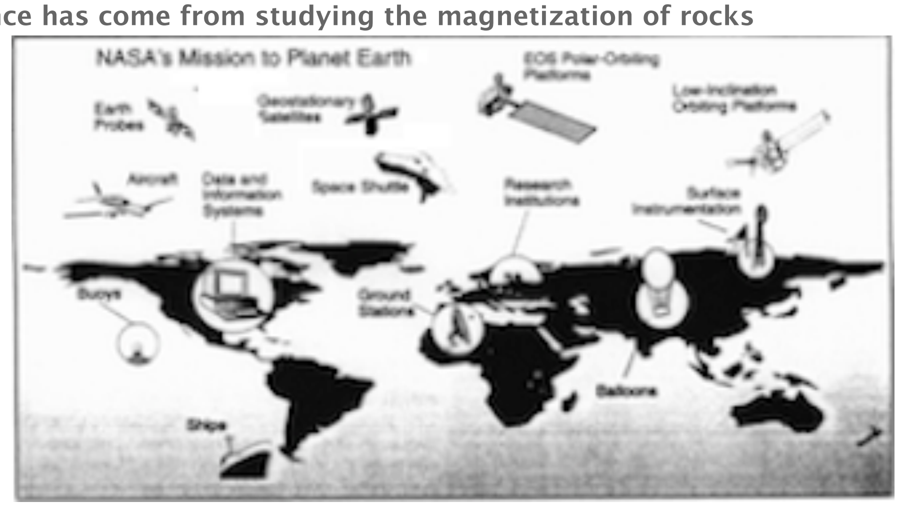
- A number of double impact craters exist on Earth.
- In 1965, researchers proposed that the Clearwater lakes craters were the result of a single incident. During an impact, rocks from the Earth's crust can be uplifted to form a central peak, or ring, within the center of the crater. In the West Lake, this is evident as a ring of islands in the middle of the lake.
- The East Lake also has a central peak, but it is below the waters of the lake and was only revealed when the Geological Survey of Canada drilled into the frozen lake in the 1960s.

Measuring the ages of craters

- Sometimes the layers of rock tell the story as the impact might have occurred at the boundary be-tween two geological time periods.
- Fossils preserved within rocks can also help place constraints on the age.
- The decay of radioactive isotopes in samples of rocks that were created at the time of the impact can reveal the age of a crater.

Two separate impacts – argon and other isotope dating

- The West Clearwater Lake was formed around 286-290 million years ago.
- The East crater 460-470 million years ago
- **Further evidence has come from studying the magnetization of rocks**



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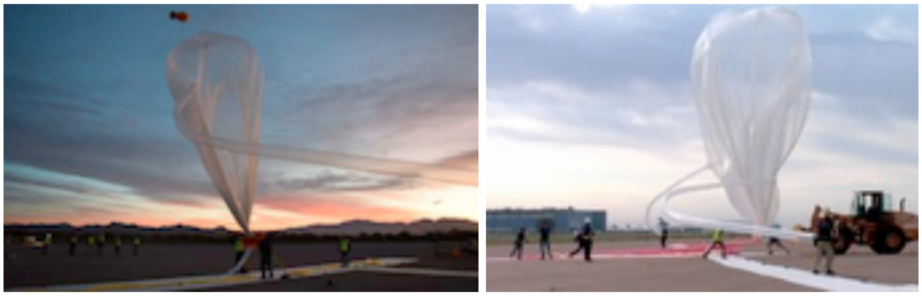
[The articles below have been bullet-summarized by the editor. For the full text, see the links cited.]

SPACECRAFT FOR TOURISTS

World View Makes Record-Setting Parafoil Flight from Edge of Space

FEB. 21, 2015 – www.space.com/28626-**world-view-parafoil-record-flight**.html
http://en.wikipedia.org/wiki/**World_View_Enterprises** – **http://worldviewexperience.com**/
http://worldviewexperience.com/content/uploads/2014/10/StratEx-WV-**Infographic**_FINAL-1024x597.png
www.space.com/28791-**world-view-commercial-space-balloon-flight**.html



World View representatives set up the balloon and parafoil
for the record-setting flight. Image released on Feb. 20, 2015

World View, a private company that aims to send tourists to the edge of space in a balloon, broke a record February 20th, flying a parafoil higher than anyone has before.

- The Arizona-based company sent the parafoil 31,151 meters (31.1 km) (102,200 ft/19.37 mi) into the air during a test flight.
- That is the altitude that officials hope to fly passengers to.
- The achievements further the company's objectives of manned spaceflight and advancing research.
- World View plans to provide flights to the edge of space – **high enough for tourists to see the curvature of the Earth and a black of sky** – for **$75,000 each**

Passenger Capusle  **has large windows**

- The company entered a partnerships with United Parachute Designs and Performance Designs to "design and build an advanced descent system that could retur payloads of increasingly higher masses."
- While the balloon had no people on board, it did include two university science experiments.
- One from Montana State U. to test high-definition video and computer equipment at high altitudes, to prepare for the 2017 United States total solar eclipse.
- Also, the U. North Florida measured ozone gas using an experimental nanocrystalline gas sensor.
- Last year, World View said it plans to launch customers in 2016.
- Competition; XCOR Aerospace is creating the Lynx suborbital rocket plane (which carries one passenger) and Virgin Galactic plans flights using SpaceShipTwo, a six-passenger suborbital spaceliner.
- XCOR plans powered test flights later this year. Virgin Galactic suffered a tragic setback last year when its SpaceShipTwo crashed during a test flight, killing one co-pilot and sending the other to hospital.

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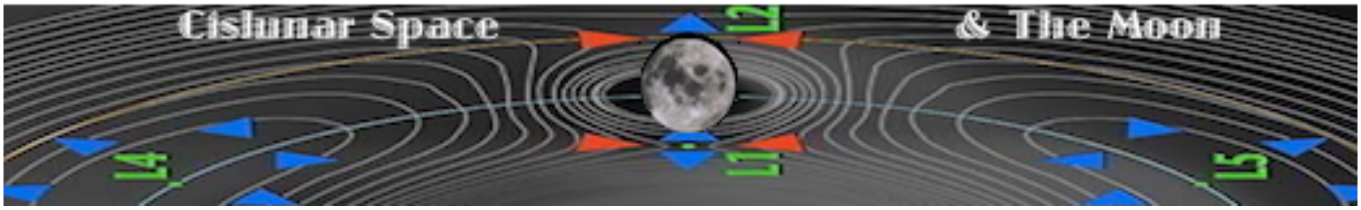


[The articles below have been bullet-summarized by the editor. For the full text, see the links cited.]

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

Extent of Moon's Giant Volcanic Eruption is Revealed

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

MAR. 22, 2015 - Scientists have produced a new map of the Moon's most unusual volcano showing that its explosive eruption spread debris over an area much greater than previously thought.

- A team of astronomers and geologists, led by experts in the Institute for Computational Cosmology and Department of Earth Sciences at Durham University, UK, studied an area of the lunar surface in the Compton-Belkovich Volcanic Complex.
- By mapping the radioactive element **thorium** which spewed out during the eruption they discovered that, with the help of the Moon's low gravity, **debris from the unnamed volcano was able to cover an area** of around 70,000 km2 (c. 27,000 mi2).
- The eruption occurred 3.5 billion years ago.
- The research used data from NASA's Lunar Prospector spacecraft which first spotted the volcanic site in 1999 when it detected **an isolated deposit of thorium** on the Moon's far-side between the Compton and Belkovich impact craters.
- The deposit had been hard to study because it is **hidden beneath debris from meteorite impacts**, but Lunar Prospector detected gamma rays from the thorium that can pass through a metre of rock.
- The Durham-led team used a "pixon" image enhancement technique, originally designed to peer into the distant Universe, to sharpen the map and reveal the enormous size of the thorium deposit from the volcanic eruption.
- Volcanoes were common in the early life of the Moon In fact the dark 'seas' you can observe on the lunar surface were created by runny, iron-rich, lava that flooded impact craters and low-lying ground.
- Eruption of viscous, light-coloured, iron-poor, lava, which creates steep-sided volcanic cones, was rare and observed only at a handful of sites such as this one.
- The explosive eruption of such lava is unknown elsewhere on the Moon, making this volcano unique.
- By mapping the radioactive content of the lava from this volcano we have been able to show that molten, radioactive rock was thrown far beyond the slopes of the volcano, reaching several hundred kilometers/miles in one direction. ##

Moon's Iron Core May Reveal Solar System Secrets with X-Ray Scan

MAR. 26, 2015 - www.space.com/28900-**moon-iron-core-solar-system-secrets**.html

Deep beneath the Moon's surface lies an iron heart that scientists are probing in a new study:

- By using X-rays to scan **the kind of iron** probably found in the Moon's core, we can better estimate the core's size and composition.
- Studying this unique kind of iron, and subjecting to incredible temperatures and pressures similar to those in the heart of a moon or planet, these findings could also help model the interior of small rocky planets such as Mars and Mercury.
- Precise knowledge of the structure and composition of the Moon's core is essential for understanding its origin and evolution, and would shed light on the birth and development of Earth.

An iron heart

- The Moon is the only rocky body other than Earth from which scientists have multiple direct seismic data, details gathered during the Apollo missions.
- Based on this seismic data, previous studies estimated the Moon had a solid inner core of pure iron and a liquid outer core made of an iron-sulfur alloy.
- But much about the structure of the Moon's core remains controversial.
- Until now, most studies of how iron behaves in the cores of rocky bodies have focused on the structure that is probably most stable in the pressures and temperatures found in Earth's inner core.
- This so-called **hexagonal close- packed**, or "**epsilon**," **phase** arranges iron atoms in a lattice whose bottom and top faces are hexagons and whose side faces are rectangles.
- At the moderate pressures in the cores of smaller rocky bodies such as the Moon, Mercury, or Mars, iron usually takes on a different structure.
- This so-called **face-centered cubic**, or "gamma," phase involves iron atoms placed at the corners of lattices shaped like cubes, with atoms also present in the middle of the face of each cube.
- Much is unknown about how this form of iron might behave at high pressures and temperatures.

X-ray vision

- Now, scientists have conducted experiments to measure the velocity of seismic waves traveling within the gamma phase of iron that is likely found in the Moon's core.
- In these experiments, the iron is subject to extreme temperatures and pressures.
- The findings could shape more accurate models of the interiors of small rocky planets and moons.
- Researchers used X-rays to see how sound waves behaved in gamma iron at temperatures of up to about 875 °C (1,610 °F) and pressures up to 19 gigapascals. (I1 gigapascal is more than 9 times greater than the pressure at the bottom ofthe Mariana Trench, the deepest part of Earth's oceans.)
- After re-examining seismic data from the Apollo missions in light of these new findings, the researchers suggest the Moon's solid inner core has a diameter of about 500 km (310 mi) and a liquid outer core about 80 km (50 mi) thick.
- The inner core may be pure gamma iron, while the outer core is composed of iron alloys made up of 3 to 6 %t sulfur by weight.
- The same approach the scientists employed to understand the properties of the Moon's core can be applied to other planets, such as Mars,.
- NASA will send the InSight robotic lander to Mars in 2016 to place a seismic station on the Red Planet.
- The new findings gathered from the Moon will help interpretsuch seismic observations," ##

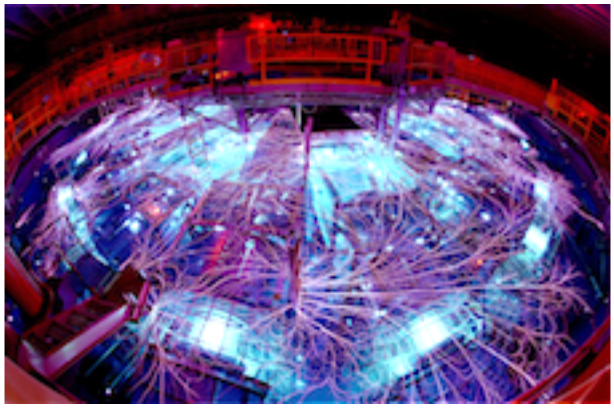
Did 'Iron Rain' Bypass the Moon to Fall Mostly on Earth?

www.space.com/28959-**did-iron-rain-bypass-the-moon-to-fall-mostly-on-earth**.html

MAR. 27, 2015 - New experiments show that the asteroids that slammed into Earth and the Moon more than 4 billion years ago were vaporised into a mist of iron.

- The findings suggest that the iron mist thrown up from the high velocity impacts of these asteroids travelled fast enough to escape the Moon's gravity, but not the gravity of more massive Earth.
- And these results may help explain why the chemistry of the Earth and the Moon differ.
- When and how Earth's metallic core formed is uncertain. Clues come from known differences in the preferences of certain elements incorporated in the silicate mantle or the metal core.
- In a mixture of silicate rock and iron metal, the atoms of certain elements, such as gold and platinum, tend to prefer to enter the metal, while others, such as hafnium, prefer the silicate.
- As Earth's iron-rich core formed it "sucked" metal-loving elements out of the planet's rocky mantle.
- However, measurements of the silicate mantle have previously shown that there are more of them left in the shallower Earth than would be expected.
- This has often been attributed to a late veneer of asteroids that delivered an extra dose of metal-loving elements to the rocky mantle.
- One problem with this picture: the abundance of metal-loving elements on Earth is ten to a hundred times greater than that measured on the Moon, which should by this argument have the same veneer.

- The chemical difference between Earth and the Moon has been perplexing, and casts a shadow over the prevalent idea that the Moon formed from the same stuff as Earth after an impact from a Mars-sized planet early in the history of the Solar System.



The Z machine generates electric currents of up to 20 million amps, to shoot aluminium projectiles at iron targets, replicating the impacts of early asteroids.

Mighty Earth attracts more metal

- The new paper seems to reconcile these differences. The experiment relied on Sandia National Laboratory's "Z-machine": a huge electromagnetic gun – twice as powerful as the world's total generating capacity – that can launch projectiles into iron targets at ultra-high velocity.
- The impact experiments show that iron vaporises under the conditions created when an asteroid crashes into Earth or the Moon.
- A cloud of iron mist will have wrapped around the globe after any such collision, falling as metal rain.
- These well-mixed droplets will have become incorporated into the mantle, delivering the excess metal-loving chemicals.
- The same experiments indicate that the velocity of the iron rain droplets will have been greater than the escape velocity on the Moon, but below that of Earth.
- Earth would thus have captured the metal cores of colliding asteroids, while the Moon failed to.
- The results could imply that models for estimating the time scales of Earth's core formation could be out by as much as a factor of ten, with the core forming much earlier than previously recognised.

Moon's History Is Surprisingly Complex, Chinese Yutu Rover Finds

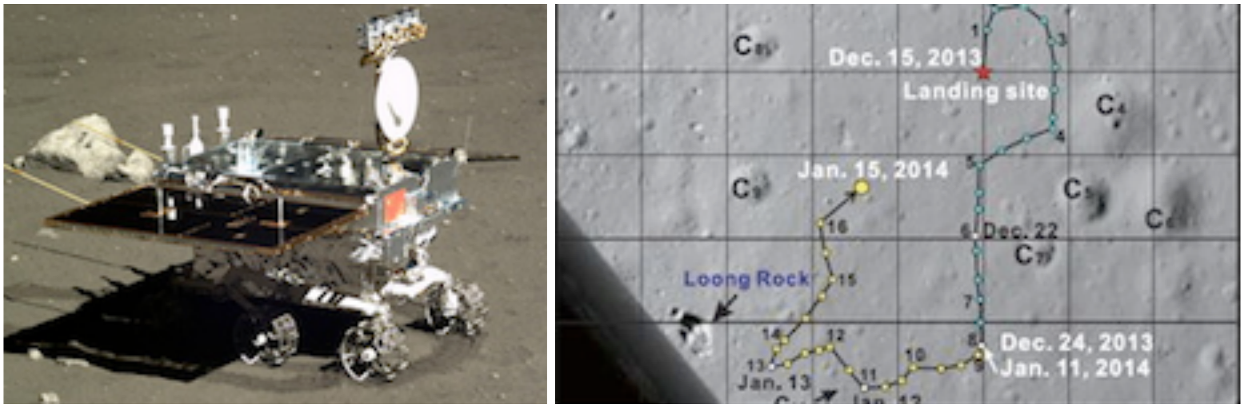
MAR. 12, 2015 - www.space.com/28810-**moon-history-chinese-lunar-rover**.html

www.asianscientist.com/2015/03/topnews/**chinas-yutu-exposes-layers-moon**/

The Moon's past was livelier and more complex than scientists had thought, new results from China's first lunar rover suggest. Yutu found evidence of at least **nine distinct rock layers deep beneath its wheels**, indicating that the area has been surprisingly geologically active over the past 3.3 billion years.

1. **More volcanic events** have been defined in the late volcanism history of the Moon
2. The **Moon's past was livelier and more complex** than scientists had thought

- Yutu found that the volcanic mare plain is not only composed of basaltic lavas, but also of explosive eruption-formed pyroclastic rocks, that may shed light on the volatile contents in the lunar mantle.
- The rover had cameras and three main scientific instruments — the Lunar Penetrating Radar (LPR) which can probe about 400 m (1,300 ft) beneath the Moon's surface, the Visible Near-Infrared Spectrometer (VNIS) and the Active Particle-Induced X-ray Spectrometer (APXS).
- These data paint a detailed portrait of the Chang'e 3 landing site, which sits just 50 m (165 ft) away from a 450 m (1,475-ft)-wide crater known as C1, which was gouged out by a cosmic impact that occurred sometime between 80 and 27 million years ago.
- Overall, the rover's observations suggest that the composition of its landing site is quite different from that of the places visited by NASA's Apollo missions and by the Soviet Union's Luna program.
- We can expect to hear soon about more discoveries from imagery & radar data from NIS & APXS. ##



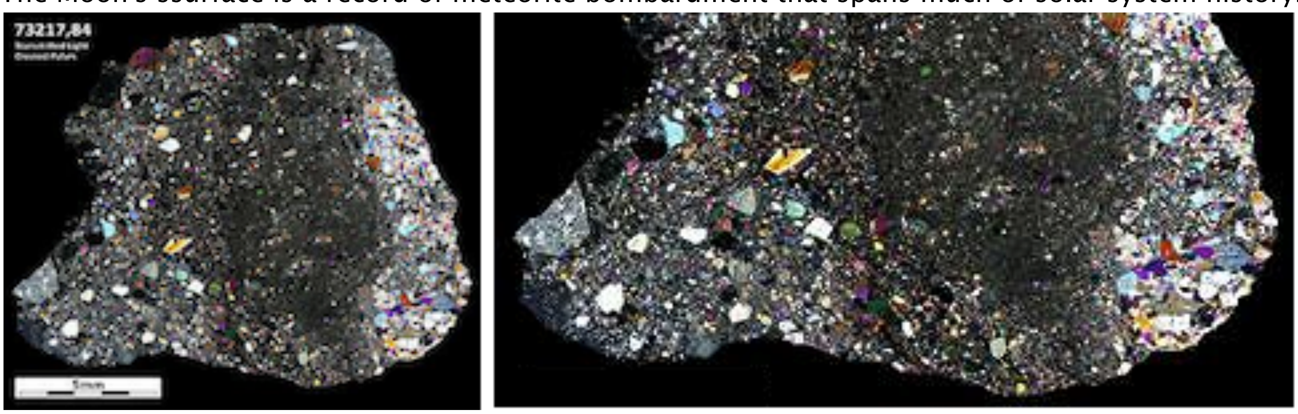
Yutu moon rover and its zig zag route, traveling 114 m (374 ft) before losing its mobility/

Laser microprobe of Apollo samples refines Lunar Impact History

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

FEB. 15, 2015 - It's been more than 40 years since astronauts returned the last Apollo samples from the moon, and since then those samples have undergone very extensive and comprehensive analysis.

- An Arizona State University (ASU) team has now refined the timeline of meteorite impacts on the moon through a pioneering application of laser microprobe technology to Apollo 17 samples.
- Impact cratering is the most ubiquitous geologic process affecting the solid surfaces of planetary bodies in the solar system.
- The Moon's ssurface is a record of meteorite bombardment that spans much of solar system history.



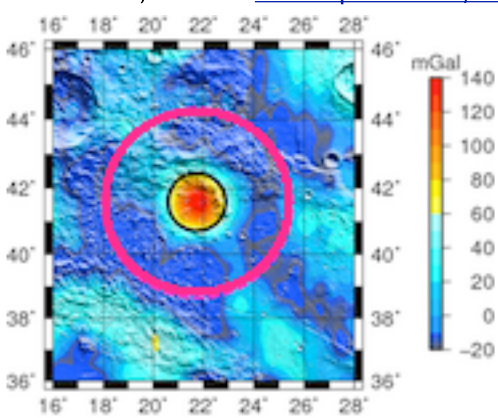
A photomicrograph of a petrographic thin section of a piece of a coherent, crystalline impact melt breccia collected from landslide material at the base of the South Massif, Apollo 17 (sample 73217, 84). Different mineral and lithic clasts, as well as impact melt phases are evident. Determining the ages of different melt components in such a complex rock requires carefully focused analyses within context of spatial and petrographic information such as this.

- Developing an absolute chronology of lunar impact events is of particular interest as the Moon's and Earth's ahared bombardment history, the latter largely erased by plate tectonics and erosion.
- The lunar impact record infers the ages of other cratered surfaces in the inner solar system.
- Researchers used an ultraviolet laser microprobe attached to a high-sensitivity mass spectrometer to analyze argon isotopes in samples returned by Apollo 17.
- This is the first time the laser microprobe 40Ar/39Ar technique has been applied to Apollo samples.
- The samples analyzed are known as lunar impact melt breccias -- mash-ups of glass, rock and crystal fragments created by impact events on the Moon's surface.
- When a meteor strikes, the impact produces very large amounts of energy, some of which goes into shock heating and melting the target rocks.

- These extreme conditions can 'restart the clock' for some mineral-isotopic chronometers, particularly for material melted during impact.
- The absolute ages of lunar craters are primarily determined through isotope geochronology of components of target rocks shocked and heated to the point of melting, long since solidified.
- But lunar rocks may have experienced multiple impact events over billions of years of bombardment, complicating attempts to date samples and relate results to the ages of particular impact structures.
- Conventional wisdom holds that the largest impact basins on the Moon were responsible for generating the vast majority of impact melts, and therefore that nearly all of the samples dated must be related to the formation of those basins.
- But images taken by the Lunar Reconnaissance Orbiter Camera confirm that even small craters with diameters on the order of 100 meters can generate impact melts.
- Sample 73217, preserves evidence for at least three impact events occurring over several hundred million years, not all of which can be related to basin-scale impacts,.
- Sample 77115, collected by Cernan and Schmitt at Station 7 records a single melt-forming event about 3.83 billion years ago.
- Sample 73217, retrieved at Station 3, preserves evidence for at least three distinct impact melt-forming events occurring between 3.81 billion years ago and 3.27 billion years ago.
- This suggests that a single small sample can preserve multiple generations of melt products created by impact events over the course of billions of years.
- This applies to both the samples currently in our lunar and meteoritic collections, as well as samples we recover during future human and robotic space exploration missions in the inner solar system. ##

Ancient Moon Crater Named After Famed Aviator Amelia Earhart

MAR. 30, 2015 – www.space.com/28870-**amelia-earhart-moon-crate**r.html



The Earhart crater, previously unknown, is 200 km wide (124 mi), outlined in the magenta circle..
A team of researchers at Purdue University found the crater through an analysis of data
from NASA's Gravity Recovery and Interior Laboratory [**GRAIL**] mission

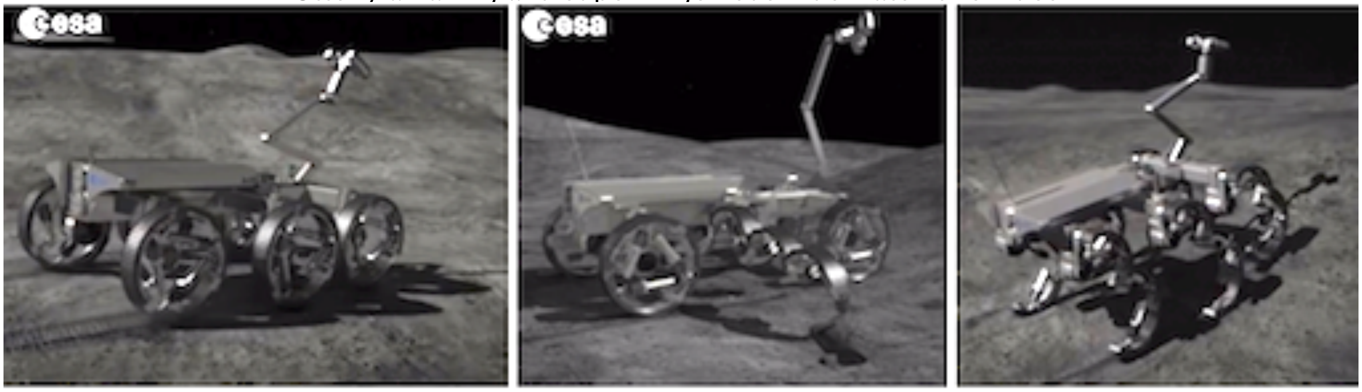
A team from Purdue University had been testing a new technique that sharpens the GRAIL observations of the Moon to see smaller-scale features, like ridges and valleys. Diving into the data, they noticed an unusual circular feature. The feature turned out to be the rim of an ancient crater, but it was so big it had not been recognized previously.

http://en.wikipedia.org/wiki/Amelia_Earhart ##

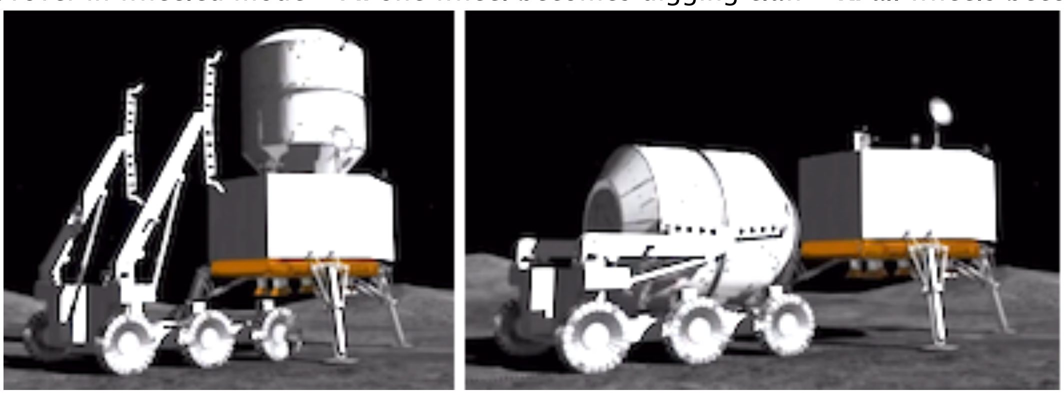
MOON PROBES

ESA Advanced Concept Robotics on the Moon

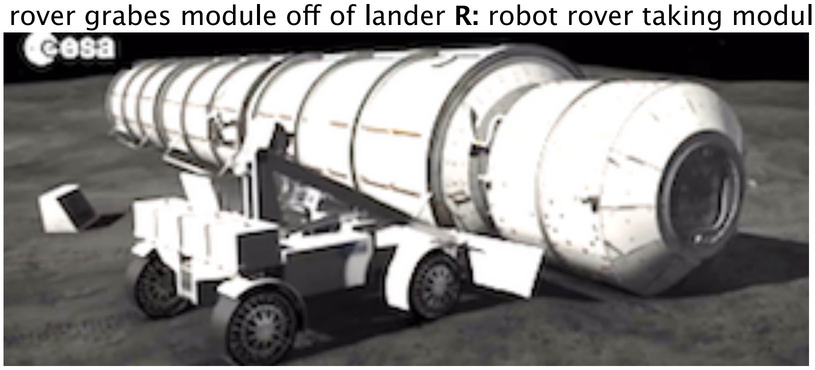
2013 – www.esa.int/spaceinvideos/Videos/2013/09/**Advanced-concept_robots**
Utterly amazing and super-ingenious – do watch this video!



L: robot rover in wheeled mode – **M:** one wheel becomes digging claw – **R:** all wheels become legs



L: Another robot rover grabes module off of lander **R:** robot rover taking module to outpost site



Robot rover attaches moduel to outpost core ##

Service Module of China's lunar Orbiter enters 127-minute Orbit

www.space-travel.com/reports/**Service_module_of_Chinas_lunar_orbiter_enters_127_minute_orbit_**999.html

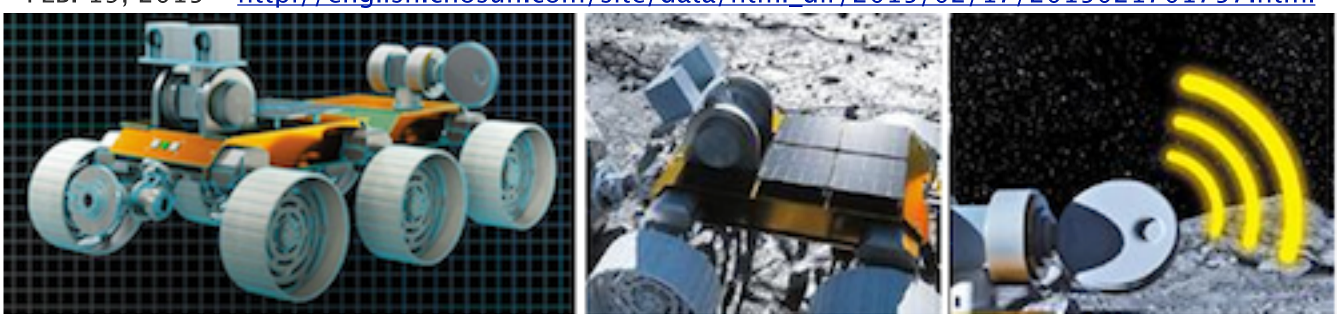
JAN. 14, 2015 – The service module of China's unmanned test lunar orbiter entered a 127-minute orbit on Tuesday after three orbital transfers.

- After the circular flight stabilizes, the module will travel along the current orbit at an altitude of 200 km above the Moon's surface for tests to validate key technologies for the next lunar probe mission/
- The spacecraft has enough power remaining and is in sound condition.
- Technicians on Earth have exercised timely and stable control, with the tasks of tracing the service module and system tests progressing well.

- The lunar orbiter was launched on Oct. 24. The service module was separated from the orbiter's return capsule on Nov. 1, with the capsule returning to Earth on Nov. 1 after circling the Moon during its eight-day mission.
- The service module reached the Earth-Moon second Lagrange Point (L2) in late November and left the L2 point on Jan. 4 after completing all preset scientific tasks.
- The orbiter is a test run for China's three step lunar program - orbiting, landing and returning.
- The obtained data and validated re-entry technology will be used for the development of Chang'e-5, slated for launch around 2017. ##

Korea Unveils Moon Rover

FEB. 19, 2015 - http://english.chosun.com/site/data/html_dir/2015/02/17/2015021701757.html



- The Korea Institute of Science and Technology has unveiled an unmanned rover that can search for rare minerals and metals on the Moon's surface.
- The rover will be sent to the Moon on a Korean-made rocket in **2020**.
- The rover is 50 cm wide, 70 cm long and 25 cm high, and weighs 20 kg, much lighter than China's 120 kg Jade Rabbit rover sent to the moon in 2013.
- It is much smaller and lighter due to the freight weight limit of the home-grown rocket that will carry the rover.
- Researchers say they developed a rover with a completely new design.
- The project involves six government research institutes and is expected to cost W7.6 billion (US$1=W1,102). ##

New Moon Missions? Europe Looks Backwards and Forward - VIDEO

www.space.com/28364-**new-moon-missions-europe-looks-back-and-forward-video**.html

A 5-Star Production! Do watch this video!

GOOGLE LUNAR X-PRIZE NEWS

Google Lunar X-Prize Milestone Awards Announced

JAN. 26, 2015 - http://www.space.com/28365-**google-lunar-xprize-milestones**.html
http://lunar.xprize.org/about/**milestone-prizes** (VIDEO)

Since 2007, teams of entrepreneurs
from around the world have been working towards a dream: to kick-start a new era of commercial exploration on the Moon. With the awarding of the Google Lunar XPrize Milestone Prizes, five talented teams have proved that those dreams may become a reality soon.

The 9 awarded Milestone Prizes are as follows:

• **Astrobotic** (US):	IMAGING ($250,000),	MOBILITY ($500,000),	LANDING ($1M)
• **Hakuto** (Japan):		MOBILITY ($500,000)	
• **Moon Express** (US):	IMAGING ($250,000),		LANDING ($1M)
• **Part-Time Scientists**(Germany):	IMAGING ($250,000),	MOBILITY ($500,000)	
• **Team Indus** (India):			LANDING ($1M)

Astrobotic, Hakuto, Moon Express, Part-Time Scientists and Team Indus have spent the past year putting their hardware and software through a series of rigorous tests and technical reviews monitored by a judging panel of leading space, science and engineering experts. They will be awarded a combined $5.25 million in Milestone Prizes in recognition of key technological advancements toward their quest to land a private spacecraft on the surface of the Moon.

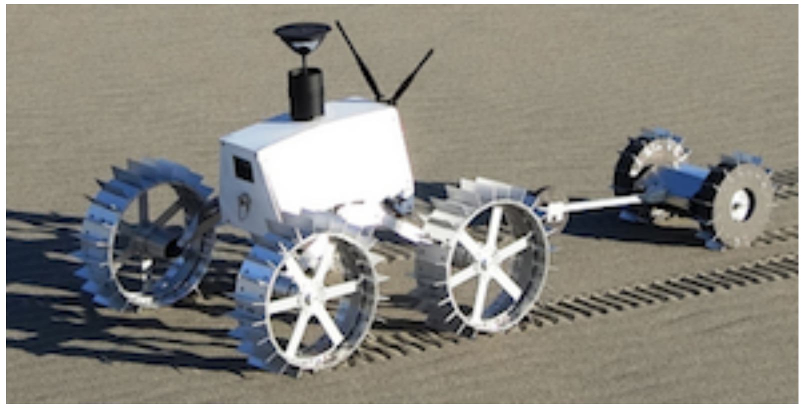
To win the $30 million Google Lunar XPrize, teams are required to land a robot on the Moon. That robot must travel at least 500 meters (1640 feet) across the lunar surface and send high-definition video and imagery back to Earth.

The Milestone Prizes have focused on three areas that are vital to the completion of this unprecedented mission: **landing**, **mobility** and **imaging.** The judging panel, whose experience stretches from the Space Shuttle program to Philae's recent touchdown on Comet Churymov-Gerasimenko, are well aware of what it takes to achieve a successful landing — and of the potential pitfalls. **The judging process has taken more than a year** and involved nine expert judges who monitored more than 25 tests and participated in more than 20 technical review meetings around the world.

Landing Milestone Prize

Reaching the Moon is only the first step in claiming the Google Lunar XPrize. Following launch, a spacecraft must transit the roughly 400,000 kilometers to the Moon. It must then fire its rocket engines with high precision to bring it down to the surface and make a landing attempt. By the time it touches down on the lunar surface, the lander will have slowed to less than human walking speed. The touchdown itself is hazardous, since the surface is pitted with craters and strewn with boulders ejected from meteorite impacts. For the Landing Milestone Prize, Astrobotic, Moon Express and Team Indus successfully demonstrated advanced progress towards building a spacecraft that can complete this journey.

- **Astrobotic** presented the development of an autonomous landing system that can determine the spacecraft's position and altitude by comparing images from cameras on-board its "Griffin" lander with NASA high-resolution images of the lunar surface. {See full text for rest of report]
- **Team Indus** constructed a full-scale prototype of their lander structure, built from aluminum honeycomb panels to give it a lightweight structure and featuring four impact-absorbing landing legs**.** {See full text for rest of report]
- **Moon Express** has developed an innovative, flexible spacecraft design, the MX-1,that could one day complete a range of commercially valuable functions in orbit, in addition to its main role as a lander. The MX-1 has a rocket engine that uses kerosene and hydrogen peroxide in bi-propellant mode to power the spacecraft through the series of orbital maneuvers needed to reach the Moon, along with outboard thrusters using hydrogen peroxide in monopropellant mode that fire just before landing to **ensure a gentle touchdown.** [See full text for rest of report]

Left: Astrobotic – **Right:** Hakuto and Tetris (lavatube explorer)

Mobility Milestone Prize

Google Lunar XPrize teams that choose to deploy a rover must be prepared for the challenges of the lunar surface. The fine dust that covers the moon is highly abrasive and can cause damage if allowed to work its way into moving parts during travel. China's Yutu fover, which landed on the Moon in December 2013, fell victim to mechanical abnormalities after traveling just over 100 meters, possibly due to damage from small stones or dust. To win the Mobility Milestone Prize, teams with rovers needed to demonstrate how they plan to maneuver across the lunar surface and how they plan to measure the distance travelled to ensure they reach the required 500 m. {See full text for rest of report]

- **Hakuto** has chosen to focus solely on the mobility aspect of competition and will purchase a ride to the Moon with one of the other teams. They have developed a small and lightweight rover called Moonraker for the Google Lunar XPrize challenge and are also planning to send a smaller rover called Tetris for an additional science mission to explore other areas beneath the Moon's surface. The four-wheeled Moonraker will tow the two-wheeled Tetris on an extendable tether that will enable the smaller rover to drop into a lunar cave [lava tube.] {See full text for rest of report]
- **Astrobotic** is also planning to investigate caves in the Lacus Mortis (or Lake of Death) region of the moon. Their rover, Andy, has a stable, four-wheeled design with a low center of gravity. For the Mobility Milestone Prize testing, Andy was put through its paces over rough terrain at the NASA Glenn Research Center in Cleveland, Ohio. {See full text for rest of report]
- **Part-Time Scientists** is planning to send their Asimov rover to the Moon aboard their Isaac landing craft. The team crossed Europe in their pursuit of the Mobility Milestone Prize, with test locations ranging from the volcanic slopes of the island of Tenerife to the planetary surface facility at the German Aerospace Center's facilities in Munich. {See full text for rest of report]

Imaging Milestone Prize

To win an Imaging Milestone Prize, the teams were asked to complete a ground demonstration of their "mooncast," collecting high-definition imagery and video in the same manner that they would during their actual Google Lunar XPrize mission. On the Moon, this will include a **360-degree panorama of the landing site as well as eight minutes of dynamic video showing the landing, mobility and potentially other phases of the mission.** The teams were also expected to carry out other tests to show how their imaging equipment will withstand the lunar environment.

- **Part-Time Scientists** have developed their entire imaging system in-house, using metallic 3D printing to create a prototype camera head. The stereoscopic camera is mounted on a rotatable mast at one end of Asimov's chassis. The team proved the camera's performance at an indoor test facility at the German Research Center for Artificial Intelligence in Bremen and completed their mooncast ground demonstration during the field tests in Tenerife. Thermal vacuum and vibration tests of the camera head were carried out at facilities in Vienna and Berlin respectively.
- **Astrobotic** completed their mooncast demonstration at an outdoor location near Pittsburgh, Penn. that closely resembles the appearance of the lunar surface. The robust industrial camera on which their imaging system is based is used for a variety of terrestrial applications.
- **Moon Express** has integrated an off-the-shelf commercial camera into a custom arm assembly, which allows the imaging system to pan and tilt as well as take "selfies" from the top deck of the lan-

der. Moon Express conducted thermal vacuum tests and reviewed existing radiation data to confirm that the camera can withstand the lunar environment.

The Milestone Prizes were optional Not every team chose to participate. All 18 Google Lunar XPrize teams are still eligible to win the Grand or 2nd Place Prizes. But the Milestone Prizes represent real, independently judged achievements by the winning teams in this new race to the Moon.

The testing process has shown that Google Lunar XPrize is as much about the human stories of the teams as the technology. Events like the unveiling of Team Indus's lander, and the spiritual ceremony that followed, was an emotional moment for all those involved. The teams competing for the Google Lunar XPrize have collectively invested countless hours of manpower, millions of dollars and an immeasurable number of hopes and dreams. The announcement of the Milestone Prize winners demonstrates that those efforts are coming to fruition.

The websites for the individual teams above, and for other teams can be found at:

http://lunar.xprize.org/teams ##

NASA releases Video on the Farside of the Moon and its phases

www.space-travel.com/reports/**NASA_releases_video_of_the_far_side_of_the_Moo**n_999.html

http://esciencenews.com/sources/space.com/2015/02/25/**the.far.side.moon.has.phases.and.now.you.can.see.em.video**

FEB. 8, 2015- NASA has released a video showing what it looks like on the side of the Moon humans can't see from Earth.

- Often erroneoucly referred to as the "dark" side of the Moon, the far side is actually lit by the Sun just as often as the side always facing Earth.
- The rendering of the Moon was made using hundreds of terabytes of data collected by the Lunar Reconnaissance Orbiter.
- The far side also has fewer maria (Latin for "seas" of once molten lava) - (the large, flat darker areas seen from Earth) than the near side
- The Lunar Reconnaissance Orbiter has been mapping the Moon since 2009. ##

Lunar Reconnaissance Orbiterr Faces NASA Budget Chopping Block

MAR. 27, 2015 - www.space.com/28943-opportunity-rover-**lro-nasa-budget**.html

THE WOODLANDS, Texas — Despite a forward-looking and overall healthy NASA planetary science program budget, two on-duty spacecraft are now on the chopping block.

- The government's current budget proposal for NASA just isn't enough to cover everything, according to NASA's Planetary Science Division. The **Lunar Reconnaissance Orbiter** and the veteran **Opportunity rover** on Mars, are now zeroed out in President Obama's NASA budget for fiscal year 2016.
- The hopes are to find money to maintain the missions.

[The part of this article which deals with the **Opportunity Rover is in the Mars Section below**]

- **High value … few dollars**
- Launched on June 18, 2009, NASA's Lunar Reconnaissance Orbiter (LRO) continues to collect an impressive amount of data, adding new knowledge about the Moon.
- LRO is in a stable orbit circling the Moon, and continues to obtain outstanding, high-resolution images of the lunar surface, shedding light on the Moon's history and processes.
- "Continuing the LRO mission is truly 'high value for few dollars' science," said Paul Spudis, a space scientist at the Lunar and Planetary Institute in Houston.
- **Scientific Sense**
- "If we can continue to operate LRO for the next few years, we may eventually obtain **a global high-resolution map of the entire Moon**. This data set will be used for decades to come and will allow the identification of new sites for exploration, utilization and, eventually, habitation.

- Another facet of LRO's duties - an ability that was previously shut down due to a money shortfall is to take **additional bistatic radar data**, making use of radar pulses blasted to the Moon via the Arecibo radio telescope in Puerto Rico with echoes picked up on the Miniature Radio-Frequency instrument (Mini-RF). It is a synthetic aperture radar instrument mounted on LRO.
- This could "uniquely **indicate the locations and amounts of polar ice**" on the Moon, [knowledge vital to positioning human outposts and settlements on the Moon in the future. - Editor]
- Spudis is a team member on the Mini-RF experiment, .
- The Mini-RF radar is currently shut by lack of funding, but it could be started up again to conduct bistatic measurements. This is an entirely new mission for lunar polar volatiles, as we have collected only demonstration amounts of bistatic radar to date.
- Using LRO for as long as possible makes economic, operational and scientific sense, and gets more bang for the buck. ##

THE MOON: PROPERTY RIGHTS & COMMERCIALIZATION

A Giant Leap for Commercialization of the Moon?

www.courier-journal.com/story/opinion/contributors/2015/02/27/**giant-leap-commercialization-moon**/24114989/

FEB. 27, 2015 - The FAA, in a carefully worded policy statement, has essentially outlined a scenario by which a U.S.-based company — Bigelow Aerospace — could stake future claims to lunar property. That could be huge.

- For nearly 50 years, ever since the 1967 UN Outer Space Treaty (signed by over 100 nations, including the United States, there has been unanimous international agreement that **no nation could stake a sovereign claim to the Moon for any reason.**
- Moreover, **every nation's government has also been responsible for any "non-governmental entities" (i.e. corporations or citizens) that wanted to do so.**
- The so-called "Moon Treaty" of 1979 (signed by nine nations, **but not the United States**) clearly states that private ownership of the Moon is forbidden.
- Fast-forward 50 years, and we're suddenly having a serious discussion about returning to the Moon.
- It's not just U.S. innovators who are getting involved — competitors from Italy, Japan, Malaysia, Spain, Germany, Hungary, Brazil, Canada, Chile, India, China, Romania and Russia are also coming up with their own plans for Moon missions.
- There's been a lot of discussion already about how to create the right legal framework to get around that pesky 1967 UN Outer Space Treaty.
- The best option for now is the claim that a "loophole" exists whereby sovereign ownership rights to the Moon might be banned, but private ownership rights are not banned.
- According to one piece of proposed legislation known as **the Space Settlement Prize Act,** the first private venture to establish a Moon base would be able to claim up to 600,000 square miles of the Moon's surface.
- Other arguments have made the case that the commercial exploration of the Moon should follow the logic of the Law of the Sea Treaty, which can be basically described as "finder's keepers" when it comes to activities such as mineral extraction.
- And, last but not least, there's the "Well, China is going to do it anyway, so we should do it first" argument for selectively opting out of the parts of the UN Outer Space Treaty that would block U.S. commercial enterprises from freely commercializing the Moon.
- That's why the FAA ruling on the Moon is so clever — it bends the ball around the 1967 Outer Space Treaty by clearly stating that the U.S. government must still approve whatever a company brings to the Moon and whatever it does on the Moon.
- It respects the 1979 "Moon Treaty" by stating that the ruling does not imply "ownership of the Moon."

- It dives into the Law of the Sea Treaty by establishing a provision for mining and exploration rights, provided some base of operation has already been established on the Moon's surface.
- And it keeps America's legal options open to take on China at a later date by suggesting that the "national regulatory framework is ill-equipped to enable the U.S. government to fulfill its obligations" under the 1967 UN Outer Space Treaty.

So what exactly did the FAA give Bigelow? A "landing spot" on the Moon?

- The right to set up an inflatable habitat on the Moon?
- Pre-approval for a future Moon payload?
- Robert Bigelow, founder of Bigelow Aerospace, put it best: "It just means that somebody else isn't licensed to land on top of you or land on top of where exploration and prospecting activities are going on, which may be quite a distance from the lunar station."

So here's the deal:

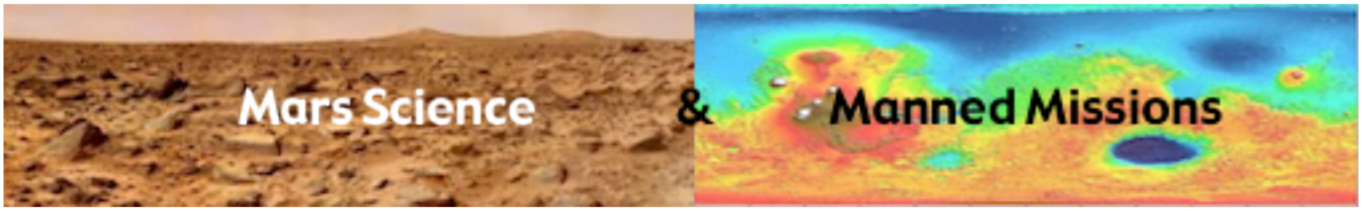
- Companies are going to the Moon, and they don't want to come back empty-handed.
- They are not getting much money from the government, so they need to make every Moon visit commercially viable.
- The easiest way to do that is by making some aspect of Moon exploration relatively routine
- For example, Astrobotic envisions ferrying "mail" and other payloads back and forth from the Moon.

What about mining and exploration?

- A company might not "own" a crater or an acre of lunar real estate, but it would hold the rights to any helium-3 found therein.
- Right now, the FAA is the only U.S. regulatory body that can regulate Moon exploration, by virtue of its ability to license commercial space transportation.
- In addition, the U.S. State Department would theoretically be in charge of making sure other countries honor any contracts that U.S. companies sign for making deliveries to the Moon.
- Other than that, it's the "Wild West."

More regulation actually speeds up innovation.

- Regulation, it turns out, might become the key to making the risk-reward payoff more attractive to private companies and encourage commercial development of the Moon.
- The problem is, the FAA might not act fast enough. The FAA is also the body that regulates drones, and that process has been slow and grinding.
- Maybe the FAA has overstepped its authority. But **it's important to be talking about these issues now, before some company or nation takes over a big chunk of Moon real estate and provokes an international legal war over lunar property rights.** ##



[The articles below have been bullet-summarized by the editor. For the full text, see the links cited.]

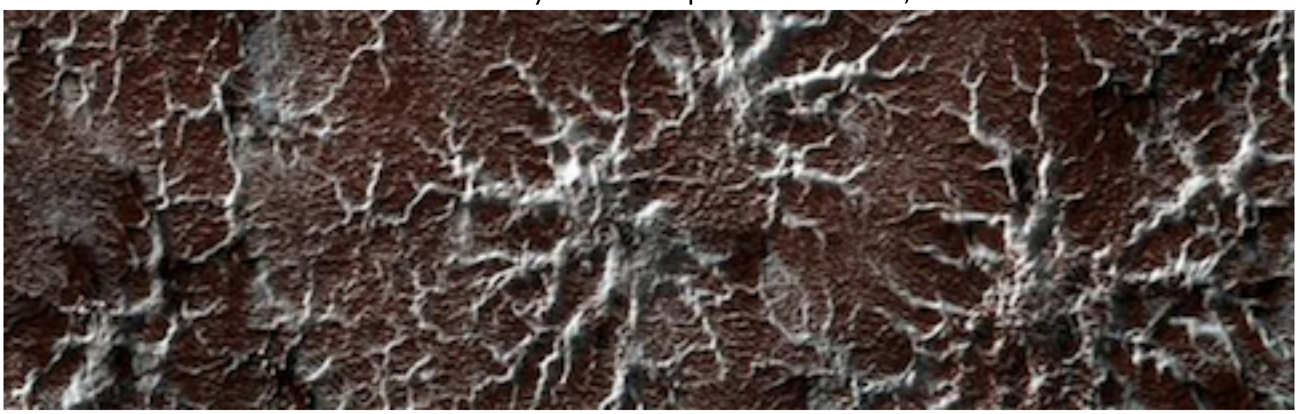
MARS ANALOG EXERCISES

MARS MISSIONS & PROBES

Mars Reconnaissance Orbiter Spies Alien Ice 'Spiders'

DEC. 30, 2014 – www.space.com/28128-**mars-orbiter-spies-alien-ice-spiders**.html

Mars' surface is covered with a diverse array of landscapes and features, but this is one of the weirdest.



Full size: http://i.space.com/images/i/000/044/624/original/dry-ice-spiders-mars-mro-photo.jpg

Imaged by the High-Resolution Imaging Science Experiment (HiRISE) camera on board NASA's Mars Reconnaissance Orbiter(MRO) that orbits the planet 240 km (150 m) overhead, strange spider-like formations, found nowhere on Earth, cover Mars' south polar region.

- It is actually a fascinating season-driven phenomena that HiRISE scientists call "**araneiform**" terrain.
- Araneiform means "spider-like" and also applies features with a "caterpillar" or "starburst"-like shape.
- Mars' climate is so cold that even carbon dioxide freezes from the atmosphere and accumulate as ice on the surface during winter. During spring, the carbon dioxide will sublimate back into the atmos-phere.
- Carbon dioxide ice does not melt into a liquid state but sublimates straight from a solid into a vapor.
- This seasonal process therefore creates its own type of erosion on the Martian landscape.
- This example shows eroded channels filled with bright ice, and the muted red of the underlying ground,
- In summer the ice will disappear, showing just the channels of ghostly spiders carved in the surface.
- This type of erosion does not take place anywhere naturally on earth because our climate is too warm
- These kinds of erosional processes provide a Overy privileged view into Mars changing seasons and how very different erosional processes on an alien world continue to shape the dynamic Martian ter-rain.

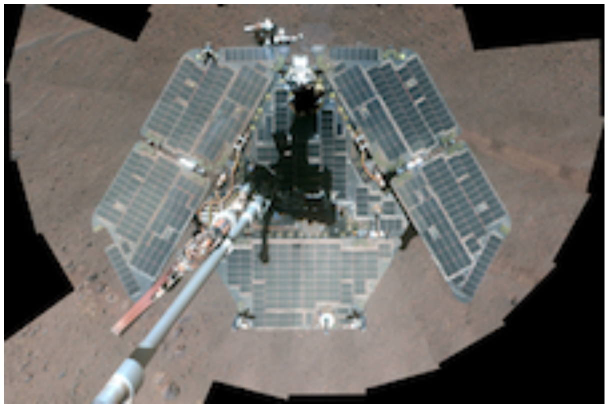
Further Reading: On Mars, Dry Ice "Smoke" Carves up Sand Dunes

http://news.discovery.com/space/**mars-sand-dunes-dry-ice**-130126.htm

Mars Rover Opportunity Suffers Worrying Bouts of 'Amnesia'

DEC. 31, 2014 - /www.space.com/28135-**mars-rover-opportunity-amnesia**.html

- Problems with Mars Exploration Rover Opportunity's flash memory have intensified over recent weeks.
- This has been affecting Opportunity's mission but the management team hope to find a fix.
- Opportunity has been exploring the Martian surface for over a decade since January 2004.
- But nevitable age-related issues have surfaced such a rover "amnesia."



Mars rover Opportunity captured this self portrait on March 22, 2014.
It shows how Martian winds have cleaned the rover's vital solar arrays.

- Opportunity utilizes two types of memory to record mission telemetry: "volatile" and "non-volatile."
- Non-volatile memory remembers everything even if you power off
- In volatile memory everything goes away,so volatile memory is like the traditional RAM you have in your computer; non-volatile memory uses flash memory technology.
- Flash memory may be great for storing data when the rover's electronics are powered down.
- But flash memory has a limitation on how many times you can read and write to it.
- **NEWS: Mars Rover Opportunity to Have Memory Wiped**
- After a decade of continuous use, the rover's flash memory ts the source of lost data and unexpected reset events that are plaguing the rover's surface mission.
- **Old Rover Memory Glitches**
- The problems with "amnesia" have become more serious.
- The rover keeps trying to use the flash memory, but it can't, so instead it uses the RAM. But when the rover goes to sleep and wakes up again, all that data is gone.

Mars Opportunity Rover faces NASA Budget Chopping Block

MAR. 27, 2015 - www.space.com/28943-**opportunity-rover**-lro-**nasa-budget**.html

THE WOODLANDS, Texas — Despite a forward-looking and overall healthy NASA planetary science program budget, two on-duty spacecraft are now on the chopping block.

- The government's current budget proposal for NASA just isn't enough to cover everything, according to NASA's Planetary Science Division. The Lunar Reconnaissance Orbiter and the veteran Opportunity rover on Mars, are now zeroed out in President Obama's NASA budget for fiscal year 2016.
- The hopes are to find money to maintain the missions.

[The part of this article which deals with the Lunar Reconnaissance orbiter is in the Moon Section above]

Science potential per dollar

- Opportunity, the venerable Mars Exploration Rover (MER), has been wheeling about on the Red Planet for more than 11 years now, following a January 2004 landing in Eagle Crater.
- "Funding of Opportunity is warranted, and I'm not alone," said Steve Squyres, Opportunity principal investigator at Cornell University in Ithaca, New York.
- Jet Propulsion Laboratory manages the Mars rover projects conducted a "senior review" of all of its ongoing planetary missions,This was **a comprehensive evaluation of future science potential per dollar,** involving written proposals submitted by the project teams, and rigorous outside peer review.

- Opportunity tied for first place with Mars Reconnaissance Orbiter among all ongoing Mars missions.
- "The rover is in excellent health, and is poised now just outside Marathon Valley, where orbital data indicate significant concentrations of clay minerals that could provide evidence for past habitable environments. The prospects for important discoveries there and beyond are good."
- Squyres hopes and expects that NASA will find the funds necessary to keep Opportunity in action.

Implications for habitability

- Closing down the Opportunity rover mission in fiscal year 2016 would preclude further exploration of the rim of the ancient Endeavour impact craters.
- Using Opportunity's ability to roam and make measurements we have found evidence for diverse rim rocks and structures, and what is likely pervasive alteration by watery fluids.
- The robot's current position, just to the north of Marathon Valley, on the Cape Tribulation rim segment, is an area where orbiting sensors show an extensive set of outcrops with evidence for smectite clay minerals formed in an aqueous environment.
- Exploring and characterizing these outcrops would provide new and important information on past aqueous conditions and implications for habitability
- These are themes central to NASA's Mars Exploration Program objectives. ##

Opportunity Rover Suffers More Amnesia on Mars

MAR. 30, 2015 – http://www.space.com/28974-**mars-rover-opportunity-memory-amnesia**.html

- Opportunity has suffered another bout of amnesia, less than a week after engineers installed a software upgrade intended to fix the robot's memory issues.
- The rover began experiencing problems with its flash memory — the kind that can store datra even when the power is off, In late 2014.
- On March 20, new software was uploaded to bypass an apparently faulty "bank" - one of seven.
- But the rover had another brief amnesia episode on March 25, five days later..
- NASA was not surprised. There is still no clear understanding of what is causing the problems.
- Opportunity was experiencing multiple computer resets per day before mission team members began operating the rover in a "no flash memory" mode in December.
- No such serious issues have resurfaced since the March 20 reformatting.
- The brief March 25 event did not result in the loss of any science data,
- Opportunity resumed its work shortly thereafter.3.

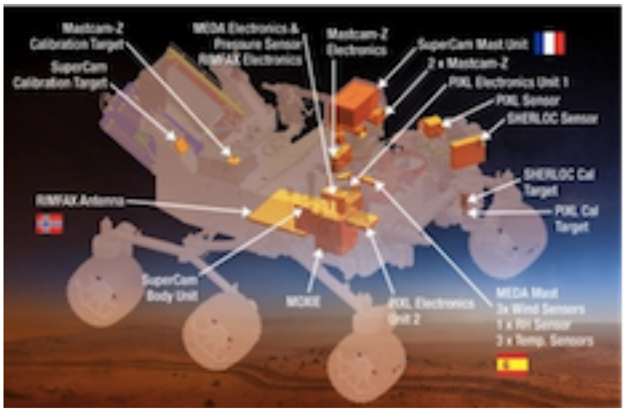
How NASA's Next Mars Rover Will Hunt for Signs of Past Life

JAN. 2, 2015 – www.space.com/28143-2020-**mars-rover-instruments-life-search**.html

Video: www.space.com/21945-destination-mars-nasas-2020-mars-rover-science-plan-video.html

How habitable was Mars in the past?

- Since NASA's Curiosity rover touched down on Mars in August 2012, it has helped answer a few of these questions in the area surrounding its equatorial landing site of Gale Crater.
- In March 2013, Curiosity investigators announced extensive evidence of a lake bed or river system in a region that NASA dubs "Yellowknife Bay." The environment, which could be a favorable spot for microbes, includes **minerals such as clays that are formed in waters that once existed there.**
- The waters themselves were probably not too salty or acidic, geologic evidence shows, which gives further credence that life could have been possible on the Red Planet.
- Curiosity is now ascending its prime target — Mount Sharp (Aeolis Mons).
- NASA is readying a successor rover to follow.
- **MARS 2020** as it's currently called, is heavily based on the Curiosity design, and as with its predecessor it will be able to search for habitable environments. will have improved instruments over Curiosity.
- The new rover would also look directly for evidence of life, something Curiosity was not designed to do. This will make choosing a landing site crucial, since it would involve finding a spot where water or volcanic activity was present in the past. These processes provide energy for microbes.



Left: For a larger image, with more legible text, go to:
http://i.space.com/images/i/000/044/645/i02/**mars-2020-rover-instruments**.jpg?1420058867
Right: www.space.com/21900-**nasa-mars-rover-2020-images**.html

- It will be a multi-year, hundreds of people effort to choose the landing site for 2020,.
- The finalist sites for Curiosity are already listed for consideration.
- These sites include Holden Crater, which scientists suspect may have been a lake system, and Eberswalde Crater, a possible ancient lake bed.

Picture zoom for science

- Mars 2020's success will depend on the seven instruments the rover will carry.
- Their capabilities range from taking pictures, to doing chemical composition analysis of the surface, to probing for organics, chemicals and carbon dioxide.

The seven instruments are:

1. **Mastcam-Z**, a camera system that can zoom, take panorama images or spectroscopic images. Predecessors of Mastcam-Z flew on Curiosity, Spirit and Opportunity.
2. **SuperCam** can sense organic compounds in rocks and regolith through mineralogy and chemical composition analysis.
3. **PIXL (**Planetary Instrument for X-ray Lithochemistry) will look for elements in the Martian surface.
4. **SHERLOC** (Scanning Habitable Environments with Raman & Luminescence for Organics and Chemi-cals), will examine the spectrum of surface samples to learn what they are made of, and possibly to find organic compounds.
5. **MOXIE** (Mars Oxygen ISRU Experiment), will try to produce oxygen from thecarbon dioxide in Mars atmosphere..
6. **MEDA** (Mars Environmental Dynamics Analyzer) will provide information on conditions around the rover: as temperature, humidity, dust size and shape, and wind speed and direction..
7. **RIMFAX** (Radar Imager for Mars' Subsurface Exploration) will use radar to probe underground to see what geology is there.

Many instruments are new technologies.

- With the Curiosity rover, it's very difficult to get stereo images from its pair of cameras without com-bining nine images from a wide-angle camera, and a single one from a narrow-angle camera of higher resolution.
- The new Mastcam system is able to zoom, so investigators can match the focal length between the cameras and make the stereo images. This is mportant for rover navigation, but also to direct the rover's science.
- Stereo pictures establishe relationships between outcrops and sand dunes, provides a view of layers of rock, and guides the investigators on where to probe next.
- Their resolution and color capability help identify the best possible places to investigate.

Proof of life?

- SHERLOC auto-focuses on an image, then scans a laser beam across a 7 x 7 mm area ans performs fluorescence spectroscopy to identify organics, and Raman spectroscopy to look at the vibrations of individual molecules.

- All ringed organic molecules fluoresce in distinctive ways, which is where the search for organics comes in. If we detect the signal of organics using this instrument, it would be a first step to looking for evidence of current life on Mars.
- (Organics can be produced from both biological and non-biological processes, so they are not definitive proof that life exists.)
- Even if the organics are living, the laser will not hurt them at such low power.
- Before doing the scans, an instrument is used to remove dust from the surface. Organics do not survive well under surface environmental conditions on Mars, but could cling to the surfaces underneath.
- The instrument is also designed to peer into drill holes that the rover does.
- If organics are found, one key to habitability will be to see where they are located. If the organics follow an individual geologic feature such as a vein, that could strengthen the case for life.

Building oxygen

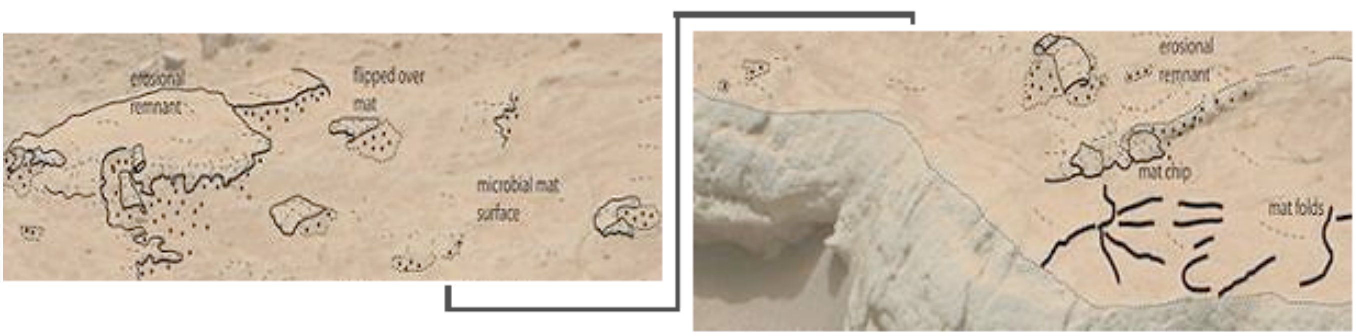
- **MOXIE** has been in the works since the 1990s, when NASA was pursuing a "faster, better, cheaper" approach to Mars using small missions.
- MOXIE builds on the predecessor instrument, MIPP, but is more efficient afer t20 years of development, and could create 20 grams of oxygen per hour at 99.6 percent purity to operate for 50 days.
- This instrument could eventually strengthen the search for habitability because it would make it easier for humans to do investigations on the Red Planet themselves.\
- One major obstacle to landing people on Mars is making sure they have enough fuel and oxygen to return. If MOXIE is successful in generating oxygen in the long term, this would be an encouraging step to making Martian colonies possible in the coming decades. ##

Potential Signs of Ancient Life in Mars Curiosity Rover Photos

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

JAN. 8, 2015 - A careful study of images taken by the NASA rover Curiosity has revealed intriguing similarities between ancient sedimentary rocks on Mars and structures shaped by microbes on Earth.

- The findings suggest, but do not prove, that life may have existed earlier on the Red Planet.



[Overlay of sketch on photograph from above to assist in the identification of the structures on the rock bed surface. Photo above split in two by editor to avoid downsizing that would make notations illegible]

The photos were taken as Curiosity drove through the Gillespie Lake outcrop in Yellowknife Bay, a dry lakebed that underwent seasonal flooding billions of years ago.

The Red Planet was a much warmer and wetter world back then.

On Earth, carpet-like colonies of microbes trap and rearrange sediments in shallow bodies of water such as lakes and costal areas, forming distinctive features that fossilize over time. These structures, known as microbially-induced sedimentary structures (or MISS), are found in shallow water settings all over the world and in ancient rocks spanning Earth's history.

- Nora Noffke, a geobiologist at Old Dominion U. in Virginia, has spent the past 20 years studying these microbial structures. Last year, she reported the discovery of MISS that are 3.48 billion years old in the Western Australia's Dresser Formation, making them potentially the oldest signs of life on Earth.
- Noffke details the striking morphological similarities between Martian sedimentary structures in the Gillespie Lake outcrop (at most 3.7 billion years old) and microbial structures on Earth.

- The distinctive shapes include erosional remnants, pockets, domes, roll-ups, pits, chips and cracks, which on Earth can extend from a few centimeters to many kilometers.
- Noffke's report is not a definitive proof that these structures were shaped by biology. Getting such confirmation would involve returning rock samples to Earth and conducting additional microscopic analyses, a mission that isn't scheduled anytime in the near future.

A Careful Analysis

- Chris McKay, a planetary scientist at NASA's Ames Research Center and an associate editor of the journal Astrobiology, says "Noffke's paper is the most carefully done analysis of the sort that I've seen, which is why it's the first of its kind published in Astrobiology."
- Noffke compared the rover pictures to images taken at several sites on Earth, including modern sediment surfaces in Mellum Island, Germany; Portsmouth Island, USA; and Carbla Point, Western Australia; as well as older fossils of microbial mats in Bahar Alouane, Tunisia; the Pongola Supergroup in Africa; and the Dresser Formation in Western Australia.
- The photos showed striking morphological similarities between the terrestrial and Martian sedimentary structures.\The terrestrial structures change in a specific way over time. As the microbial mats form, grow, dry up, crack and re-grow, specific structures become associated with them.
- The distribution pattern in Martian rocks correspond with microbial structures on Earth that have changed over time. Taken together, these clues strengthen her argument beyond simply pointing out the similarities in shape.
- "If the Martian structures aren't of biological origin," Noffke says, "then the similarities in morphology, but also in distribution patterns with regards to MISS on Earth would be an extraordinary coincidence."

Confirmation Pending

- Noffke outlines a detailed strategy for confirming the potential biological nature of the Martian structures. But one important step – returning samples to Earth for further analyses – is just not feasible yet.
- On Earth, scientists typically confirm the biological nature of microbial sediment structures by searching for specific microscopic textures, which involves cutting rocks into thin slices and studying them under a microscope.
- On Mars, this would be very difficult do from an engineering perspective, although McKay doesn't rule out the possibility for future missions. "I don't know if it can be done, but engineers are pretty smart," he says. "If you give them a challenge, they usually find a solution."
- "A sample return mission would be the gold standard. But that's unlikely to happen anytime soon." ##

Uk's Beagle 2 Mars Lander, Lost in 2003, Found in NASA Photos

JAN. 16, 2015 – www.space.com/28286-**europe-beagle-2-mars-lander-found**.html
www.space.com/28292-**mars-lander-beagle-2-photos**.html

Artist's interpretation shows what the UK's Beagle 2 lander would have looked like if it deployed properly on Mars.

The United Kingdom's Beagle 2 Mars lander mysteriously disappeared during a landing attempt over Christmas in 2003, but has finally been found by a NASA spacecraft in orbit around Mars.

- The **Beagle 2 Mars Lander** is clearly visible in new photos from NASA's sharp-eyed Mars Reconnaissance Orbiter (MRO) now in orbit.
- While the probe landed successfully, it failed to unfold itself properly on the Martian surface.

- The spacecraft had hitched a ride to Mars on the European Space Agency's Mars Express mission
- It had not been heard from since it detached from that spacecraft on Dec. 19, 2003.
- Beagle 2 was supposed to land on Mars six days later, on Dec. 25, but never “phoned home.”
- Now, the mission's science team knows that it did not crash, but landed intact.
- Images from MRO's HiRISE (High Resolution Science Experiment) camera show that Beagle 2 indeed survived the harrowing entry, descent and landing sequence to touch down inside its target landing area in the Isidis Planitia region of Mar, about 5 km (3 mi) from the center of its target landing zone.
- Beagle 2 appeared to have only a few of its four solar arrays deployed, perhaps three at most.
- The lander's main parachute was seen close by, and the lander's rear cover and drogue parachute appeared to be still attached to the lander's main body.
- The lander used parachutes to slow its descent, and then deployed airbags to bounce to a stop much like NASA's successful Mars rovers Spirit and Opportunity.
- But Beagle 2's design required a full deployment of its four solar arrays to expose its radio antenna, the vital link to Earth. Because the antenna was not free, Beagle 2 was unable to phone home to relay data and await instruction. It was stuck, forever silent, on the surface of Mars.
- The Beagle 2 — named after HMS Beagle, the ship that carried a young Charles Darwin around the world in the 1830s — looked like a giant pocket watch, with a protective outer casing that would open upon touchdown. At that point, the lander's four solar panels would unfold, its robotic arm would spring into action and Beagle 2 would get to work on the Martian surface.

Beagle 2's work on Mars would have been varied and ambitious.

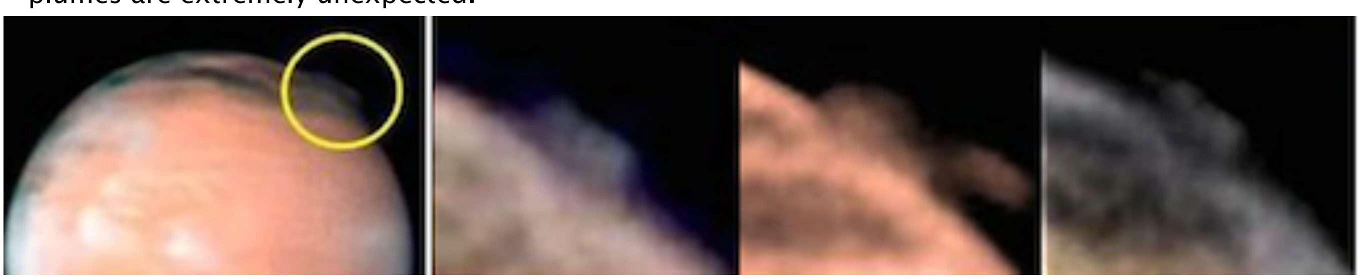
- The lander was designed to hunt for signs of possible life on Mars and characterize Martian geology, weather and climate, among other tasks. Its science gear included two stereo cameras, a microscope, two different spectrometers, a sample-heating gas analysis package and weather sensors, along with a drill and a burrowing, sample-collecting instrument dubbed the "mole." ##

Mystery Mars Plume Baffles Scientists

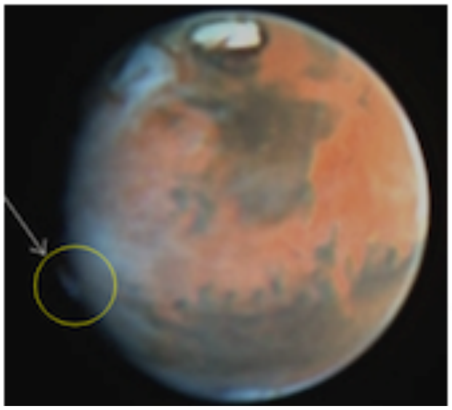
FEB. 16.2015 - www.esa.int/Our_Activities/Space_Science/**Mystery_Mars_plume_baffles_scientists**

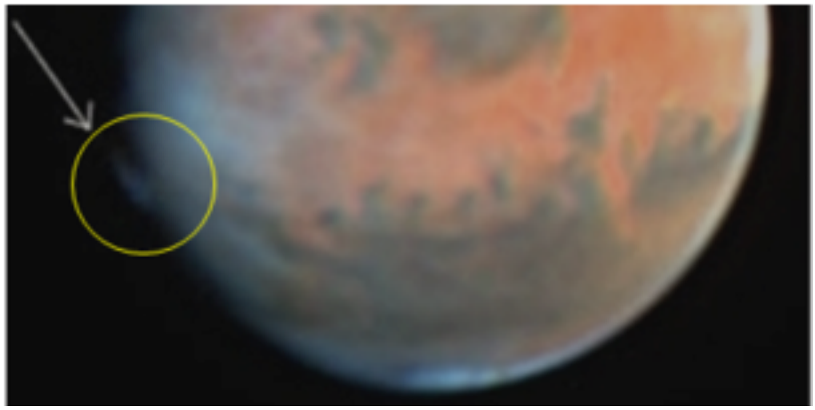
Plumes seen reaching high above the surface of Mars are causing a stir among scientists studying the atmosphere on the Red Planet. On two separate occasions in March and April 2012, amateur astronomers reported definite plume-like features developing on the planet.

- The plumes were seen rising to altitudes of over 250 km above the same region of Mars on both occasions - confirming evidence.
- At about 250 km, the division between the atmosphere and outer space is very thin, so the reported plumes are extremely unexpected.



- The features developed in less than 10 hours, covering an area of up to 1000 x 500 km, and remained visible for around 10 days, changing their structure from day to day.
- None of the spacecraft orbiting Mars were in viewing range at the time.
- Checking archived Hubble Space Telescope images taken between 1995 and 1999 and of databases of amateur images spanning 2001-2014 revealed occasional clouds on Mars’ limb, but usually only up to 100 km in altitude.
- One set of Hubble images from 17 May 1997 did show an abnormally high plume, similar to that spotted by the amateur astronomers in 2012.
- Scientists hope to determine the nature and cause of the plumes by combining the Hubble data in with the images taken by amateurs.





- If these features are caused by a reflective cloud of water-ice, carbon dioxide-ice or dust particles this would require exceptional deviations from standard atmospheric circulation models to explain cloud formations at such high altitudes.
- They could be related to an auroral emission, and auroras have been previously observed at these locations, linked to a known surface area where there is a large anomaly in the crustal magnetic field,
- Further insights should be possible following the arrival of ESA's ExoMars Trace Gas Orbiter, scheduled for launch to Mars next year. ##

The Search For Volcanic Eruptions On Mars Reaches The Next Level

FEB. 17, 2015 - /www.space.com/28536-**mars-volcano-eruptions**.html
www.marsdaily.com/reports/**The_Search_For_Volcanic_Eruptions_On_Mars_Reaches_The_Next_Level**_999.html

A new study of emissions from Martian volcanoes suggests there is no activity going on right now, but that does not rule out recent eruptions.

- Science teams using NASA's Infrared Telescope Facility at Mauna Kea in Hawaii, searched for signs of sulfuric acid — a key indicator of volcanic activity.
- They focused on the major Volcanic areas - Tharsis Plateu with three major volcanoes (Arsia, Pavovinis, Ascreus) and Syrtis Major in two multi-week observation sessions.
- Their findings match similar negative results from searches using the Very Large Telescope in Chile and the Palomar Observatory radio telescope.

Signatures

- Different types of molecules emit characteristic "signatures" based on the energy of their individual elements, with each one acting as a sort of fingerprint for investigators.
- In radio wavelengths, the search technique is slightly different, looking for distinctive lines that occur as the molecules rotate.
- Sulfuric acid shows up quite well in these wavelengths.
- The results were presented at the American Astronomical Society Department of Planetary Sciences meeting in November under the title, "A new search for active release of volcanic gases on Mars: Sensitive upper limits for OCS."
- The next logical step in the research is getting up close to Mars to do a lengthy search. An instrument approved on a forthcoming European spacecraft will be availablle.
- The orbiter will provides daily maps of the atmosphere, revealing a lot about actual processes on Mars
- NOMAD (Nadir and Occultation for Mars Discovery) is a spectrometer that will fly on ESA's 2016 ExoMars Trace Gas Orbiter.
- The instrument will look for volcanism — a sign of energy that could be a source for life to grow on — but also for organic substances that could indicate byproducts of life itself.
- On Earth volcanoes recycle carbon dioxide, which plants use, and also spew out plant-friendly ash.
- Hot springs are also a common feature of terrestrial volcanoes: they form when heated underground rocks interact with groundwater.

- Despite their high temperature and acidity, for example — some "extremophiles" live in this habitat.

A dynamic planet

- When the first landers visited Mars in the 1960s, they saw a "dead planet." NASA's first Mariner spacecraft happened to pass by mostly cratered areas, giving an appearance similar to the dead Moon.
- Mariner 9 changed that perception forever, arriving during a global dust storm. A few odd, circular features appeared to be sticking out of the dust.
- When the dust storms subsided, scientists saw vast volcnoes, including Olympus Mons, rising 25 km (16 miles) high, about three times higher than Earth's Mount Everest.
- Whether these volcanoes are extinct still puzzles researchers today
- In 2004, ESA's Mars Express examined Olympus Mons, and found geological evidence suggested that lava flowed in the area within the past two million years.
- Based on Earth observations, sulfuric acid would be the most likely trace gas we are likely to detect.
- But there has not been any systematic searche: Earth-based observations tend to happen under the limitations of available telescope time (which is typically only days or weeks).
- The issue of poor resolution. Perhaps eruptions do happen, but at such small levels that they cannot be detected easily from Earth.
- Researchers endeavor to get readings from higher up in our atmosphere where it's dryer and where it's less likely for atmospheric water in our atmosphere to interfere.

NOMAD, a dedicated Mars orbiter will be a key step

- Using technology heavily based on the Venus Express mission, NOMAD has three channels.
- One is a solar occultation channel that provides information on gas composition when the Sun is visible through the atmosphere.
- A second is a channel more sensitive to emissions as seen from the surface, primarily downward-facing The third channel permits observations at ultraviolet wavelength searching for sulphuric acid, ozone and also aerosols.

Working with other spacecraft

- The main targets of NOMAD will be organic molecules that have **a carbon-hydrogen bond**, such as **ethane, methane and ethylene**, not necessarily signs of life, but signs past or current habitability.
- NOMAD will also hunt for a plethora of biologically and geologically relevant molecules, with a diverse mix of sulfur, chlorine, oxygen and nitrogen atoms.
- Evidence of organic species on Mars is still under investigation, yet the Curiosity rover has recently reported definitive signs of organics, and also confirmed **methane plumes** in the atmosphere.
- Curiosity has found sulfur and chlorine compounds in the Martian surface
- To be in the atmosphere, there has to some thermal release, perhaps volcanic, from an underground heat source.
- It will take multiple instruments to confirm any findings.
- Another tool will be the James Webb Space Telescope, to be in orbit in 2018, with a resolution ample enough to detect sulfur in Mars air.
- There is ample geological evidence of past water on Mars such as gullies
- Rovers have detected substances that form in liquid water, such as hematite and clay.
- These signs all point to water forming millions or billions of years ago, implying something in the atmosphere changed. ##

MAVEN Completes First Deep Dip Campaign

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

FEB. 20, 2015 - NASA'S Mars Atmosphere and Volatile Evolution has completed the first of five deep-dip maneuvers designed to gather measurements closer to the lower end of Mars' upper atmosphere.

- During normal science mapping, MAVEN makes measurements between an altitude of about 150-6,200 km (93=3,853 mi) above the surface.

- "During the "deep-dip campaigns," we lower the lowest altitude in the orbit, the periapsis, to about 125 km (78 mi) which allows us to take measurements throughout the entire upper atmosphere.
- The 25 km (16 miles) altitude difference may not seem like much, but it allows scientists to make measurements down to the top of the lower atmosphere. At these lower altitudes, the atmospheric densities are more than ten times what they are at 150 km (93 miles).
- The first deep dip campaign ran from Feb. 10 to 18. The first three days of this campaign were used to lower the periapsis. Each of the five campaigns lasts for five days allowing the spacecraft to observe for roughly 20 orbits.
- Since the planet rotates under the spacecraft, the 20 orbits allow sampling of different longitudes spaced around the planet, providing close to global coverage.
- Scientists aimed at a certain atmospheric density, to go as deep as they could without putting the spacecraft or instruments at risk.
- Even though the atmosphere at these altitudes is very tenuous, it is thick enough to cause a noticeable drag on the spacecraft.
- Going to too high an atmospheric density could cause too much drag and heating due to friction that could damage spacecraft and instruments.
- At the end of the campaign, two maneuvers were conducted to return MAVEN to normal science operation altitudes.
- Science data returned from the deep dip will be analyzed over the coming weeks.
- The science team will combine the results with what the spacecraft has seen during its regular mapping to get a better picture of the entire atmosphere and of the processes affecting it.
- One of the major goals of the MAVEN mission is **to understand how gas from the atmosphere escapes to space, and how this has affected the planet's climate history through time.**
- It is the thicker lower atmosphere that controls the climate. MAVEN is studying the entire region from the top of the upper atmosphere all the way down to the lower atmosphere so that the connections between these regions can be understood.
- MAVEN is the first mission dedicated to studying the upper atmosphere of Mars.
- MAVEN successfully entered Mars' orbit on Sept. 21, 2014.

MAVEN Takes another 'Deep Dip' Into Martian Upper Atmosphere

MAR. 27, 2015 - www.space.com/28946-**maven-mars-probe-atmosphere-deep-dip**.html

NASA's newest Mars probe recently made a risky dive into the Red Planet's upper atmosphere to learn more about how the planet's climate changed over time.

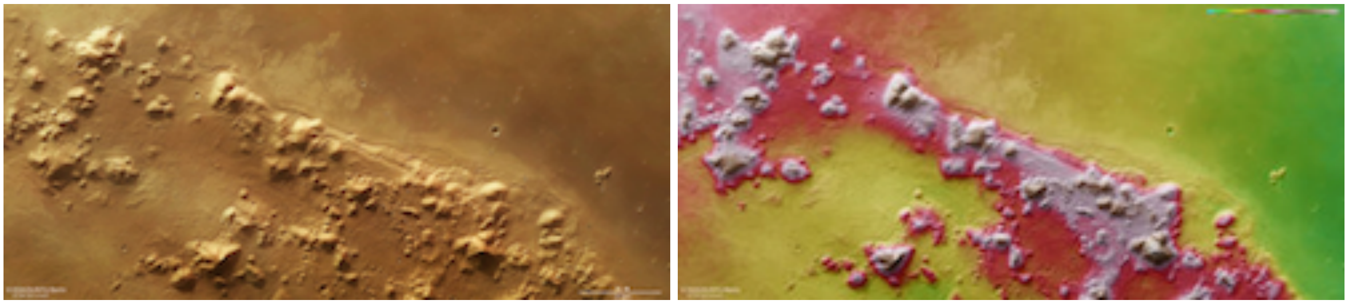
- Between Feb. 10-18, NASA's MAVEN (**M**ars **A**tmosphere and **V**olatile **E**voloutio**N**) spacecraft reduced its minimum altitude to 125 km (78 mi) — about 25 km (15 mi) lower than usual.
- This subjects the spacecraft to atmosphere 10 times thicker than in its normal orbit altitude.
- There are few atmospheric molecules at that altitude, but if MAVEN were to dip much below that, it risks encountering too much drag — the spacecraft could loss speed and can fall to Mars' surface.
- However, MAVEN successfully completed the maneuver and is preparing for at least four more "deep dips" during its mission, projected to last at least a year.
- NASA actually aimed at a certain atmospheric density - as deep as we can without putting the spacecraft or instruments at risk.
- By better understanding how molecules escape into space, scientists hope to track how Mars lost its atmosphere over time.
- There is abundant evidence of water flowing on Mars in the ancient past, between water-soaked minerals detected by rovers on the surface and gullies spotted by orbiters far above the surface.
- Extensive amounts of water require a thicker atmosphere.
- It is believed that Mars atmosphere had more light molecules — a lighter type of hydrogen.
- Over millions of years, the sun's energy pushed these molecules out into space, thinning the atmosphere.

- MAVEN spent five days collecting data across 20 orbits.
- After Feb. 18, MAVEN was brought back to its usual minimum altitude of 150 km (93 mi).
- More data on the dive will be available in the coming weeks. ##

Mars' Hills Hide Icy Past

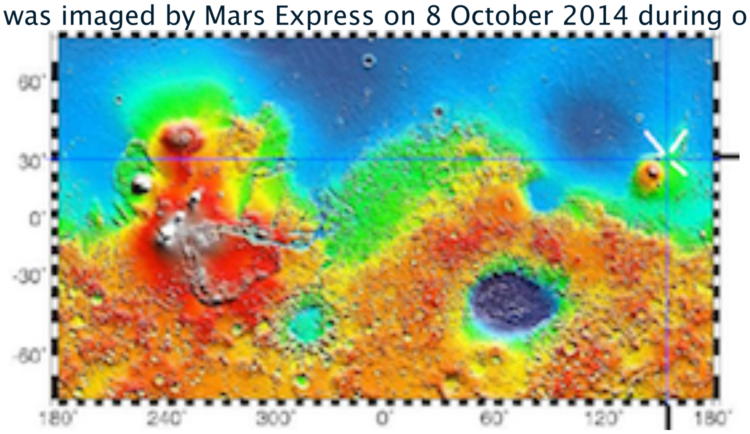
FEB. 19, 2015 – www.esa.int/Our_Activities/Space_Science/**Mars_Express/Mars_hills_hide_icy_past**

A complex network of isolated hills, ridges and small basins spanning 1400 km (870 mi) on Mars is thought to hide large quantities of water-ice.

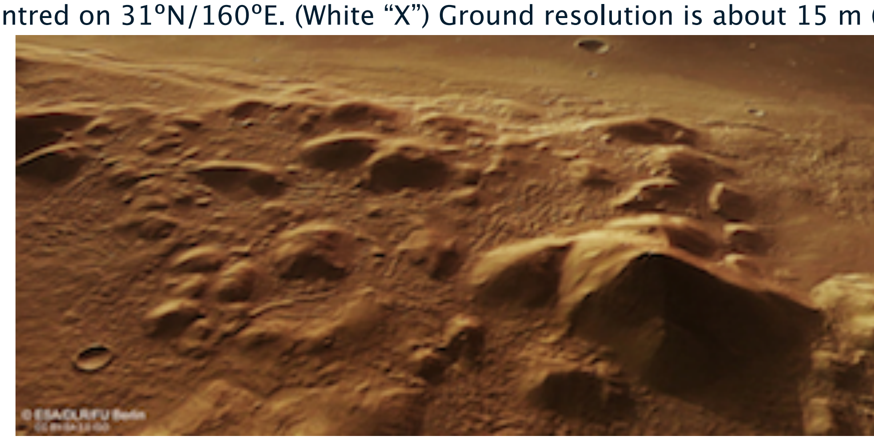


Left: Phlegra Montes southern tip **Right:** topography

The region was imaged by Mars Express on 8 October 2014 during orbit 13670.



The image is centred on 31ºN/160ºE. (White "X") Ground resolution is about 15 m (~50 ft) per pixel.



This oblique perspective view of the southernmost portion of Phlegra Montes was generated using data from the stereo channels of the High Resolution Stereo Camera on ESA's Mars Express.

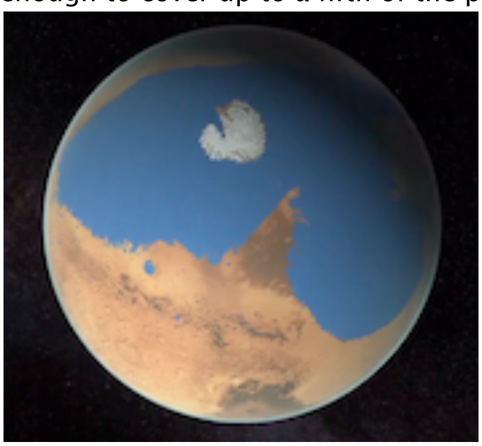
- The region was imaged by Mars Express on 8 October 2014 during orbit 13670. The image is centred on 31ºN / 160ºE. The ground resolution is about 15 m per pixel.
- Phlegra Montes, about 3.65-3.91 billion years old, stretches from the Elysium volcanic region at about 30ºN, deep into the northern lowlands at about 50°N, as a product of ancient tectonic forces.
- Its age is estimated to be 3.65-3.91 billion years.

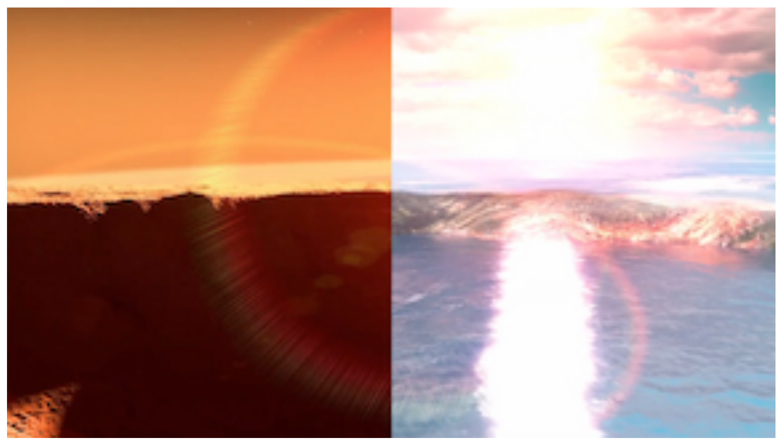
- Radar data from NASA's Mars Reconnaissance Orbiter, and studies of the region's geology from other orbiters, indicate extensive glaciers may have covered this region several hundred million years ago.
- It is thought that ice is still there today, perhaps only 20 m below the surface.
- Mars' polar axis tilt seems to have varied considerably over time, significantly changing climatic conditions that allowed the development of glaciers at what are today the mid-latitudes of Mars.
- Features visible in the Phlegra Montes mountain range are strong evidence for glacial activity
- Examples are aprons of rocky debris surrounding many of the hills, similar to features seen in glacial regions on Earth, where material has gradually slumped downhill with the help of subsurface ice.
- Additional features in the region include small valleys cutting through the hills and appearing to flow into regions of lower elevation, in particular towards the centre of the image.
- 'Wrinkle ridges, visible in the lava plain, arise from the cooling and contraction of lava owing to compressive tectonic forces following its eruption onto the surface.
- This Phlegra Montes and its local surrounds illustrate some of the key geological processes that have worked to shape Mars over time, from ancient tectonic forces, to glaciation and volcanic activity. ##

Wet Mars: Red Planet Lost Ocean's Worth of Water, New Maps Reveal

MAR. 6, 2015 – www.space.com/28742-**ancient-mars-ocean-water-lost**.html
www.space.com/28745-**ocean-covered-20-percent-of-mars-new-research-suggests-video**.html
http://arstechnica.com/science/2010/06/**ocean-once-covered-the-northern-third-of-mars/**

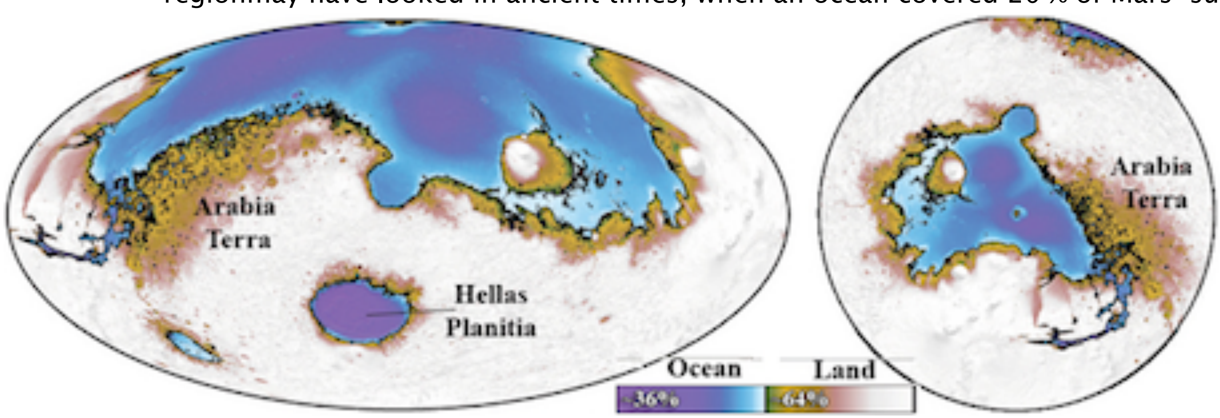
New maps of water in the atmosphere of Mars reveal that the Red Planet might once have had enough to cover up to a fifth of the planet.





Left: Maps of the water content in the atmosphere of Mars suggest the Red Planet once had an ocean that covered 20 % of its surface, 1/5th of the planet. Most of that water was lost to space.

Right: artist's illustration shows a view of how Mars looks today (left) and how the same regionmay have looked in ancient times, when an ocean covered 20 % of Mars' surface.



Above: Looking at the "ocean" from above (right) better shows probable extent. Note that the **Hellas Planitia Basin** – the deepest area on Mars, probably held part of this endowment.

Note: The estent of **"the blue area"** on familiar MOLA maps of Mars indicates how much of the planet's surface is below the average height (something like "sea level" – but only the deeper parts of this area probably were likely to have been covered by ocean. That is still a significant amount, with **some underground reservoirs still preserved**.

Refining these maps could help identify underground reservoirs on Mars

- Mars' surface is now cold and dry, but there is plenty of evidence suggesting that rivers, lakes and seas covered the Red Planet billions of years ago.
- Life might have evolved on Mars back then, and could still be there, in subterranean aquifers.
- We aren;t sure how Mars lost its water and how much if any might remain in underground reservoirs.
- One way to solve these mysteries is to analyze the percentage of water molecules still in the Martian atmosphere, that have deuterium – (instead of two hydrogen atoms and one oxygen atom, one or both of these might be deuterium atoms creating "deuterated water} (with one neutron.)
- Normal water wold vaporize more easily. Solar radiation can break this water up into hydrogen and oxygen, and the hydrogen can then escape into space.
- Deuterated water is heavier than normal water, and will not escape that easily
- The current ratio of deuterium to hydrogen in Mars water, is a clue how much total water Mars lost .
- New maps of the ratio between hydrogen and deuterium in the water in the Martian atmosphere have been created using data gathered from 2008 to 2014 by the Very Large Telescope in Chile, and the Keck Observatory and NASA's InfraRed Telescope Facility in Hawaii.
- The ratio between deuterated water and normal water in some regions of Mars was higher than thought, **typically seven times higher than in Earth's oceans**.
- This high ratio suggests that Mars has lost a great deal of water over time.
- Much remains unknown about how Mars lost its water and how much liquid water might remain in underground reservoirs.
- Based on their findings, scientists estimate that Mars might have had enough water to cover up to 20 percent of the planet about 4.5 billion years ago.
- They suggest the Red Planet could still possess substantial underground reservoirs of water.
- But not to forget that some of that water is preserved in Mars north and south polar caps, (covered in winter with a larger expanse of frozen carbon dioxide) ##

EDITOR'S COMMENTS: The existence of sub-surface ice deposits here and elsewher on Mars, could be essential in "drawing the map" of future human settlement. We are water-dependent creatures! ##

Search For Volcanic Eruptions On Mars Reaches The Next Level

www.marsdaily.com/reports/**The_Search_For_Volcanic_Eruptions_On_Mars_Reaches_The_Next_Level_999.html**

FEB. 26, 2015 – A new study of emissions from Martian volcanoes suggests there is no activity going on right now, but researchers aren't ruling out recent eruptions.

No signs of sulfuric acid – a key indicator of volcanic activity

- The team focused on the major volcanic provinces of Mars (Tharsis and Syrtis Major) in two, multi-week observation sessions, one from December to January 2012, and another in May and June 2014.
- These findings match similar negative results from searches the team conducted using the Very Large Telescope in Chile and the Palomar Observatory radio telescope.
- Different types of molecules emit characteristic "signatures" based on the energy of their individual elements, with each one acting as a sort of fingerprint for investigators.
- In radio wavelengths, the search technique is slightly different; scientists look for distinctive lines that occur as the molecules rotate.
- Fortunately, sulfuric acid shows up quite well in these wavelengths.
- The next logical step in the research is getting up close to Mars to do a lengthy search, using an instrument approved on a forthcoming European spacecraft, the 2016 ExoMars Trace Gas Orbiter

- From Earth, searching is tricky. Telescope time only gives you a particular time or instance and you don't have the whole picture
- The orbiter provides daily atmosphere maps, to learn a lot about the actual processes on the planet.
- The ExoMars iinstrument will not only look for volcanism - a sign of energy that could be a source for life to grow on - but also organic substances that could indicate byproducts of life itself.|One key question has been whether Mars great volcanoes are extinct.
- In 2004, ESA's Mars Express spacecraft examined Olympus Mons. Geological evidence suggested that lava flowed in the area within the past two million years, implying the volcano may still erupt again.\
- Evidence of recent volcanic eruptions would require either direct observations or looking for the products of their emissions in the atmosphere.
- Based on Earth observations, sulfuric acid would be the most likely trace gases.
- On Mars, however, there has been little in the way of systematic searches.\A dedicated Mars orbiter will be a key step.

NOMAD will examine Mars in three ways.

1. A solar occultation channel provides information on gas composition when the Sun is visible through the atmosphere.
2. A channel that is more sensitive to emissions as seen from the surface, and that will be primarily downward facing during the mission.
3. A channel that permits observations at ultraviolet wavelength searching for sulphuric acid, ozone and also allows for aerosol studies.

Working with other spacecraft

- The main targets of NOMAD will be organic molecules that have a carbon-hydrogen bond, such as ethane, methane and ethylene - not necessarily signs of life - but could indicate past or current habitability and could point to recent activity.
- NOMAD will also hunt for a plethora of biologically and geologically relevant molecules, with a diverse mix of sulfur, chlorine, oxygen and nitrogen atoms.
- The Curiosity rover recently reported definitive signs of organics and sulfur and chlorine compounds on the surface of Mars, and existence of methane plumes in the atmosphere,.
- In order to be in the atmosphere, there has to some thermal injection or release.
- This release could come from some underground heat source, or perhaps from volcanism.
- It will take multiple instruments to confirm any findings

Another tool will enter Earth's orbit in 2018.

- The James Webb Space Telescope, to be in orbit in 2018, has a resolution that should be ample enough to search for sulfur in the Martian atmosphere.

"The theory is that if you have water protected for a long time underground, it should have a different isotopic ratio of hydrogen and deuterium than any on the surface"

- This is one of the main goals of MAVEN (Mars Atmosphere and Volatile EvolutioN), a NASA spacecraft that arrived at Mars this year.
- ExoMars will also perform investigations of this and as more landing missions hunt for water below the surface, they could provide more evidence of Mars' atmosphere changing over geologic time.
- Meanwhile, NASA’s 2020 Mars rover will focus on searching for habitability. ##

Scientists fly kites on Earth to study Mars Volcanic Flows

MAR. 17, 2015 - www.marsdaily.com/reports/**Scientists_fly_kites_on_Earth_to_study_Mars**_999.html

Scientists of the U. of Arizona's Lunar and Planetary Laboratory have taken to kites that they fly above lava flows blanketing the Hawaiian landscape to unravel the past mysteries that shaped Mars.

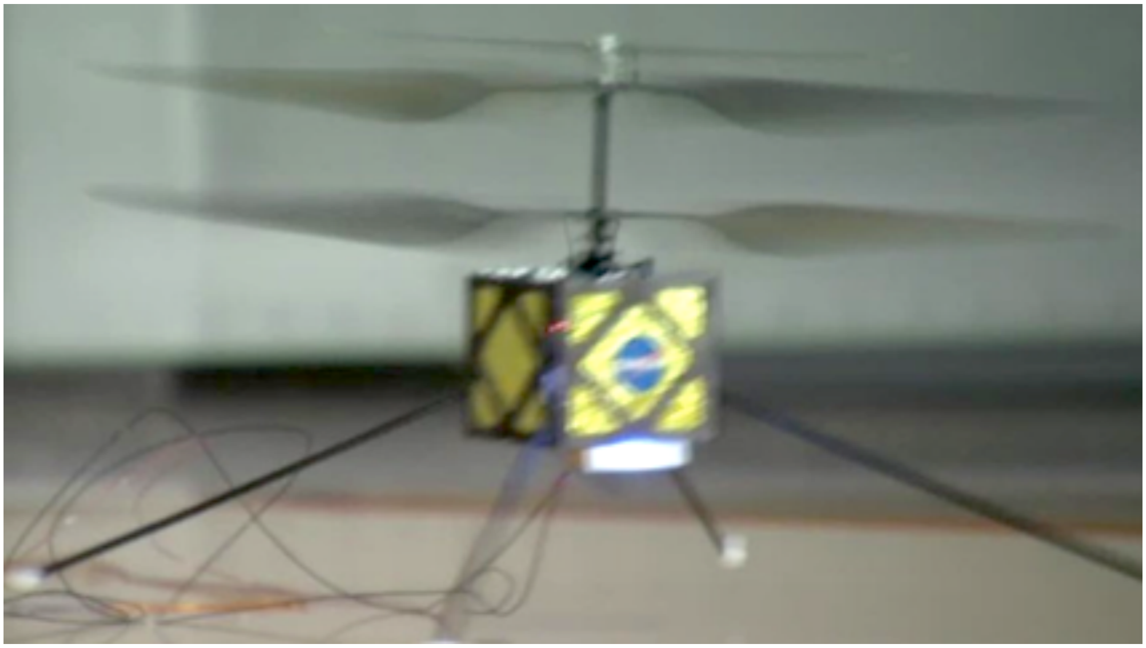
- A kite, equipped with off-the-shelf instruments - a camera, a GPS, and orientation sensors, scans the terrain from high above.
- The team then employs parallel computing and powerful software algorithms to assemble tens of thousands of images into extremely detailed and accurate 3D digital terrain models.

- In terms of studying volcanic landscapes, the project is unprecedented in its scope and in the quality of the data it produces, with a spatial resolution of approximately half an inch per pixel.
- They presented their results and methodology at the 46th Lunar and Planetary Science Conference, March 16-20 in The Woodlands, Texas.
- The insights gained from these terrain models are used to inform interpretations of images of the surface of Mars, taken with the HiRISE camera aboard NASA's Mars Reconnaissance Orbiter, which has been examining Mars with six instruments since 2006.
- HiRISE (**Hi**gh **R**esolution **I**maging **S**cience **E**xperiment) has revealed never-before seen details on Mars.
- "The idea is to understand places we can't go by analyzing places we can go."
- Christopher Hamilton, the principal investigator of the research team, joined LPL in 2014 to establish a terrestrial analog research group to study how the Mars' internal processes manifest on the surface.
- Lava flows are terrestrial analogs that can provide insights into processes that shape other planets.
- The goal is to develop diagnostics to help recognize actual processes that formed a certain feature.
- Kilauea Volcano on the Island of Hawaii was chosen as their study area, a "chemical desert" with several geologically very young lava flows, in particular the December 1974 flow, which poured out of the volcano on New Year's Eve 1974 in a short-lived eruption, which is currently accessible by foot.
- Comparing it to images of the Martian surface taken by HiRISE, brings out striking similarities.
- This is how the big lava flows formed on Mars, strongly suggesting they may not be what they seem.
- Many features once seen as channels carved by running water are more likely to be the result of a volcanic "fill-and-spill" lava emplacement, which developed when lava accumulated in enormous "perched ponds" that breached like an overtopped dam, giving way to catastrophic floods of lava.
- In fact, many of these features on Mars formed by flowing lava, not water."
- In certain areas, the surface is broken up into plates and what superficially looks like channels carved by running water. However, these turn out to be not carved at all, but rather are the result of a complex pattern of lava movements within the flow.
- First, liquid lava filled the area between the cliffs from older lava lows like a big bathtub, and when the perched lava pond breached, the lava surged forward causing plates of cooled lava on the surface to break apart and fresh lava to well up from underneath. As the plates were floating toward the drain, they became crumpled.
- The digital terrain models even revealed a "bathtub ring" formed when lava filled the pool.
- The driving question is, 'how can we assemble this kind of data for Mars landscapes and decide whether a feature is volcanic or fluvial - shaped by water - and allow us to develop a story?'"
- The relationships between textures allow you where to look and what to look for."
- A technique, called Multi-View Stereo-Photogrammetry, produces images that appear like aerial photographs taken from an airplane, but they are not actually photographs, but image mosaics projected onto digital terrain models.
- The kite takes an image every two seconds, producing up to tens of thousands of photos of a site, The software then removes any distortion, and stitches those images together to create a virtual representation of the terrain that you would never have otherwise.
- This "orthorectification" process, uses massive computing power and in weeks forms a terrain model.
- The result is a resolution high enough to clearly show footprints in the sand blanketing the lava flow.
- This approach shows how the combination of ground-based observations and an aerial perspective can help us to decipher the geologic history of Earth and Mars.
- The combination of ground-based observations and an aerial perspective can help us to decipher the geologic history of Earth and Mars. ##

How Micro-Helicopters Could Fly on Mars - Video

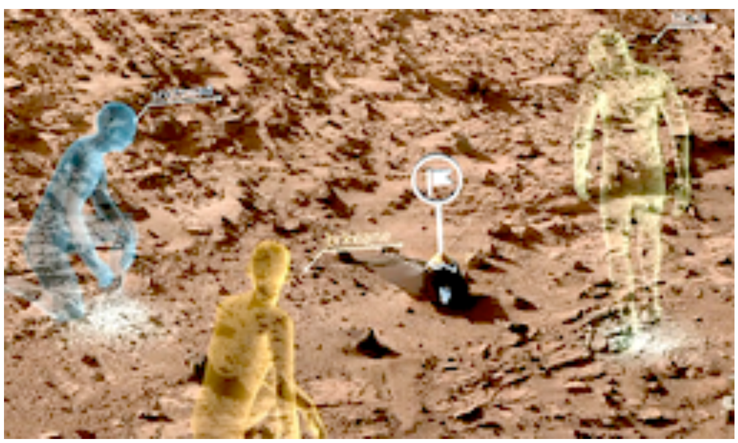
www.space.com/28358-**how-helicopters-could-fly-on-mars-video**.html

The gravity and atmosphere of the Red Planet are far different than that of Earth. Helicopter designs would have to be altered. NASA Jet Propulsion Laboratory's Bob Balaram explains the challenges, with a "cubesat" sized helicopter model 10 cm (4") on a side, with NASA logo..This Mars "chopper" could scout the path ahead for future Mars rovers, perhaps finding more "interesting" routes than the ones planned.



NASA, Microsoft Collaboration Will Allow Scientists to 'Work on Mars'

www.nasa.gov/press/2015/january/**nasa-microsoft-collaboration-will-allow-scientists-to-work-on-mars/**



This view shows what **OnSight**, a new holographic planning tool using Microsoft HoloLens technology, looks like when viewing the Martian surface. NASA will start using the technology to plan the Curiosity rover's Martian route later in 2015.

JAN. 21, 2015 – NASA and Microsoft are developking software called **OnSight**, a new technology that will enable scientists to work virtually on Mars using **wearable technology called Microsoft HoloLens**.

- Developed by Jet Propulsion Laboratory (JPL), OnSight will give scientists a means to plan and, along with the Mars Curiosity rover, conduct science operations on the Red Planet.
- "OnSight gives scientists the ability to walk around and explore Mars right from their offices. It changes our perception of Mars, and how we understand the environment surrounding the rover."
- OnSight will use real rover data and extend the Curiosity mission's existing planning tools by creating a 3-D simulation of the Martian environment where scientists around the world can meet.
- Program scientists will be able to examine the rover's worksite from a first-person perspective, plan new activities and preview the results of their work firsthand.
- Until now, rover operations required scientists to examine Mars imagery on a computer screen, and make inferences about what they are seeing. But images, even 3-D stereo views, lack a natural sense of depth that human vision employs to understand spatial relationships.

- The OnSight system uses **holographic computing to overlay visual information** and rover data into the user's field of view.
- Holographic computing blends a view of the physical world with computer-generated imagery to create a hybrid of real and virtual.
- To view this holographic realm, members of the Curiosity mission team don a Microsoft HoloLens device, which surrounds them with images from the rover's Martian field site. They then can stroll around the rocky surface or crouch down to examine rocky outcrops from different angles.
- The tool provides access to scientists and engineers looking to interact with Mars in a more natural, human way.
- The OnSight tool also will be useful for planning rover operations. Scientists can program activities for many of the rover's science instruments by looking at a target and using gestures to select menu commands.
- The joint effort to develop OnSight with Microsoft grew from an ongoing partnership to investigate advances in human-robot interaction.
- The JPL team responsible for OnSight specializes in systems to control robots and spacecraft. The tool will assist researchers in better understanding the environment and workspace of robotic spacecraft -- something that can be quite challenging with their traditional suite of tools.
- JPL plans to begin testing OnSight in Curiosity mission operations later this year.
- Future applications may include Mars 2020 rover mission operations, and other applications in support of NASA's journey to Mars. ##

How Smart Can Robotic Space Explorers Get?

MAR. 10, 2015 - www.space.com/28774-**robots-intelligence-space-exploration**.html

[We have placed this article here, because out as far as Mars, where teleoperation is quite tedious, if possible at all, because of the long time delays, 6-40 minutes, 120-800 times longer than with the Moon (3 seconds).

- It gets far worse out by Jupiter/Europa) and Saturn/Titan. Our exploring spacecraft and surface vehicles must be intelligent enough to decide where to go to next, and what to do next.]
- If a robot plunges into the ocean of an icy moon, its main problem will be figuring out what to do next. Even at light speed, it takes hours for communications to pass back and forth to Earth.
- A robotic explorer must be smart enough to avoid danger, and sophisticated enough to figure out what information to send back.

Parallel difficulties underwater on Earth and in deep space

Yogesh Girdhar, as a part of his doctorate dissertation at McGill University in Montreal, redid the "brains" of an undersea robot called Aqua. An underwater robot is somewhat analogous to a space-bound robot, as both face the difficulties of communication.

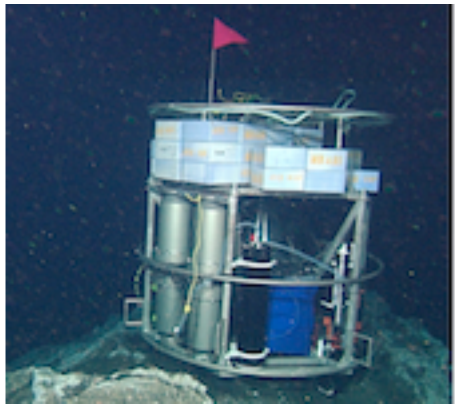
- The amount of data is a problem. You can't be streaming HD video from Mars all the time, live.
- Underwater, there are no radio waves. Because of salt water, you can only use an acoustic modem. It's very low bandwidth. You can receive data at a much higher speed from Mars than you can from a robot deep underwater.

Self-training robots

- The key to getting around that problem is having therobot train itself to recognize **what is typical terrain and what is unusual.**

Seeking the unusual

- A typical underwater robot on Earth can do simple tasks, such as moving in a predesigned "mowing the lawn" pattern Along the way, it can gather thousands or perhaps hundreds of thousands of pictures. The robot can sift through all that information through pattern recognition.
- The robot would build a database of the various kinds of patterns associated with these terrain types.
- If the robot spotted something different (e.g. a coral reef the robot considers it "interesting."
- If programmed to prioritize the more unusual items it comes across, the robot could then spend more time examining that corresponding terrain and send those pictures back to Earth.



The successful test-run of a deep-sea explorer is a significant step toward proving the feasibility of launching autonomous robots to search ocean depths for exotic new life forms:.
www.astrobio.net/topic/exploration/robotics-a-i/new-robotic-explorer-to-search-for-deep-sea-dna/

- The robot starts off with no information, so you don't need to feed anything into it.
- We don't want to create bias. ##

White House Seeks $18.5 Billion NASA Budget, with Mars in Mind

FEB. 2, 2015 – www.space.com/28433-**nasa-budget-request-2016-deep-space**.html – (**Video**)
http://www.space.com/28409-**ligo-generations-the-film-hd-video**.html

The White House budget proposal for NASA in 2016 calls for a $500 million boost over the 2015 enacted budget and **would keep NASA on its path to Mars**.

- The $18.5 billion budget request includes funding for developing **a mission to Jupiter's moon Europa**, and the agency's **Asteroid Redirect Missio**n (ARM).
- Officials think ARM could help pave the way for crewed missions to the Red Planet by the 2030s.
- The iscal year 2016 budget could end the long-running Opportunity mission on Mars next year.
- The NASA budget request would also end operations for the Lunar Reconnaissance Orbiter (LRO), but, like Opportunity, officials are looking for additional funding to keep the mission going through fiscal year 2016. LRO has been orbiting the moon since 2009.
- NASA's **Orion spacecraft program** to bring humans to deep-space destinations like Mars — and **Space Launch System** mega-rocket are funded at lower levels than the budget enacted in 2015.
- The new budget also includes funds or the continuation of the Commercial Crew Program, to help private companies create space systems that can ferry astronauts to and from the Space Station.
- The $1.2 billion budget is up from the $805 million allotted in 2015.
- Private spaceflight companies Boeing and SpaceX are to deliver astronauts to the station by 2017.
- Under the proposed budget, NASA should be given a little less than $5.3 billion for science missions, including $620 million for the James Webb Space Telescope, expected to launch in 2018.
- The science budget also includes $1.36 billion for planetary science, with a mission to Europa.
- The request also asks NASA to develop the next in the series of Landsat satellites, Earth-gazing missions to monitor the climate and observe deforestation among other objectives. ##

Russia, US to Jointly Prepare Mars, Moon Flight Road Map

www.spacedaily.com/reports/**Russia_US_to_Jointly_Prepare_Mars_Moon_Flight_Road_Map_999.html**

MAR. 31, 2015 – Russia and the United States will work together on a roadmap to send humans to Mars and the Moon, according to NASA Administrator Charles Bolden.

- The Russian Federal Space Agency Roscosmos and iNASA will jointly hammer out a "road map" program on flights to Mars and the Moon.
- Bolden, currently on a tour of Russia's Baikonur cosmodrome in Kazakhstan, had discussed joint efforts twith Roscosmos head Igor Komarov, including time frames and funding.

- They discussed how best to use our/their resources, finances, and time frames
- They also discussed how bet to distributing efforts in order to avoid duplication.
- NASA announced the extension of cooperation with its International Space Station partners, including Russia, for another nine years in February.
- The US-Russia cooperation on the development of the international Space Station is under way despite the fact that NASA halted the majority of its joint activities with Russia over the Ukraine crisis in April 2014.

NASA's Opportunity Rover Wins 1st Marathon on Mars

[The original Greek Marathon was 42.195 km (26.219 mi)]

MAR. 24, 2015- www.space.com/28922-**mars-marathon-opportunity-rover**.html

www.space.com/28923-**mars-marathon-opportunity-rover-infographic**.html

www.nasa.gov/press/2015/march/**nasas-opportunity-mars-rover-finishes-marathon-clocks-in-at-just-over-11-years**

Over the past 11 years and 2 months, **Opportunity** has traveled 42.198 km (26.221 mi) since touching down on Mars' surface on Jan. 24, 2004

Its twin, "**Spiri**t," landed successfully on Mars three weeks earlier, on January 4, 2004, but bogged down in late 2009, a little over 5 years ago, after almost 6 years of field work. ##

NASA May End Long-Lived Mars Rover Opportunity Mission Next Year

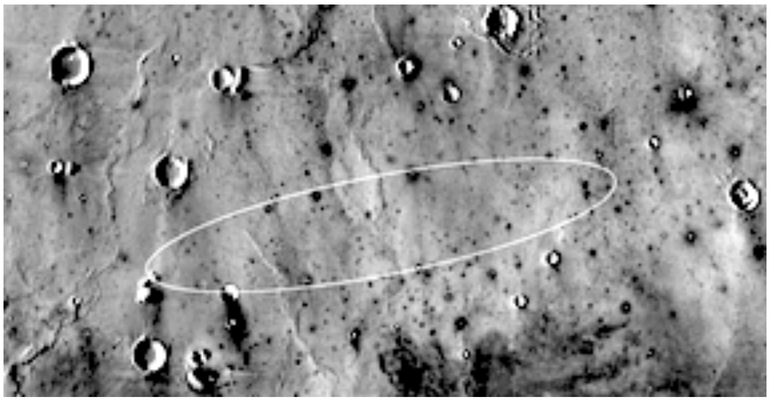
FEB. 2, 2015 - www.space.com/28434-**mars-rover-opportunity-nasa-budget**.html

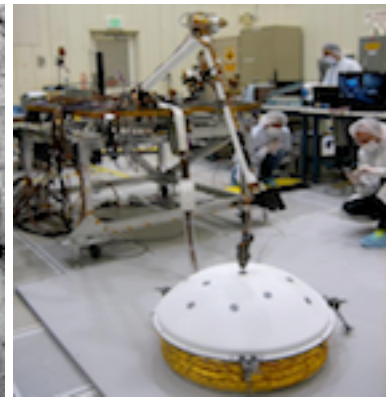
- Long-lived Mars rover Opportunity could lose its funding in 2016, but that is not definite.
- (Fiscal year 2016 begins on Oct. 1, 2015.)
- The proposed federal budget for fiscal year 2016 does not include money for Opportunity.
- That seemingly signals the impending end of a mission exploring Mars for more than 11 years.
- But NASA has not officially axed Opportunity — or the agency's prolific Lunar Reconnaissance Orbiter (LRO), which finds itself in the same budgetary situation
- "We will look at continuing the operation of those activities, and finding ways to fund them - if in fact they actually are operational by 2016 - and the science value does make sense."
- Neither Opportunity nor LRO were allocated funds in thefiscal year (FY) 2015 budget request, but money has been found to keep both missions going.
- The 2016 federal budget proposal is just that — a proposal. Final funding for NASA and other federal agencies must still be approved by Congress, and that is not assured.
- Opportunity and LRO got $14 million and $12.4 million, respectively, in FY 2014.
- Opportunity and its twin, Spirit, touched down on Mars a few weeks apart in January 2004, and were tasked with three-month missions to search for signs of past water activity on the Red Planet. Both rovers found plenty of such evidence, which helped to reshape scientists' understanding of Mars and its history. And the two golf-cart-size rovers just kept rolling along.

- Spirit stopped communicating with Earth in March 2010 and was declared dead in 2011.
- Opportunity ris still exploring the rim of 22 km (14-mi) wide Endeavour crater since August 2011.
- But the rover's robotic arm has long been a bit arthritic, and Opportunity recently began experiencing problems with its flash memory, which allows the rover to store information when the power is off.
- Opportunity has traveled 42 km (26 mi) on Mars — farther than any other vehicle on another world.
- The previous record of 39 km (24.2 mi) was set by the Soviet Lunokhod 2 moon rover in 1973.
- If the White House request for $18.5 billion to NASA in the FY 2016 would be a $500 million boost over the enacted budget for FY 2015. ##

NASA Eyeing Landing Site for 2016 Mars Mission

MAR.11, 2015 - www.space.com/28793-**nasa-insight-mars-lander-landing-site**.html





L: Elliptical area being evaluated as landing site for NASA's InSight Mars (R) mission, to launch in March 2016, is a particularly smooth patch of terrain just north of the Martian equator. The site lies at about 4° N and 136° E is the leading canditate for the InSight rover

"**InSight**" is short for **In**terior Exploration using **S**eismic **I**nvestigations, **G**eodesy and **H**eat **T**ransport.

- After touching down, Insight will use several different science instruments to study Mars' crust, mantle and core, in an attempt to better understand how rocky planets take shape and evolve.

Mars Core: Liquid or Solid?

- Data gathered by InSight should reveal, the size of Mars' core, and whether it's liquid or solid,
- Based heavily on NASA's Phoenix Mars lander, InSight features a heat-flow probe that will hammer itself up to 5 m (16.5 ft) beneath the Martian surface.
- Besides smooth terrain, another top priority for landing-site selection, is ground soft enough for for the probe to burrow so deep.
- The site is one of four finalists selected in 2014, all in a flat Martian region called Elysium Planitia.
- Each site has a landing ellipse about 130 km (81 mi) long by 27 km (17 mi) wide. ##

HUMANS TO MARS

SpaceX's Elon Musk to Reveal Mars Colonization Ideas This Year

JAN. 8, 2015 - www.space.com/28215-elon-musk-spacex-mars-colony-idea.html

- The details of his Mars Colonial Transporter would be unveiled by the end of the year
- The plan would be different from the Dragon capsules and Falcon 9 rockets SpaceX is flying today.
- The Mars transport system will be a completely new architecture,.
- He hopes to present the plan towards the end of this year.
- The goal will be to send 100 metric tons (110 tons) of "useful payload." h
- “This obviously requires a very big spaceship and booster system."

Elon Musk, the billionaire entrepreneur behind the private spaceflight company SpaceX, says he will unveil his concepts for Mars colonization later this year (2015). ##

Buzz Aldrin: "How to Get Your Ass to Mars" Video

www.space.com/28313-**buzz-aldrin-how-to-get-your-ass-to-mars-video**.html

1-Year Space Station Mission May Pave NASA's Way to Mars

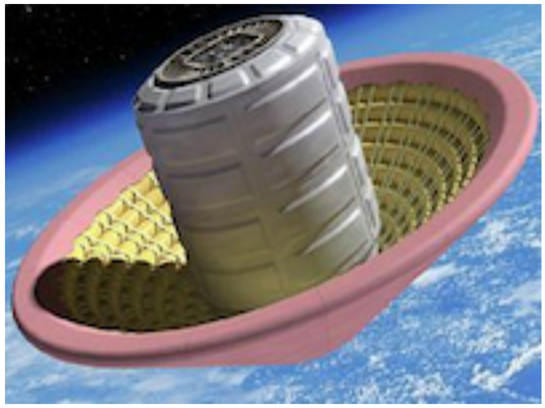
JAN. 16, 2015 – www.space.com/28287-y**earlong-space-station-mission-mars**.html

- The first crew to embark on a yearlong Space Station mission could help NASA get to Mars.
- NASA astronaut Mark Kelly and Russian cosmonaut Mikhail Kornienko will launch to the space station in March and remain aboard, performing research until March 2016.
- This mission will mark the first time a crew has spent a continuous year on the space station
- Researchers, scientists and doctors on the ground will monitor the way their \bodies change throughout the year in order to understand potential effects of long-term spaceflight (like a mission to Mars).
- Kelly said "Traveling around Earth at 17,500 mph in a vacuum, extremes of temperature and pressure, building this facility that allows us to understand how to operate for long periods of time in space, most likely in weightlessness, to allow us someday to go to Mars."
- How Kornienko and Kelly perform in orbit could be a first step toward understanding how to mitigate any harmful changes the body might go through during a long trip in space.
- NASA officials have a good sense of how the body behaves when exposed to the rigors of spaceflight 'for up to six months,' but after that, the data is a little hazy. ##
-

Inflatable 'Donut' to Bring Astronauts to Mars

JAN. 6, 2015 – www.marsdaily.com/reports/**Inflatable_Donut_to_Bring_Astronauts_to_Mars**_999.html

- NASA is crafting a donut-shaped inflatable landing mechanism to land a manned expedition on Mars.
- A manned expedition cannot be sent to the Red Planet without a safe and reliable landing system.
- Because of the thin atmosphere, rockets or parachutes can't deliver loads heavier than a rover.
- However, NASA's Langley Research Center engineers have invented an inflatable donut-looking heat shield for entering a planet's atmosphere – the Hypersonic Inflatable Aerodynamic Decelerator, or HIAD. The rings will be filled with nitrogen and covered with a thermal blanket. When activated, they will enlarge just like a car airbag and form a large "mushroom" operating as a brake.
- The bigger the aeroshell, the more you decelerate.
- The projected device must be quite light to save valuable energy and volume during a space journey: something that could be packed up in a very small volume and then deployed into a very large size.
- Making use of Mars' atmosphere as much as possible, means we need to carry less fuel.



Video explanation: https://www.youtube.com/watch?v=fVcSaki8d-4

- This idea can be applied to exploration of such atmosphere-covered planets as Titan, Jupiter or Venus, and other celestial bodies.
- Experiments are underway with diameters of roughly 11, 13 and 14.5 feet, about half the size needed and would use about 8-10 concentric rings.
- The scientists plan to check how HIAD will stand the re-entry in Earth's atmosphere in 2016 to decide whether it can return equipment from the International Space Station (ISS). ##

Tiny Mars One Greenhouse Could Fly Plants to Mars in 2018

JAN. 6, 2015 – www.space.com/28165-**tiny-greenhouse-mars-one-colony**.html

www.marsdaily.com/reports/**Students_to_Send_Life_to_Mars_Onboard_Mars_One_Lander_in_2018**_999.html

Lifeforms from Earth may touch down on Mars just a few years from now

- A team composed of students from Portugal, Spain and Netherlands has won the Mars One University Competition which offers a one way ticket to Mars for a scientific payload.
- The greenhouse experiment, known as **Seed**, was one of 35 proposed lander science payloads submitted by university groups around the world. Mars One whittled this original pool down to 10 finalists, and Seed was chosen by a monthlong public vote that closed on Dec. 31
- "Plants could supply oxygen and food, but according to several researches on the International Space Station, plants have trouble growing in a (no gravity) environment outside Earth. We would like to check in situ the real difficulties for plant development, monitoring the growth of some seeds that in the future could serve as vital support for the first humans on Mars."
- The payload will send seeds of the small flowering plant **Arabidopsis thaliana**, an organism commonly used in space-science experiments, to Mars inside two containers. (The outer one will serve a protective function.)
- Upon landing, the seeds will be exposed to heat and a growth medium, giving them the chance to germinate and grow. Images relayed to Earth will let team members — based at several universities in Portugal and Spain — know how the experiment is going.
- Seed is designed to advance researchers' understanding of the potential for plant growth on Mars, which could aid the development of life-support systems on the Red Planet.
- Although Seed won the competition, it has not yet locked down its spot on the 2018 mission.
- Mars One will first examine the proposal, to make sure it is feasible and can be integrated on the lander. If this analysis reveals any serious issues, Mars One may end up going with one of the contest runners-up. (The second- and third-place finishers are Cyano Knights and Lettuce on Mars.)
- Mars One aims to land four astronauts on the Red Planet in 2025, kickstarting a permanent colony that will be augmented with new arrivals every two years thereafter. There are no plans at the moment to bring any of the settlers back to Earth.

- To help prepare for colonization, Mars One — a nonprofit based in the Netherlands — plans to launch a number of robotic precursor missions, including the 2018 effort, which would send a communications orbiter and lander to Mars.
- Mars One intends to pay for its ambitious activities primarily by staging a global media event around the colonization process, from astronaut selection through the pioneers' time on the Red Planet.

The 'Seed' project, selected by popular vote from 35 university proposals, aims to contribute to the development of life support systems and provide a deeper understanding of plant growth on Mars.

- "The first evidence, provided by recent NASA exploration missions, does not confirm the fertility of Mars soil, and the sunlight that arrives might be not enough for the photosynthesis.
- "We imagine a garden covered and protected under a greenhouse, isolated from Mars' environment."
- Plants are one of the key solutions tfor the settlement of a human extraterrestrial base due to their photosynthetic capacity to create oxygen and food and resistance to adverse environments.
- The 'Seed' team consists of four bioengineering students from the University of Porto (Portugal) and two PhD students from MIT Portugal and the University of Madrid.
- The University of Portois helping with the project, and some tests in microgravity will take place at the VU-University of Amsterdam, simulating part of the environment that the seeds will have in Mars.
- This 2018 mission will be a demonstration mission and will provide proof of concept for some of the technologies that are important for a permanent human settlement on Mars. ##

Mars One Colony Project Cuts Applicant Pool to 100 Volunteers

FEB. 16, 2015 – www.space.com/28571-**mars-one-colony-100-applicants**.html

One hundred people are still in the running to become humanity's first Mars explorers. .

- Netherlands-based nonprofit **Mars One**aims to land four pioneers on the Red Planet in 2025 as the vanguard of a permanent colony. More than 202,000 people applied to become Red Planet explorers after Mars One opened the selection process in April 2013.
- The pool of astronaut candidates has now been whittled down to 100.
- The latest cut came after Mars One medical director Norbert Kraft interviewed the 660 candidates who had survived several previous rounds of culling.
- The cut is an important step towards finding out who has the right stuff to go to Mars "to stay."

- The remaining pool consists of 50 men and 50 women who range in age from 19 to 60.

Where they come from

- 39 from the Americas, including 33 from the United States, others from Canada
- 31 from Europe, 16 from Asia, 7 from Africa and 7 from Australia.
- These remaining 100 candidates will next participate in group challenges, to demonstrate their ability and willingness to deal with the rigors of life on Mars.
- After another round of cuts, the finalists will be divided into four-person teams, which will **train in a simulated Red Planet outpost**.
- Mars One intends to select 24 astronauts in six 4-person teams), who will become full-time employees of the organization and prepare for the Mars colonization mission.
- "Being one of the best individual candidates does not automatically make you the greatest team player," so it is important to learn how the candidates work together in the upcoming challenges,.
- Mars One wants to send new four-person crews to the Red Planet every two years or so after the first touchdown, currently scheduled for 2025.
- At the moment, there are no plans to bring any of these Mars colonists back to Earth. "To Mars to stay" is the goal, becoming the first permanent settlers.

Robotic precursor missions to prepare the ground for people

- The first robotic mission would deliver a lander and orbiter to Mars, leaving Earth in 2018.
- Mars One will not build any Mars-bound spacecraft itself, but will contract the work out to aerospace companies.
- The organization plans to pay for its ambitious activities primarily by staging a global media event around the colonization process, from astronaut selection and training to the pioneers' time on Mars.

Mars One Colony Project Delays Manned Red Planet Mission to 2026

MAR 19, 2015 – http://www.space.com/28877-**mars-one-colony-launch-delay**.html

The private colonization project Mars One has pushed its planned launch of the first humans toward the Red Planet back by two years, to 2026.

- The delay was necessitated by a lack of investment funding, which has slowed work on a robotic precursor mission that Mars One had wanted to send toward the Red Planet in 2018, to test out technologies needed for human settlement.
- The Netherlands-based nonprofit awarded contracts to Lockheed Martin and Surrey Satellite Technology to work on the lander and orbiter, respectively.
- Mars One had a "very successful investment round in 2013 that has financed all the things that we have done up to now. And we have actually come to an agreement with a consortium of investors late last year for a much bigger round of investments. Unfortunately, the paperwork of that deal is taking much longer than we expected,"
- Delaying the first unmanned mission by two years also means that all the other missions will move by the same period of time, having our first human landing now planned for 2027.
- Astrophysicist Joseph Roche, a former Mars One astronaut candidate, alleges that the organization has been picking its astronauts at least partly based on how much money they donate to the private colonization effort.
- Roche also says that Mars One's selection process is flawed and slipshod.
- Article author Elmo Keep alleges that Mars One received just 2,761 applications from prospective settlers, not the 202,000 claimed by the organization.
- Mars One disputes these assertions in the video, saying that money has nothing to do with the selection process, and that Mars One's numbers are accurate.
- Lansdorp said that the selection process will become more thorough from here on out, as the organization whittles the group down from 100 finalists to the 24 who will train to go to Mars.

- Mars One aims to launch four-person crews to the Red Planet every two years, beginning in 2026.
- They would not be returning home

Editor: a strong stimulurs to "make it work" - which, given the proposed architecture, will not happen.

New Tech Could Protect Astronauts' Eyes on Mars Mission

MAR. 26, 2015 – www.space.com/28938-**mars-mission-astronaut-vision-tech**.html

Three new technologies could help keep astronauts' vision sharp during a mission to Mars.

The National Space Biomedical Research Institute (NSBRI) Industry Forum earlier this month funded three companies as part of its "Vision for Mars" challenge to encourage the development of technologies that can mitigate the visual problems astronauts experience during long-term spaceflight.

The Vision for Mars winners are:

- **Annidis Inc.** and its retina-imaging ophthalmoscope;
- **Equinox**, which is developing a pair of pressure-regulating goggles;
- **Web Vision Centers Group**, which aims to manufacture glasses with lenses that can be swapped out easily to accommodate a changing prescription.
- Long-term exposure to a reduced-gravity environment can take a toll on the human body. Space Station astronauts must exercise vigorously every day to stave off muscle atrophy and a decrease in bone density.
- Doctors have begun to realize that lots of time in space can lead to seriious eye problems as well.
- Many researchers think the issues result primarily from an increase in pressure inside the skull.
- Cerebrospinal fluid flows into the head more in space than on Earth, where it's pulled down by gravity.
- Such health issues are a real concern for astronauts on journeys in space of a year or more.
- To get a better handle on just what rigors a Mars expedition could impose, NASA astronaut Scott Kelly and Russian Mikhail Kornienko will launch to ISS March 27 on the 1st-ever year long misson .
- The ophthalmoscope should be able to image the retina in fine detail without invasive procedures,
- The goggles are designed to stabilize pressure within the eye.
- And the lens-swapping glasses could help astronauts adjust when their eyes change shape in micro-gravity, causing their visual acuity to change as well.

Down to Earth Spin-offs

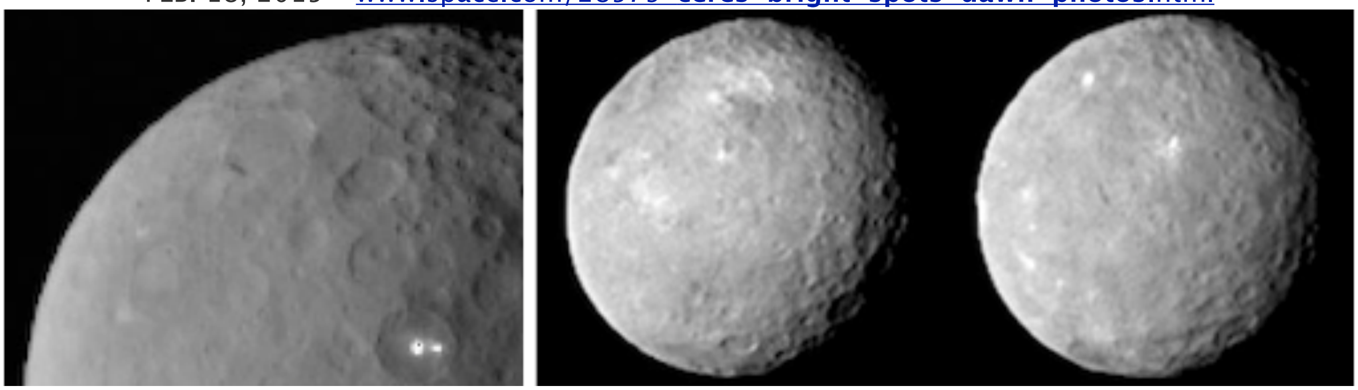
- The prescription-changing glasses are well-suited for children, whose eyesight shifts over time.
- And the goggles have similarly high spinoff potential.
- The Equinox device could provide a non-invasive method to treat eye problems affecting astronauts on prolonged space missions.
- The spinoff of this technologyi could be a therapeutic option for patients suffering from glaucoma. ##

[The articles below have been bullet-summarized by the editor. For the full text, see the links cited.]

CERES

Mysterious Bright Spots Shine on Dwarf Planet Ceres (Photos)

FEB. 18, 2015 – www.space.com/28579-**ceres-bright-spots-dawn-photos**.html



Two photos of the dwarf planet Ceres taken by NASA's Dawn spacecraft on Feb. 12, 201, from a distance of about 52,000 miles (83,000 kilometers).

- NASA's Dawn spacecraft will have plenty of mysteries to investigate when it begins orbiting the dwarf planet Ceres, as the probe's latest photos attest.
- Images taken by Dawn Febuary 12 at a distance of (83,000 km (52,000 mi) away, show an abundance of craters on the dwarf planet, as well as numerous bright spots that have scientists baffled.
- The new photos, with a resolution of 7.8 km (4.9 mi) per pixel, are the sharpest ever taken of Ceres.

Large, flickering white spot

- This feature became visible in photos Dawn took of Ceres in January.
- It is something on Ceres that reflects more sunlight, but what that is remains to be learned.
- Dawn os scheduled to enter orbit around the 950 km (590-mi) wide Ceres, the largest body in the main asteroid belt between Mars and Jupiter, on the night of March 5.
- Dawn will start studying Ceres in earnest six weeks after that;
- The probe is scheduled to work its way down to its first science orbit on April 23.FEB. 24, 2015 –
- Dawn is scheduled to study Ceres from a variety of orbits through June 2016, when the probe's mission will come to an end. ##

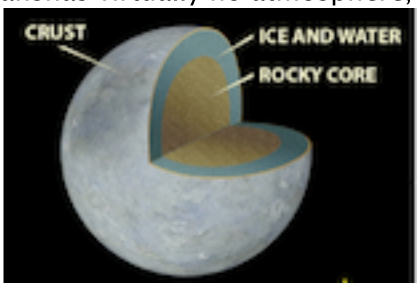
What Would It Be Like to Live On Dwarf Planet Ceres?

FEB. 24, 2015 – www.space.com/28640-**living-on-ceres**-asteroid-belt.html
www.space.com/28595-**living-on-asteroids-dwarf-planet-ceres-infographic**.html

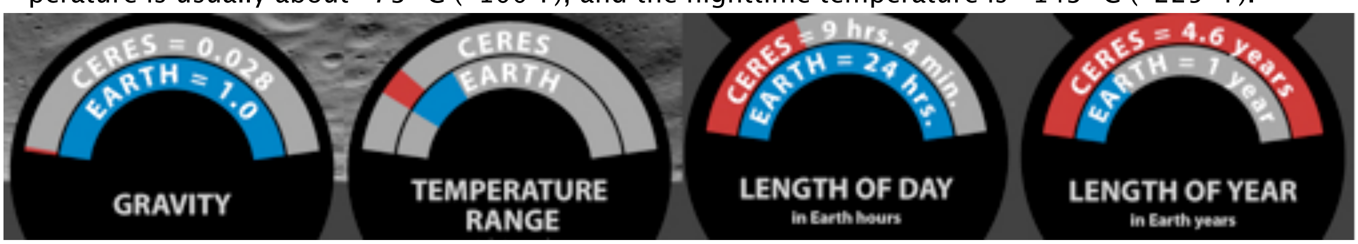
In recent years, asteroid belt objects have gained much attention as potential locations for future space mining operations to harvest water to be btoken down into hydrogen and oxygen to fuel long-distance space missions

- A potential resource is Ceres, the largest object in the asteroid belt, ~1/3 of the belt's mass.
- Ceres may contain more subsurface water ice than all the **fresh** water on Earth
- Its high gravity compared with other belt objects makes it one of the most suitable locations for a permanent base in the asteroid belt.
- We probably wouldn't start mining ice there because it's very far away.

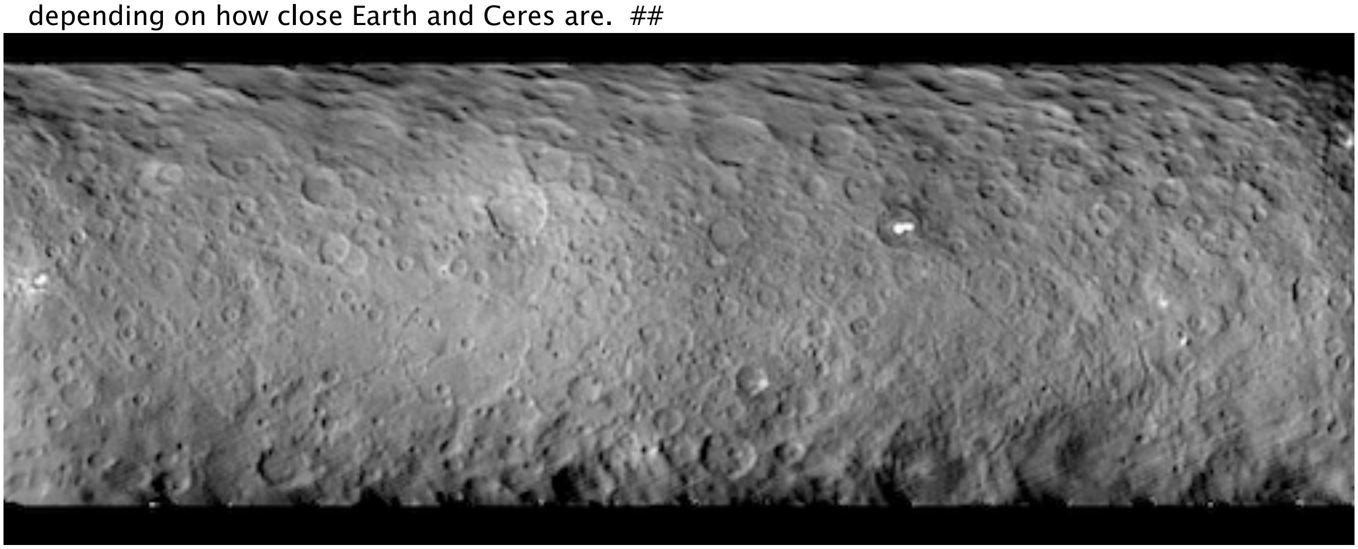
- From a resource and mining standpoint, lots of other objects are closer.
- The European Space Agency's Herschel Space Observatory found that water vapor ejects into space from Ceres, possibly from volcano-like icy geysers or ice patches on the dwarf planet's surface.
- But these vapor jets would be far too weak to pose any danger to you if you walked near them. They're so tenuous that "they would probably be difficult to even see," from close up.
- Though Ceres is the largest asteroid belt object, its gravity is still only less than 3% of Earth's gravity.
- But you could probably walk around on it.
- Ceres has the surface area of India (or of the United States east of the Mississipi.)
- We do not know the health effects of living with 3% normal gravity for an extended period of time.
- Ceres also meanshas virtually no atmosphere, so you wouldn't experience weather or see any “sky”



- The sky would be a clear black, loaded with stars
- You likely wouldn't be able to see many other asteroids through your spacesuit helmet because objects in the belt are on average about 1.6 million km (a million mi) apart from each other.
- Living on Ceres, you'd be subject to extreme shifts in (always cold) temperatures. The daytime temperature is usually about -73 °C (-100°F), and the nighttime temperature is -143 °C (-225 °F).



- Ceres' axis is tilted only 3° so there wouldn't be much “seasonal” difference
- Ceres is nearly three times as far away from the sun as Earth.
- In the middle of Ceres's 9-hour-long day, the Sun would only be about 15% as bright and a 3rd as large as it would appear at noon on Earth.
- Sunrises on Ceres would be short — just 45 seconds to go from pitch black to full sunlight
- As to communications with Earth, you could expect a response from between 15 ans 30+ minutes, depending on how close Earth and Ceres are. ##



Mercator projection of Ceres' surface. Note the two bright spots in one crater

Dawn entered orbit around Ceres March 6 so where are the hot Pix?

MAR. 6, 2015 – http://dawn.jpl.nasa.gov/feature_stories/**Dawn_First_Orbit_Dwarf_Planet**.asp

"The most recent images received from the spacecraft, taken on March 1, show Ceres as a crescent, mostly in shadow because

- **The spacecraft's trajectory put it on a side of Ceres that faces away from the sun**
- **Until mid-April.**
- **When Dawn emerges from Ceres' dark side, it will deliver ever-sharper images as it spirals to lower orbits around the planet."** – Patience!

ASTEROIDS

Cosmic Impacts May Have Seeded Early Earth with Ingredients for Life

JAN. 20, 2015 – http://www.space.com/28309-**early-earth-cosmic-impacts-life**.html

- Bullets of ice shot at high speeds can deposit organic compounds on surfaces they strike. New findings suggest that comets might, indeed, have helped deliver key ingredients of life to Earth and perhaps elsewhere, researchers say.
- Craters on the Moon sjpw that the Inner Solar Systemw as prone to giant impacts from asteroids and comets during the "Late Heavy Bombardment," between 4.2 billion to 3.8 billion years ago.
- This violent period overlaps with evidence of the earliest life on Earth, suggesting that these impacts may have played a role in the origin of life.
- The key building blocks of life on Earth — such as sugars, amino acids and DNA — are carbon-based molecules known as organic compounds. Decades of research have revealed that complex organic compounds are found in space and can be successfully delivered to Earth.
- Scientists have found amino acids in meteorites, and NASA'a Stardust mission to the comet 81P/Wild 2 returned samples from the envelope of gas and dust around the comet's heart that revealed the presence of amino acids and other organic materials.
- Cometary impacts could deliver vast quantities of organic compounds to Earth, and perhaps other potential abodes of life as well, such as Mars and Jupiter's moon Europa.
- An open question is how well complex organic compounds delivered by cosmic impacts actually survive these crashes, given destructive factors: high speeds, extreme pressures and extraordinary heat.
- A number of experiments have sought to mimic these conditions in the lab, subjecting amino acids to high temperatures and pressures. These conditions, far from harming the organic compounds, might even help synthesize them.
- A variety of tests have shot projectiles at targets rich in organic molecules. Researchers have fired steel projectiles at nearly 11,200 mph (18,000 kph) at ices loaded with organic compounds, and have also experimented with shooting projectiles containing organic-rich mudrock, and other organic compounds, at sand and water targets. The research suggested that organic molecules, and even microbes, could survive high speed impacts.
- However, no one had sought to see if organic molecules in frozen projectiles could survive high-speed impacts. Now, scientists have fired such icy bullets at a variety of types of targets in order to mimic the effects of a comet's impact on Earth and other bodies in the Solar System.
- Projectiles made of a frozen mixture containing organic compounds, such as anthracene and stearic acid found in coal tar.were fired using a gun powered by gas pressure, kept refrigerated before use.
- Three types of target — sand, ice and liquid water — represent various surfaces found throughout the Solar System
- The projectiles were launched at these targets at speeds of roughly 7,200 to 14,400 kph (4,475 to 8,950 mph), the kinds of speeds at which rocks blasted off Earth hit the Moon, or at which meteorites collide with Pluto and other icy bodies in the Outer Solar System.
- The organic compounds survived well after slamming into all targets.

- In the future, the researchers would like to use organic-rich icy projectiles launched at roughly 54,000 -72,000 kph (33,550-44,750 mph), more typical of the speeds of comets striking the Earth or Moon.
- They can currently fire projectiles at speeds up to about 21,600 - 25,200 kph (13,425 - 15,650 mph)

Asteroids May Not Be Planet Building Blocks After All

JAN. 16, 2015 - www.space.com/28272-**asteroids-planet-building-blocks**.html

Asteroids have long been regarded as planetary building blocks. But ta new study suggests that they may actually be byproducts of planet formation, born when violent collisions smashed an earlier generation of objects apart.

- Asteroid fragments that fall to Earth as meteorites often contain tiny, round pellets called chondrules that formed when molten droplets quickly cooled in space in the solar system's early years. Chondrules are found in 92% of all meteorites, and are often thought to be the building blocks of planets.
- Chondrules were part of the protoplanetary disc of gas and dust surrounding the newborn sun that gave birth to Earth and the other planets.
- A recent study found that chondrules formed about 1 million years after planetesimals — the building blocks of protoplanets — came together.
- Prior research had suggested that chondrules in some meteorites were probably born when rocks in space collided at speeds of more than 36,000 km/h (22,370 mph). However, it was uncertain how the majority of chondrules formed.
- Now, scientists have found that cosmic impacts could have generated enough chondrules during the first 5 million years or so of planet formation to explain the large quantity of these pellets.
- "The most surprising implication of our work is that the meteorites we find on Earth are not actually the building blocks of planets, as has been thought for a long time." I
- "Instead, they may be a byproduct of planetary formation."
- Chondrule-bearing meteorites — known as chondrites — may thus not be representative of the objects that built the solar system's planets.
- The researchers simulated impacts of varying speeds between protoplanetary objects 100 to 1,000 km wide (about 60 to 650 mi) wide. When collision speeds exceeded 9,000 km/h (5,590 mph), plumes of molten rock that blasted out from these impacts could form millimeter-size droplets that could have cooled into chondrules.
- Cosmic impacts within a typical protoplanetary disc could have generated more than 20 billion trillion kg (44 billion trillion lbs.) of chondrules. For compartson, the present asteroid belt currently has a mass of about 20 billion trillion kgms (6.6 billion trillion lbs.).
- This finding suggests that cosmic impacts could have generated many of the chondrules in the asteroid belt from which nearly all meteorites originate. ##

NASA Asteroid Hunter Spacecraft Data Available to Public

www.nasa.gov/press/2015/march/**nasa-asteroid-hunter-spacecraft-data-available-to-public/**

MAR. 26, 2015 - 2.5 million image sets, detecting and providing data on over 10,000 solar system objects, including asteroids, observed by NASA's Near-Earth Object Wide-field Infrared Survey Explorer (NEOWISE) spacecraft now are available online to the public.

- The data was collected following the restart of the asteroid-seeking spacecraft in December 2013 after a lengthy hibernation.
- The collection of millions of infrared images and billions of infrared measurements of asteroids, stars, galaxies and quasars spans data obtained between December 13, 2013, and December 13, 2014.
- The data revealed 129 new solar system objects, including 39 previously unknown near-Earth objects.
- Each of the images also contains a multitude of background stars, nebulae and galaxies. More than 10 billion measurements of these more distant objects are contained in the release of the NEOWISE data.
- NASA has already added another 21 new discoveries including six new near-Earth objects."

- The NEOWISE telescope scans the skies for asteroids and comets, sensing infrared light, picking up the heat signature of asteroids and obtaining better estimates of their true sizes.
- Thus NEOWISE can see dark asteroids that are harder for visible-light surveys to find.
- Nearly all of the NEOWISE discoveries have been large -- hundreds of meters ~ yards wide and as "dark as printer toner."
- Combining NEOWISE's infrared data with that of a visible-light optical telescope provides clues to the object's composition.
- NEOWISE always looks in the dawn and twilight skies - perpendicular to a line between Earth and Sun.
- This vantage point makes it possible for NEOWISE to spot objects that approach Earth from the direction of the Sun, unlike ground-based telescopes that are only able to view the night sky.
- Originally called the Wide-field Infrared Survey Explorer (WISE), the spacecraft was placed in hibernation in 2011 after its primary mission was completed.
- In September 2013, it was reactivated, renamed NEOWISE and assigned a new mission to assist NASA's efforts to identify the population of potentially hazardous near-Earth objects and help characterize previously known asteroids and comets to provide information about their sizes and compositions.

Application

- NASA has announced more details in its plan for its Asteroid Redirect Mission (ARM), which in the mid-2020s will test a number of new capabilities needed for future human expeditions to deep space, including to Mars.
- For ARM, a robotic spacecraft will capture a boulder from the surface of a near-Earth asteroid and move it into a stable orbit around the Moon for exploration by astronauts, all in support of advancing the journey to Mars.
- The agency plans to announce the specific asteroid selected for the mission no earlier than 2019, approximately a year before launching the robotic spacecraft.
- With Neowise, NASA has increased its detection of near-Earth Asteroids by 65% since launching its asteroid initiative three years ago.

Budgets

- NEOWISE is a vital asset in NASA's program to find objects that truly represent an impact hazard to Earth,
- The President's 1992 NASA budget included, and Congress authorized, $20.4 million for an expanded NASA Near-Earth Object (NEO) Observations Program, increasing the resources for this critical program from the $4 million per year it had received since the 1990s.
- The program was again expanded in fiscal year 2014, with a budget of $40.5 million.
- NASA is asking Congress for $50 million for this important work in the 2016 budget.
- JPL manages the NEOWISE mission for NASA's Science Mission Directorate in Washington.
- The Space Dynamics Laboratory in Logan, Utah, built the science instrument.
- Ball Aerospace & Technologies Corp., Boulder, CO, built the spacecraft.
- Science operations and data processing take place at the Infrared Processing and Analysis Center at the California Institute of Technology in Pasadena. Caltech manages JPL for NASA. ##

ASTEROIDS AS A DANGER TO EARTH

Mystery Antarctic 'Crater' Could Be House-Sized Meteor Blast | Video

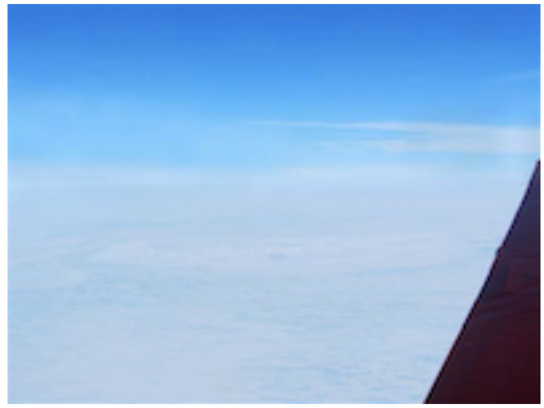
www.sciencepoles.org/interview/**a-serendipitous-find-during-an-airborne-geophysical-survey**

www.nbcnews.com/science/weird-science/**sudden-impact-did-meteorite-carve-icy-crater-antarctica-**n283181

www.space.com/28209-**mystery-antarctic-crater-could-be-house-sized-meteor-impact-video**.html \

DEC. 24, 2014 - A massive area of fractured ice more than a mile wide (2 km across) could by an meteorite impact crater in East Antarctica's King Baudoin ice shelf. On Dec. 20th, 2014, the circular structure was spotted during a survey by German scientists at Belgium's Princess Elisabeth research station.

The possible crater is twice the size of Arizona's famed Baringer Meteor Crater, and possibly just 25 years old. There is some skepticism about the feature's "meteor impact" creation. ##



Origin of Chelyabinsk meteorite remains unknown

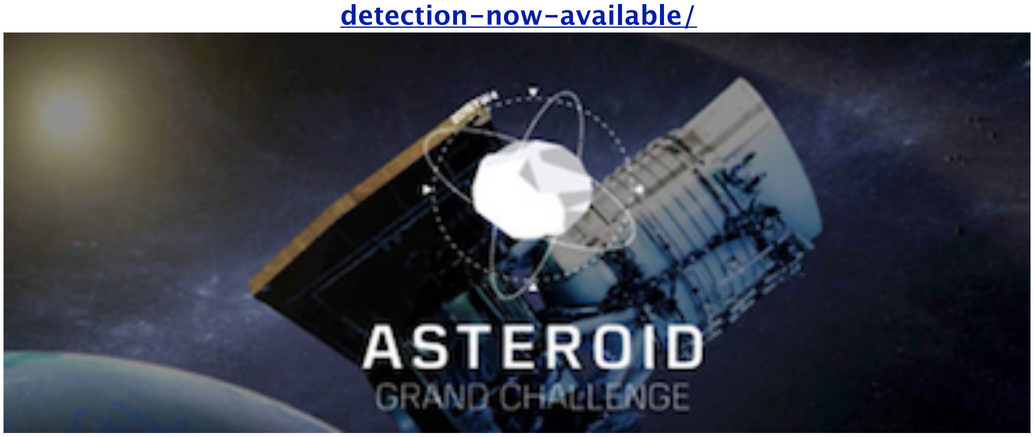
http://behindtheblack.com/behind-the-black/points-of-information/**origin-of-chelyabinsk-meteorite-remains-unknown/**

FEB. 16, 2015 - The origin of the Chelyabinsk meteorite that crashed over the Russian city of that name two years ago remains uncertain.

- Originally, astronomers thought that the Chelyabinsk meteor came from a 2 km (1.24-mi)-wide near-Earth asteroid called 1999 NC43.
- But a closer look at the asteroid's orbit and likely mineral composition, gained from spectroscopy, suggests few similarities between it and the Russian meteor.
- We really can't use the similarity of orbits to link different asteroids, as their orbits are chaotic and ever changing.

New Desktop Application Has Potential to Increase Asteroid Detection Now Available to Public

www.nasa.gov/press/2015/march/**new-desktop-application-has-potential-to-increase-asteroid-detection-now-available/**



A software application based on an algorithm created by a NASA challenge has the potential to increase the number of new asteroid discoveries by amateur astronomers.

"The Asteroid Data Hunter challenge has been successful beyond our hopes, creating something that makes a tangible difference to asteroid hunting astronomers and highlights the possibility for more people to play a role in protecting our planet."

- Analysis of images taken of our solar system's main belt asteroids between Mars and Jupiter using the algorithm showed a 15 % increase in positive identification of new asteroids.
- Citizen scientists have made a difference in asteroid hunting.

- NASA released a desktop software application developed in partnership with Planetary Resources, Inc.
- The application is based on **an Asteroid Data Hunter-derived algorithm** that analyzes images for potential asteroids.
- This tool can be used by amateur astronomers and citizen scientists.
- The data hunter challenge incorporated data provided by the Minor Planet Center (MPC), at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, and images provided by the Catalina Sky Survey, an astronomical survey project run by the University of Arizona, Tucson, and focused on the discovery and study of near-Earth asteroids and comets.
- Astronomers find asteroids by taking images of the same place in the sky and looking for star-like objects that move between frames, an approach that has been used for more than 75 years.
- With more telescopes scanning the sky, the ever-increasing volume of data makes it impossible for astronomers to verify each detection by hand.
- This new algorithm gives astronomers the ability to use computers to autonomously and rapidly check the images and determine which objects are suitable for follow up, which leads to finding more asteroids than previously possible.
- The desktop software application is free and can be used on any basic desktop or laptop computer. Amateur astronomers may take images from their telescopes and analyze them with the application.
- The application will tell the user whether a matching asteroid record exists and offer a way to report new findings to the Minor Planet Center, which then confirms and archives new discoveries.
- The new asteroid hunting application can be downloaded at: http://topcoder.com/asteroids ##

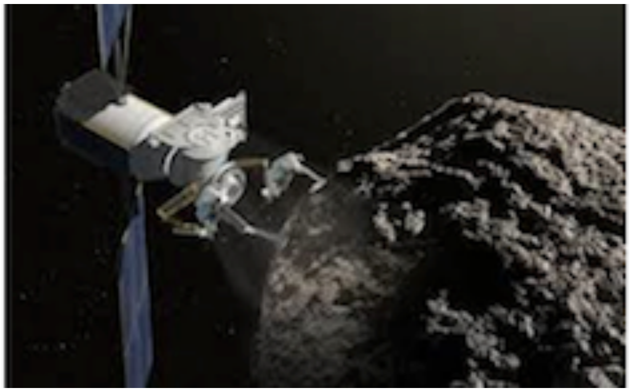
ASTEROIDS AS A RESOURCE

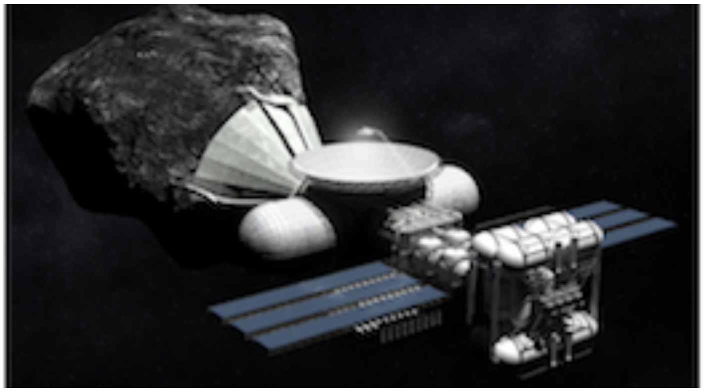
Deep Space Industries: Commercial Space Resource Acquisition & Utilization

http://**deepspaceindustries**.com & **Video**

Deep Space Industries Inc will change the economic model of doing business in space by

- Providing the technical resources, capabilities and system integration required to discover, harvest, process and market in-space resources.
- The company's small-but-daring asteroid scouting missions will begin prospecting for the richest targets.
- The goal is producing water, propellant, and building materials to serve markets in space.. from extending the life and capabilities of commercial satellites to providing life support and power to new private-sector orbiting research stations.





Prospecting Tiny Scouts - Identifying asteroids rich in water and metals will be done using foot-long spacecraft hitching rides on space-available launches.

Harvesting Space Resources - Deep Space will enable the expansion of the human race into the space frontier by developing the ability to find and harvest in-space resources.

Large Scale Asteroid Missions – Multi-ton spacecraft will gather boulders and soil from asteroids rich in resources confirmed by our scouts. Deep Space is under contract to NASA to analyze how the agency and industry can cooperate on the initial industrial-scale missions.Harvesting Space Resources. ##

For Asteroid-Capture Mission, NASA Picks 'Option B' for Boulder

MAR. 25, 2015 – www.space.com/28934-**nasa-asteroid-capture-mission-boulder**.html

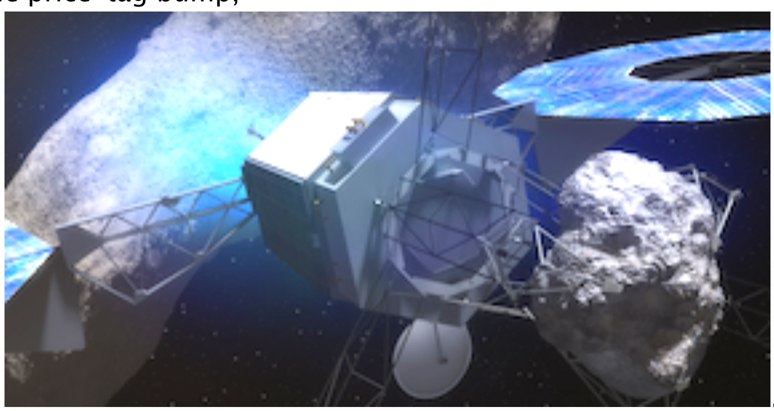
www.nasa.gov/press/2015/march/**nasa-announces-next-steps-on-journey-to-mars-progress-on-asteroid-initiative**/

www.nasa.gov/press/2015/march/**nasa-to-discuss-progress-today-on-asteroid-initiative**/

www.space.com/28940-**nasa-asteroid-mission-what-astronauts-will-do-conceptual-animation**.html

NASA's bold asteroid-capture mission will pluck a boulder off a big space rock rather than grab an entire near-Earth object, agency officials announced today (March 25).

- NASA intends to drag the boulder to lunar orbit, where astronauts will visit it beginning in 2025, chosing the boulder snatch — "Option B," as opposed to the whole-asteroid "Option A" .
- Option B will probably cost about $100 million more than Option A would have, but its advantages =could bee worth the price-tag bump,



- Large asteroids are known to harbor multiple boulders, so the mission will have a number of targets to choose from when it gets to the big space rock.
- Option A is riskier; the capture probe would likely have no recourse if its chosen asteroid proved too large to handle, or otherwise unsuitable.
- Option B will also help develop more of the technologies we need to extend our footprint beyond Earth.
- The idea is to demonstrate capabilities that we may need in taking humans further into space, and ultimately to Mars.

The asteroid plan

- NASA's Asteroid Redirect Mission (ARM) will launch a robotic probe in December 2020.
- After about two years of spaceflight, the craft will rendezvous with a large near-Earth asteroid.
- The target asteroid does not need to be selected before launch, but the leading contender at the moment is the roughly 1,300-foot-wide (400 meters) 2008 EV5.
- The capture probe will assess the chosen asteroid's boulders, grab one up to 4 m (13 ft) wide and then retreat to a "halo orbit around the big space rock.
- The spacecraft will stay in this orbit for 215 to 400 days, long enough for the boulder-toting probe's subtle gravitational tug to influence the orbit of the larger space rock.
- This aspect of the mission should help researchers learn more about how to deflect asteroids that may pose a threat to Earth.
- The capture probe will then head toward lunar orbit, where it should end up by late 2025.
- Two NASA astronauts will then journey out to meet the robotic spacecraft and the boulder, using the agency's Orion capsule and Space Launch System megarocket, both now in development.
- This manned mission will likely last 24 or 25 days..

- The cost of the robotic component of the capture/redirect mission, without any astronaut visits —will be capped at $1.25 billion, not including the launch vehicle.

Getting the show on the road

- The next big milestone for ARM is an "acquisition strategy meeting" in July, at which we'll decide how we're going to procure all these systems – the solar-electric propulsion system that will power the ARM capture probe as one prominent example. ##

More on this topic

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

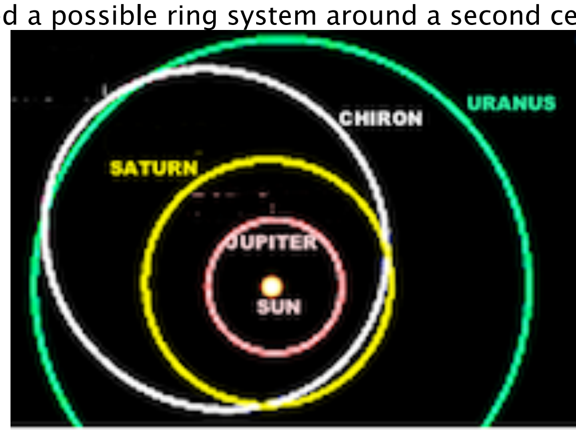
A second minor planet may possess Saturn-like rings

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

http://en.wikipedia.org/wiki/**10199_Chariklo** – http://en.wikipedia.org/wiki/**2060_Chiron**

MAR. 17, 2015 – There are only five bodies in our solar system that are known to bear rings. The most obvious is the planet **Saturn**; to lesser rings of gas and dust also encircle **Jupiter**, **Uranus**, **Neptune**.

- The fifth member of this haloed group is **Chariklo**, one of a class of minor planets called **centaurs**: small, rocky bodies that possess qualities of both asteroids and comets t anbat roam the space between Jupiter's orbit and that of Pluto.
- Chariklo's ring system was only recently discovered – centaurs had been seena as relatively dormant.
- Now scientists have detected a possible ring system around a second centaur, **Chiron**.



- In November 2011, a stellar occultation in which Chiron passed in front of a bright star, briefly blocking its light was analyzed showing the momentary shadow created by Chiron
- Optical features suggest the centaur may possess a circulating disk of debris that may signify a ring system, a circular shell of gas and dust, or symmetric jets of material shooting out from the surface.
- **Catching a shadow**
  Chiron, discovered in 1977, was the first planetary body categorized as a centaur, after the mythological Greek creature -- a hybrid of man and beast. Like
- As in mythology, these centaurs are hybrids, embodying traits of both asteroids and comets.
- Scientists now estimate there are more than 44,000 centaurs in the solar system, concentrated mainly in a band between the orbits of Jupiter and Pluto.
- While most centaurs are thought to be dormant, glimmers of activity have been noted on Chiron – patterns of brightening from the centaur, as well as activity similar to that of a streaking comet.
- A stellar occultation of Chiron led to the first estimates of Chiron's size.
- Optical data looked like jets of water and dust spewing from the centaur's surface.
- MIT researchers have now obtained more precise observations of Chiron, using two large telescopes in Hawaii: one on Mauna Kea, and one on Maui at Haleakala.
- In 2010, the team started to chart the orbits of Chiron and nearby stars in order to pinpoint exactly when the centaur might pass across a star bright enough to detect.

- The researchers determined that such a stellar occultation would occur on Nov. 29, 2011, and reserved time on the two large telescopes in hopes of catching Chiron's shadow.
- Chiron itself is small enough that the event is very short; if you blink, you might miss it.
- The entire event lasted just a few minutes, and the telescopes recorded the fading light as Chiron cast its shadow over the telescopes.
- **Rings around a theory**
  Analysis of resulting light, showed unexpected, symmetrical, sharp features near the start and end of the occultation – a sign that dust might be blocking some of the starlight.
- There were two such features, each about 300 km (185 mi) from the center of the centaur and 3 and 7 km (1.9 and 4 mi) wide, respectively, similar to those observed in the 1990s.
- Chiron may still possess symmetrical jets of gas and dust. However, other interpretations may be equally valid, including the "intriguing possibility," Bosh says, of a shell or ring of gas and dust.

It is possible to imagine scenarios in which centaurs may form rings:

- For example, when a body breaks up, the resulting debris can be captured gravitationally around another body, such as Chiron.
- Rings can also be leftover material from the formation of Chiron itself.
- **Another possibility** involves the history of Chiron's distance from the sun Centaurs may have started further out in the solar system and, through gravitational interactions with giant planets, have had their orbits perturbed closer in to the sun.
- The frozen material that would have been stable out past Pluto is becoming less stable closer in, and can turn into gases that spray dust and material off the surface of a body.
- An independent group has since combined the MIT group's occultation data with other light data, and has concluded that **the features around Chiron most likely represent a ring system**.
- Researchers will have to observe more stellar occultations of Chiron to truly determine which interpretation -- rings, shell, or jets -- is the correct one.
- We'll need observations by multiple observers, distributed over a few hundred kilometers, so that we can map the ring geometry.
- But that alone doesn't tell us if the rings are a temporary feature of Chiron, or a more permanent one.
- The possibility of a second ringed centaur in the solar system is an enticing one.
- Until Chariklo's rings were found, it was believed that these smaller bodies don't have ring systems,Bosh If Chiron has a ring system, it will show it's more common than previously thought. ##

COMETS

Getting to Know Rosetta's Comet

JAN. 22, 2015 www.esa.int/Our_Activities/Space_Science/Rosetta/**Getting_to_know_Rosetta_s_comet**

www.esa.int/spaceinimages/Images/2015/01/**Comet_regional_maps**

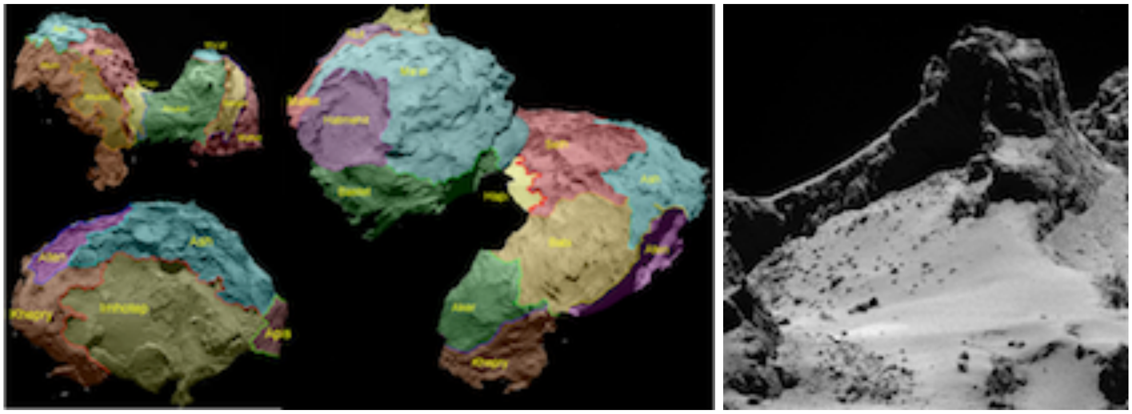
Rosetta is revealing its host comet as having a remarkable array of surface features and with many processes contributing to its activity painting a complex picture of its evolution.

Initial results from seven of Rosetta's 11 science instruments are based on measurements made during the approach to and soon after arriving at Comet 67P/Churyumov-Gerasimenko in August 2014.

A dual lobe shape

- The small lobe measures 2.6 × 2.3 × 1.8 km and the large lobe 4.1 × 3.3 × 1.8 km.
- The total volume of the comet is 21.4 km^3
- Its mass is 10 billion tonnes, yielding a density of 470 kg/m^3.
- The comet has a very high porosity of 70-80%
- Interior structure of weakly bonded ice-dust clumps with small void spaces between them.
- The OSIRIS scientific camera, has imaged some 70% of the surface to date:

- The unseen area in the southern hemisphere has not yet been fully illuminated since Rosetta's arrival.
- Some 19 regions separated by distinct boundaries
- Regions are named for Egyptian deities,
- Regions are grouped according to the type of dominant terrain dominant within.



L: The comet's various regions – R: a view from 8 km (5 mi) away

Five basic – but diverse – categories of terrain type have been determined:

1) dust-covered; 2) brittle materials with pits and circular structures; 3) large-scale depressions; 4) smooth terrains; 5) exposed more consolidated ('rock-like') surfaces.

Much of the northern hemisphere is covered in dust.

- As the comet is heated, ice turns directly into gas that escapes to form the atmosphere or coma.
- Dust is dragged along with the gas at slower speeds
- Particles not travelling fast enough to overcome the weak gravity fall back to the surface instead.

Some sources of discrete jets of activity have also been identified.

- A significant proportion of activity emanates from the smooth neck region
- Jets have also been spotted rising from pits.
- Gases that escape from the surface have also been seen to play an important role in transporting dust across the surface, producing dune-like ripples, and boulders with 'wind-tails'
- The boulders act as natural obstacles to the direction of the gas flow, creating streaks of material 'downwind' of them. ##

Strange Comet Discoveries Revealed by Rosetta Spacecraft

JAN. 22, 2015 – http://www.space.com/28337-**rosetta-comet-spacecraft-strange-discoveries**.html
www.space.com/24266-**rosetta-comet-mission-photos**-esa.html

Rosetta's navigation camera took this 4-image mosaic at a distance of 28.4 km (17.6 mi) from the center of Comet 67P/Churyumov-Gerasimenko on Jan. 16, 2015.

From "Dirty Snowballs" to "Smowy Dustballs" (better reflects its dust-to-gas ratio)

It is craggy, powdery, mysterious, and even holds the building blocks of life. Rosetta has now found that Comet 67P/Churyumov-Gerasimenko's is even stranger than initially expected.

A series of new findings beamed back to Earth by the spacecraft since its arrival at the comet in 2014 could help scientists learn more about how comets evolved through time.

Comets appear to be quite different compared one to the other.

- This comet confirms that we would be wrong speaking only of dirty snowballs.They are thought to be leftovers from the dawn of the solar system, so learning more about them could help piece together the history of the planets and other solar system bodies.
- Scientists have now analyzed various features on the comet's surface to see what the ancient, icy body has experienced in its lifetime.
- The comet harbors carbon-based molecules that are the chemical building blocks of life - the first time organic molecules have been detected on the surface of a comet's nucleus.
- The comet's northern hemisphere is filled with dunes and ripples that look somewhat like geological markings on Earth, Mars and Venus. The comet doesn't have a robust atmosphere and high gravity like those planets, and yet it still has structures resembling sand dunes. So how is that possible?
- While the data isn't crystal clear, it seems possible that the comet's outgassing in the active region on the comet could cause the odd surface features. The high-speed gas flows from the regions, expanding into the vacuum of space, and potentially creating the features.

Bouncing on a come

- The comet's composition is also very diverse. One might sink in into the smooth dust thick snow-field like layers, other areas might be robust enough to support one; The dust is dry like powder.
- Comet 67P/C-G is darker than charcoal — without much water-ice on its surface possibly because it has taken multiple trips around the sun, burning off much of its ice.
- Right now, most of the comet's jet-creating activity is happening from the cliffs and pit walls,
- The northern hemisphere of the comet is relatively warm, while the southern hemisphere is somewhat colder, indicating seasonal changes.
- Many scientists assumed that comets brought water to Earth; Rosetta's findings may upturn that theory. as the deuterium-rich water found in Comet 67P/C-G is so different from terrestrial water it may be **asteroids, rather than comets, as the objects that delivered water to Earth**.

Orbiting dust grains

Rosetta has also been studying the atmosphere (coma) around the comet's nucleus. The probe has detected dust grains orbiting the comet, and scientists are hoping to learn more about how they form and why they remain in the comet's orbit. As the comet gets closer to the Sun and more dust is released from the cosmic body, it's possible that the Rosetta team will have more opportunities to learn about **the dust-to-gas ratio** of the comet.

- Is this comet what is known as a contact binary? — two different cosmic bodies stuck together?
- Comet 67P/C-G appears to be dehydrated on its sunlit side, but as the sun starts to hit the southern hemisphere of the comet, that side of the comet will begin to become active and heat up.
- The shifting sunlight could give the team a chance to understand more about the comet's origins.
- Rosetta scientists are expecting the comet to change quite a lot as it makes its way around the Sun.
- Rosetta and the comet will make its closest approach to the Sun in August.
- The spacecraft should continue studying the comet until around the end of 2015.
- It's even possible that the Philae comet lander, currently on the surface of the comet, might wake up and start beaming back data as the comet heats up during its lap around the Sun this year. ##

Rosetta watches Comet shed its Dusty Coat

www.esa.int/Our_Activities/Space_Science/Rosetta/**Rosetta_watches_comet_shed_its_dusty_coat**

JAN. 26, 2015 = ESA's Rosetta mission is providing unique insight into the life cycle of a comet's dusty surface, watching 67P/Churyumov-Gerasimenko as it sheds the dusty coat it has accumulated over the past four years.

- The COmetary Secondary Ion Mass Analyser, or COSIMA, is one of Rosetta's three dust analysis experiments. It started collecting, imaging and measuring the composition of dust particles shortly after the spacecraft arrived at the comet in August 2014.
- Results from the first analysis of its data covers August to October, when the comet moved along its orbit between about 535 to 450 million km (332 to 280 million mi) from the Sun.
- Rosetta spent the most of this time orbiting the comet at distances of 30 km (19 mi) or less.
- The smany large dust grains broke apart when they were collected on the instrument's target plate, typically at low speeds of 1-10 m/s (3.3-32 ft/s).
- The grains, which were originally at least 0.05 mm across, fragmented or shattered upon collection.
- The fact that they broke apart so easily means that the individual parts were not well bound together.
- If they had contained ice, they would not have shattered. Instead, the icy component would have evaporated off the grain shortly after touching the collecting plate, leaving voids in what remained.
- By comparison, if a pure water-ice grain had struck the detector, then only a dark patch would have been seen.
- The dust particles released first when the comet started to become active again are 'fluffy' - ice free - but with a lot of sodium, characteristic of 'interplanetary dust particles found in meteor streams originating from comets, including the annual Perseids from Comet 109P/Swift-Tuttle and the Leonids from 55P/Tempel-Tuttle.
- The grains detected were probably stranded on the comet's surface after its last nearest approach to the sun, after the flow of gas away from the surface was no longer sufficient to lift dust grains from the surface.
- While the dust was confined to the surface, the gas continued evaporating at a very low level, coming from ever deeper below the surface during the years that the comet travelled furthest from the Sun.
- Effectively, the comet nucleus was 'drying out' on the surface and just below it. ##

Rosetta Spacecraft Makes Nitrogen Discovery on Comet

MAR. 20, 2015 - www.space.com/28884-**rosetta-comet-nitrogen-discovery**.html

A peculiar mix of molecular nitrogen on the comet target of Europe's Rosetta spacecraft may offer clues to the conditions that gave birth to the entire solar system.

- Molecular nitrogen was one of the key ingredients of the young solar system. Its detection in **Comet 67P/Churyumov-Gerasimenko**, which Rosetta is orbiting, suggests that the comet formed under low-temperature conditions (a requirement to keeping nitrogen as ice).
- Since nitrogen is also found in planets and moons in the outer solar system, Rosetta's discovery implies that 67P's family of comets formed in the same area,
- Its detection is particularly important since molecular nitrogen is thought to have been the most common type of nitrogen available when the solar system was forming.
- The colder outer regions likely provided the main source of nitrogen incorporated into the gas planets. t also dominates the dense atmosphere of Saturn's moon Titan and is present in the atmospheres and surface ices on Pluto and [on] Neptune's moon Triton."
- This is the first time it was detected by itself, as molecular nitrogen. Previously, nitrogen was detected inside compounds such as ammonia or hydrogen cyanide.

Weird ratio

- Rosetta detected molecular nitrogen with its ROSINA instrument (**R**osetta **O**rbiter **S**pectrometer for Ion and **N**eutral **A**nalysis) Oct. 17-23, 2014 when orbiting just 10 km (6.2 mi) from the Comet's center.
- The finding also carried a surprise: The **ratio of molecular nitrogen to carbon monoxide** in the comet was **25 times less than what was expected** from models of the early solar system.
- CO is important for the measurements, because the ice that trapped the molecular nitrogen likely formed at similar temperatures as those needed to trap carbon monoxide.
- The unexpectedly low ratio resulted from the way ice is formed at extremely low temperatures.
- The molecular nitrogen may have been trapped inside "cagelike" water-ice called clathrates, at temperatures between -250° C and -200° C (-418 °F and -364°F).

- Alternatively, the ice could have trapped the molecular nitrogen at a temperature of roughly minus -253° C (423 °F). This would make sense if 67P had been in the same region of the solar system as Triton and Pluto, which both have nitrogen in their ices.
- Regardless of the origin story, 67P would have released the nitrogen as it drew closer to the sun, which caused the comet's ice to melt. This could explain the low ratio. ##

On Comet, Philae Lander Still Silent as Europe Keeps Listening

MAR. 26, 2015 - www.space.com/28915-**philae-comet-lander-not-responding**.html

The first spacecraft to make a soft-landing on a comet sits still quiet on the comet's dusty cosmic body, despite being hailed by another probe orbiting the lander.

- The European Space Agency's Philae spacecraft hasn't responded to pings from the Rosetta orbiter since officials began trying to revive the spacecraft his month.
- Phiae is parked in a shady spot on Comet 67P/Churyumov-Gerasimenko t
- Philae made a bumpy landed on the comet in November 2014, but its batteries ran down when it didn't have enough sunlight to recharge.
- The lander has been quiet ever since.
- The comet is much closer to the Sun now than six months ago.
- Mission managers started trying to contact the lander mid-month, hopinge that it had enough energy to respond. But so far, no luck. There's still a chance that Philae could respond next time.
- They will repeat this process until they receive a response from Philae.
- The next favorable opportunity for listening will be in the first half of April, date yet to be set,
- Periodic listening attempts are expected to take place at least through the summer.
- Previously, ESA sent commands to the hibernating spacecraft to helpit conserve power.
- The spacecraft is designed to wake up when its solar panels can generate 5.5 watts of power and its internal temperature is higher than -45°C (-49 °F)
- But, the lander must generate about three times as much power (19 watts) before it can respond .
- If Philae does awaken, the first priority will be to see how healthy it is after half a year hibernating.
- If Philae is able, it will observe the surface to see how the Comet changes while approaching the Sun.
- The Rosetta mission has made numerous discoveries so far: organic molecules on the surface, the first detection of molecular nitrogen in comet gases, and water that is likely of a different isotope composition than what arrived at the early Earth. ##

Comets Are Like Deep Fried Ice Cream, Scientists Say

FEB. 23, 20-15 - www.space.com/28530-**comets-like-deep-fried-ice-cream**.html

www.space.com/28610-**rosetta-makes-closest-fly-by-of-comet-more-to-come-video**.html

Why do comets have a hard, crispy outside and a cold but soft inside?

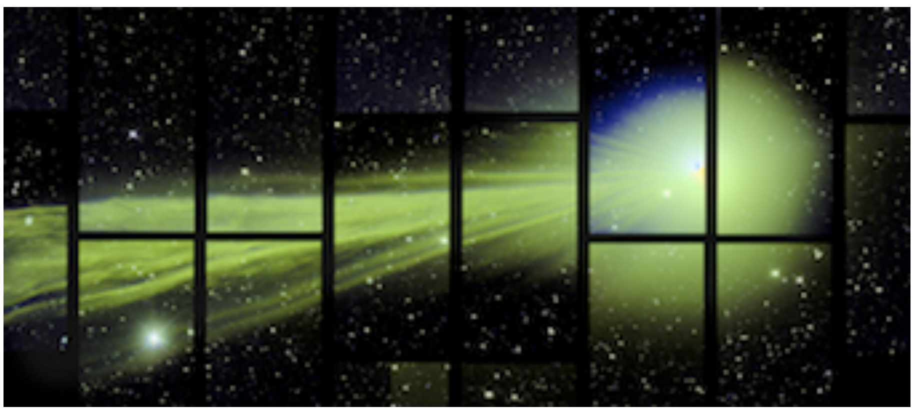
NASA researchers think they have this surprise finding figured out.

- Two NASA spacecraft have interacted with a comet surface, and both found a crunchy exterior and somewhat softer, more porous interior.
- We know that comets are made of a mixture of rock and ice, but until now we could not fully explain this change in texture from the inside to the outside.
- Using a souped-up refrigerator - a "cryostat instrument" - scientists have reproduced the conditions on the surface of a comet.
- We suspect that the very coldest comets and icy moons in the solar system contain a special kind of ice called **amorphous, or porous, ice**.
- To create amorphous ice, water vapor molecules must be **flash-frozen at a temperature of about -243 °C (-405 °F).**

- This flash-freezing process is something like the flash-freezing alive of Han Solo in the science fiction film "The Empire Strikes Back"
- Amorphous ice is extremely cold, but relatively soft, like cotton candy
- Researchers re-created what happens on the comet's exterior when the temperature starts to rise as the comet gets closer to the Sun and the surfacebecome too hot for amorphous ice to survive.
- In the experiment, the amorphous ice is mixed with an organic molecule, polycyclic aromatic hydro-carbons, or PAHs, common in deep space.
- As the researchers turned up the temperature, the PAHs stuck together and were expelled from the ice host as it crystallized
- With the PAHs expelled, the now-purified ice was free to form a dense, crispy outer shell around the body of the comet.
- Inside, the ultracold, somewhat fluffy amorphous ice remains.
- "Deep fried ice cream is really the perfect analogy, because the interior of the comets should still be very cold and contain the more porous, amorphous ice.
- The PAHs, meanwhile, come together to form a final layer on top of the crunchy outer shell,
- The organics are like a final layer of chocolate on top. ##

Amazing Photo of Green Comet Lovejoy Captured by Dark Energy Camera

MAR. 2, 2015 – www.space.com/28699-**comet-lovejoy-dark-energy-camera-photo**.html /www.space.com/28159-**comet-lovejoy-c2014-q2-amazing-photos**.html

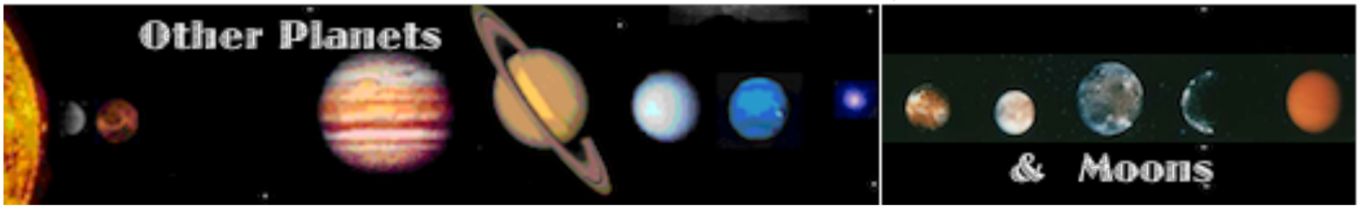


570-megapixel Dark Energy Camera in Chile captured this photo of Comet Lovejoy on Dec. 27, 2014.

The world's most powerful digital camera caught an amazing glimpse of Comet Lovejoy when it passed in front of the sensitive field of view.

- The "accidental observation" of Comet Lovejoyon Dec. 27 shows the comet's nucleus and coma **splayed across several frames** the camera took.
- Lovejoy was 82 million km (51 million mi) from Earth.
- The Dark Energy Camera normally focuses on far more distant objects; up to 12.8 billion km (8 billion mi) away.
- The image was captured while astronomers were scanning the southern sky for the five-year Dark Energy Survey, which aims to learn more about the mysterious force that is accelerating the universe's expansion.
- The camera is 570 megapixels and is designed to look for lights from galaxies and stars far away from Earth.
- Its field of view is about 2.2 degrees, equivalent to an area of sky 20 times the size of the Moon seen from Earth. ##

[The articles below have been bullet-summarized by the editor.



For the full text, see the links cited.]

MERCURY

NASA's Mercury MESSENGER Spacecraft Gets a Life 'Boost'

JAN. 5, 2015 - www.space.com/28161-**mercury-spacecraft-messenger-life-boost**.html
www.space.com/11952-**latest-photos-mercury-nasa-messenger-probe**-part2.html

Engineers have figured out a way to buy some time for NASA's Mercury-orbiting MESSENGER [MErcury Surface, Space ENvironment, GEochemistry and Ranging} spacecraft, which was due to end its four-year mission with a suicidal plunge into the innermost planet in March. The spacecraft became the first to put itself into orbit around Mercury in March 2011

MESSENGER is about out of hydrazine fuel for its steering thrusters. It's already flying quite low. Engineers estimate its altitude will be just 24 km (15 mi) above the surface on January 21. On that day, despite its empty gas tank, MESSENGER will attempt a reboost. Engineers devised a maneuver using leftover helium from the system that keeps the propulsion system pressurized.

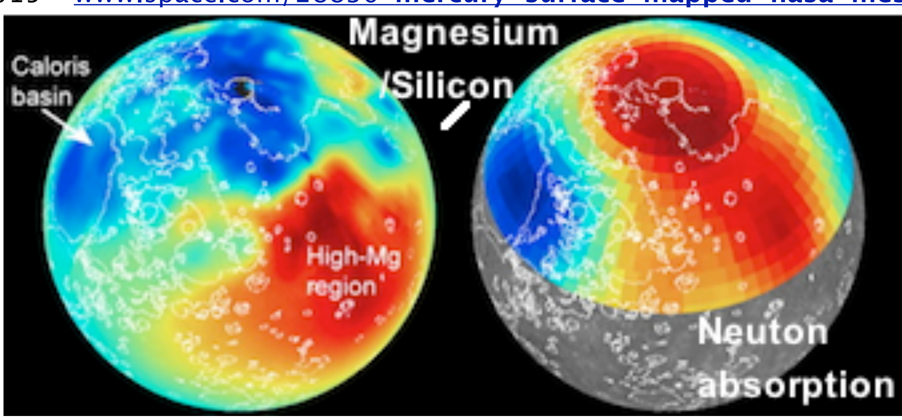
This is the first time that helium pressurant has been intentionally used as a cold-gas propellant through hydrazine thrusters.

With its low mass, helium doesn't provide much of a boost, but it should buy scientists another month of time to learn about

- Variations in Mercury's internal magnetic field
- Water ice inside craters in the planet's northern latitudes.

Mercury's Odd Surface Features Mapped by Messenger Spacecraft

MAR. 16, 2015 - www.space.com/28836-**mercury-surface-mapped-nasa-messenger.**html



Maps of magnesium-to-silicon ratios (left) and thermal neutron absorption (right) captured by MESSENGER orbiter help dentify previously unseen terrains on the planet Mercury.

- Two new maps of Mercury taken by Messenger have identified never-before-seen formations on the planet's surface.
- These areas of Mercury;s surface differ significantly from the crust around them.
- These “geochemical terranes” provide insight into the formation of the planet’s outer skin.

- Two new studies suggest that these most recently identified features may have formed not from the planet's crust but from just below it, in the mantle.
- Created using the X-Ray Spectrometer (XRS) and Gamma-Ray Spectrometer (GRS) instruments on the MESSENGER probe, the maps are used to study Mercury's surface chemistry of Mercury.
- This analysis will provide information about the concentrations of elements like potassium, uranium and sodium on Mercury's surface, as well as ratios of silicon to other elements on planet's surface.
- By studying X-rays streaming from the sun, the authors were able to examine the composition of geochemical terranes on the planet's surface.
- The most obvious of these unusual terranes is a large feature that covers more than 5 million sq km (3 million sq mi – [the size of the continental United Sates or of Australia]
- This terrane exhibits the highest observed ratios of silicon to each of the elements of magnesium, sulfur and calcium, as well as some of the lowest aluminum-to-silicon ratios on the planet.
- One possible explanation for the unusual region is that it stems from an impact long ago, an impact large enough to expose Mercury's mantle.
- A second map shows the distribution across Mercury's northern hemisphere of elements that absorb thermal neutrons.
- By combining that information with previously data, the authors were able to identify four distinct geochemical terranes on the planet.
- Mercury's largest well-preserved impact Caloris basin contains smooth interior plains that the new results reveal have a distinct composition from other volcanic plains on the planet formed by partial melting of the mantle.
- The differences in composition now observed among geochemical terranes indicate that Mercury has a chemically heterogeneous mantle.
- "The crust we see on Mercury was largely formed more than 3 billion years ago."
- "The remarkable chemical variability revealed by MESSENGER observationsl provides critical constraints on future efforts to model and understand Mercury's bulk composition and the ancient geological processes that shaped the planet's mantle and crust." ##

NASA Mercury Probe, Messenger, Trying to Survive for Another Month

MAR. 29, 2015 – http:/www.space.com/28948-**messenger-mercury-probe-final-days**.html
www.space.com/11102-**mercury-nasa-messenger-mission-infographic**.html

Last week, NASA's Messenger spacecraft executed the first of a series of engine burns designed to lift the probe's orbit slightly and delay its inevitable impact into Mercury's surface by up to a month.

- The probe will execute five maneuvers in as many weeks to keep the spacecraft within a tight altitude range of 5-39 kms [3-24 mi] above Mercury's surface at closest approach,
- If everything goes according to plan, Messenger could keep observing Mercury through April 30
- **ME**rcury **S**urface, **S**pace **EN**vironment, **GE**ochemistry and **R**anging, launched in August 2004.
- In March 2011 Messenger became the first spacecraft to orbit Mercury.
- The probe has constructed the best-ever maps of Mercury, and it also discovered carbon-containing organic compounds and water ice inside permanently shadowed craters near the north pole.
- Currently operating on an extended mission, the spacecraft is almost out of fuel.
- When its tank is empty, Messenger will spiral down to a crash on Mercury.
- The probe's handlers want to wring as much science out of the mission as possible — hence, the current sequence of orbit-raising maneuvers, extending a low-altitude "hover" campaign designed to get great close-up looks at Mercury's surface.
- Observations by the orbiter's magnetometer (MAG) and neutron spectrometer (NS), have priority.
- It will hone in on shadowed craters at northern high latitudes to search for water ice. Scientists hope to find more at low altitudes and spatially resolve the distribution within individual craters if ppossible.

- It will also look for crustal magnetic anomalies. Establishing the presence of crustal magnetic anomalies on Mercury would be a huge result, because it would extend the known temporal baseline for Mercury's internal magnetic field by eight orders of magnitude."

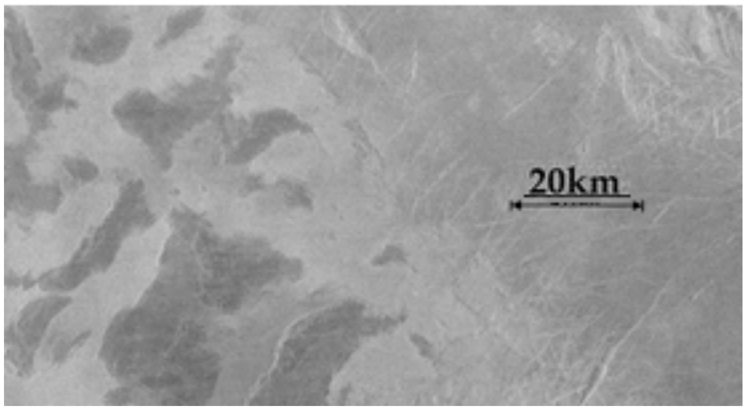
Last week's 32-sec engine burn, March 18, increased Messenger's closest-approach altitude from 7.2 miles (11.7 km) to 21.4 miles (34.5 km). The next such maneuver is scheduled for April 2. ##

VENUS

Heavy-Metal Frost May Coat Mountains On Venus

JAN. 22, 2015 - www.space.com/28334-**venus-heavy-metal-frost**.html

Exotic metallic frost and crusts loaded with crystals might shroud Venus' highlands and mountains.



Radar image of Venus' Ovda highlands region. The bright areas are highland plateaus, and the curious dark spots are mysterious areas at the highest elevations.

Venujs is the hottest world in the solar system:

- Venus has long been mysterious to scientists because dense clouds hide its surface.
- Any probes that have landed on the planet survived only a few hours before getting destroyed, because surface temperatures reach 465 °C (870°F), hot enough to melt lead.
- Venus' atmosphere is crushing, exerting a pressure more than 90 times that of Earth's at sea level,
- Venus' skies occasionally rain acid.

To penetrate Venus' clouds and study the surface from 1990 to 1994, Magellan scientists used radio emissions that Venus gives off and used radar to reflect radio waves off the planet.

- Magellan found that radio-wave probes gave different impressions of Venus depending on the elevation of the area being examined.
- The highlands of Venus generally brightened with elevation, reflecting radio waves well, although there were dark spots at the highest locations.
- The higher on Venus, the more radio-reflective the ground gets, until it abruptly goes radio-black.
- Both these radio-bright and radio-dark areas have defied explanation for more than 20 years.

The planet's highlands are colder than its lowlands, and these cooler temperatures might lead to frost on Venus that looks radio-bright due to all the radio waves it reflects, just as snow on Earth eflects light and looks bright white in visible light.

Two possible explanations

- Since Venus is so hot, any frost on the planet could not be composed of frozen water.
- Frost made of metallic compounds, such as **coloradoite** (consisting of **mercury** and **tellurium**) and **tellurobismuthite** (made of **bismuth** and **tellurium**) would stay **radio-bright** regardless of elevation.
- Another explanation involvs a kind of **crystal in which the positive and negative electric charges are separated, making one side of the crystal positive and the opposite side negative.**

- These crystals would increase in radar brightness with elevation until they reached a certain temperature, after which point they would drop precipitously in radar brightness at the highest elevations,.
- The ferroelectric material wouldn't be a frost. It would be a mineral present in the surface rock.

Which is it? Revisiting Magellan Data

- Researchers used recently available stereo radar elevation data from Magellan, improving the resolution from patches about 8x12 km (5x7.5 mi) in size to only about 600x600 ms (2,000x2,000 ft) large.
- Data from Magellan's synthetic aperture radar gave a resolution of about 75x75 m (250x250 ft) at Venus' surface, much better than coarser data based on Venus' radio emissions, which provided a resolution of about 15 by 23 km (9.3 by 14.3 mi).\
- The scientists re-examined two areas in Venus' Ousenvda Regio highlands region. The scientists confirmed the same pattern of radar reflections brightening with increasing elevation found by previous researchers, with radar reflection low at an elevation of 2,400 m (7,900 ft) and rapidly brightening up to 4,500 m (14,700 ft).
- Researchers also found a lot more of the strange radio-dark spots at the highest elevations, about 4,700 m (15,400 ft), suggesting ferroelectric crystals might explain the findings at Ovda Regio.
- Maxwell Montes, the tallest range on Venus, seems to lack these radar-dark spots, even at high elevations, suggesting that metallic frost might explain the findings at Maxwell Montes.
- Observations by Venus Express orbiter might shed light on this potential frost. Since this frost would be a precipitation from the atmosphere, insight from Venus Express into surface-atmosphere interactions will be highly valuable.

We currently have no idea what type of compound would fit the data for the ferroelectric material. "No suitable compounds have been proposed."

- Given the high temperatures and pressures found on Venus' surface, as well as the planet's acid rains, it is not easy to test the properties of materials under Venusian conditions.
- This suggests it remains possible an as-yet-unknown ferroelectric crystal might explain the Ovda Regio highlands of Venus.

JUPITER

Jupiter's eroding core may already be just a husk

www.newscientist.com/article/mg22530032.200-jupiters-eroding-core-may-already-be-just-a-husk.html

JAN. 8, 2015 - Jupiter's core seems to be rotting, with heavy elements from Jupiter's core diffusing into its gassy body about twice as fast as previously thought.

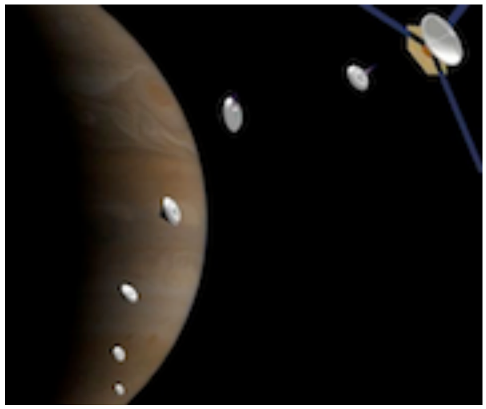
- Jupiter formed when rock and ice from the disc of material around the young sun coalesced.
- The gravity of this dense core then swept up 300 Earth-masses of hydrogen and helium.
- The rock and ice sank to Jupiter's centre but won't stay there forever. Earlier calculations treating atoms in the core as billiard balls found that every so often, some of them will detach and mix into the surrounding hydrogen and helium
- But it was unclear how fast that process would be.
- A quantum-mechanical model calculates how carbon, silicon and iron - three key elements in the core - would diffuse into the fluid layer.
- This model found diffusion rates twice those calculated by the earlier models.
- When the Juno spacecraft arrives at Jupiter in 2016, there might just be "a partially eroded husk of the planet's original core"
- Juno will give us excellent data on Jupiter's gravitational field, but that's not enough information to work out the interior structure on its own. Core erosion may complicate analysis
- It's important to pin down its rate to make sense of Juno's view of Jupiter's insides.

Tiny Microprobes Could Explore Jupiter's Atmosphere By 2030

FEB. 18, 2015 – www.space.com/28584-**jupiter-microprobes-smara-mission-concept**.html

Researchers are developing a concept mission called **SMARA** (**SMA**ll **R**econnaissance of **A**tmospheres) in which a swarm of tiny probes could zip through the clouds of Jupiter by 2030, beaming home data about the gas giant's dense atmosphere.

- The bantam spacecraft should survive for about 15 minutes in Jupiter's thick air before bursting up,.
- During this brief time, the microprobes would transmit enough information to give scientists a greater understanding of the atmosphere of Jupiter.



Artist's impression of "microprobes" headed for Jupiter to probe the gas giant's atmosphere.

- In this concept, with a small enough probe, you can strip off the parachute and still get enough time in the atmosphere to take meaningful data while keeping the relay close and the data rate high
- The microprobes would have multiple, separate functions in order to provide the most complete picture of Jupiter's skies.
- Some might take images, while others could measure the atmosphere's chemical composition.
- SMARA could also shed light on the composition of the nebula from which the solar system formed, as well as on the nature of small cosmic bodies like asteroids.
- Studying Jupiter in depth could additionally help scientists understand gas giants outside Earth's solar system, yielding general insights about flow dynamics, cloud physics and other phenomena.
- The probes' small size is essential to the scientists' plan, as larger spacecraft — anything weighing more than, say, 300 kg (660 lbs.) — would sample less of Jupiter's atmosphere before burning up.
- The proponants would like to coordinate their mission with the European Space Agency's Jupiter Icy Moons Explorer effort (JUICE), scheduled to launch in 2022 and reach the Jovian system in 2030.
- For a precedent, in February 2014, astronauts on the International Space Station released a record-breaking 33 tiny satellites, also known as cubesats, into orbit. ##

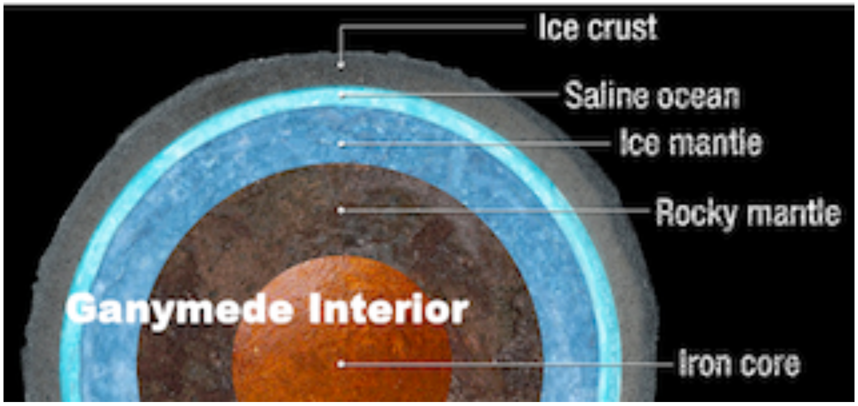
JUPITER's MOONS - GANYMEDE

Ganymede has a Salty Ocean "with More Water than Earth"

MAR. 12, 2015 – www.space.com/28807-**jupiter-moon-ganymede-salty-ocean**.html

The ocean on Ganymede, buried under a thick crust of ice, could actually harbor more water than all of Earth's surface water combined. NASA scientists think the ocean is about 100 km (60 mi) thick, 10 times the depth of Earth's oceans.

- They are particularly interested in learning more about watery worlds because life as we know it depends on water to thrive.
- Scientists have long suspected that there was an ocean of liquid water on Ganymede — the largest moon in the solar system, at about 5,268 km (3,273 mi) across (half again as wide as the Moon) — has an ocean of liquid water beneath its surface. The Galileo probe measured Ganymede's magnetic field in 2002, providing some data that supported the theory that this moon has an ocean.



- The newly announced evidence from the Hubble telescope is the most convincing data supporting the subsurface ocean theory.
- Scientists used Hubble to monitor Ganymede's auroras, ribbons of light at the poles created by the moon's magnetic field. These auroras are also affected by Jupiter's magnetic field because of the moon's proximity to the huge planet.
- When Jupiter's magnetic field changes, so does Ganymede's. Researchers were able to watch the two auroras "rock" back and forth with Hubble.
- Ganymede's aurora didn't rock as much as expected, so by monitoring that motion, researchers concluded that a subsurface ocean was likely responsible for dampening the change in Ganymede's aurora created by Jupiter.
- **Hunting for auroras on other worlds could potentially help identify water-rich alien planets**. Scientists might be able to search for rocking auroras on exoplanets that could potentially harbor water using the lessons learned from the Hubble observations of Ganymede.

NOTE: two of **Ganymede**'s fur sister moons, **Calliso** and **Europa** also have oceans. **Io**, the innermost, is most likely quite dry given its constant volcanic activity. Ed. ##

JUPITER's MOONS - EUROPA

NASA Europa Mission Gets White House Approval

FEB. 2, 2015 - www.space.com/28436-**nasa-europa-mission-white-house**.html

The quest to explore Jupiter's ocean-harboring moon Europa has taken a big step forward.

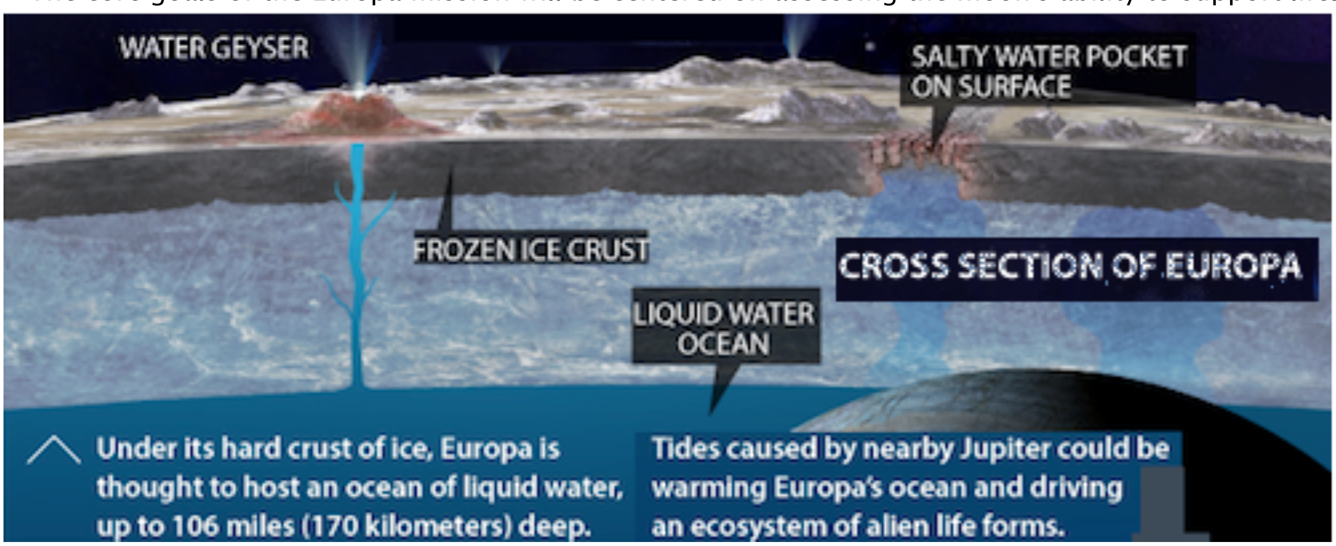
- The White House fiscal yea 2016 budget request for NASA, released February 2, allocates $18.5 billion to NASA, including $30 million to formulate a mission to Europa.
- Europa is perhaps the solar system's best bet to host alien life.
- NASA has been studying a potential Europa mission for a while, but the new budget proposal signals a commitment from the White House that wasn't there before.
- For the first time, the budget allows NASA to formulate and develop a Europa Mission, Phase A.
- The new budget request assumes multiple years of funding for the mission.
- The current funding profile would assume a launch in the mid-2020s.
- It's unclear how much NASA will get for a Europa mission in the 2016 fiscal year (begins Oct. 1, 2015).
- Congress must approve the final budget, often quite different than the proposal by the White House.
- Congresional support for a bold Euroopa mission is very strong.
- NASA appears to be zeroing in on a mission that would feature multiple flybys of Europa — along the lines of the Europa Clipper, a concept being developed by agency scientists and engineers.
- Once in orbit around Jupiter, the Clipper would make 45 flybys of Europa over 3.5 years.

- Europa possesses an liquid water ocean under an icy shell. During many flybys, the Clipper would study that ocean, yielding insights about its depth, salinity and conductivity, and other characteristics.
- The Clipper would also measure and map Europa's ice shell, returning data that could be useful for a potential future mission to the moon's surface.
- We have a preconceived notion of what a lander looks like. What we find may or may not support that.
- According to plan, the Europa Clipper could be ready to launch as early as 2022
- The mission would probably cost about $2 billion.
- The Europa mission will really start coming into focus a few months from now:
- NASA aims to select science instruments for the mission this spring, The agency had asked scientists around the world to propose instruments in July 2014. ##

(Sequel) – FEB. 20, 2015 – www.space.com/28614-**nasa-europa-mission-alien-life**.html

NASA has asked scientists to consider ways a Europa mission could **search for evidence of alien life in the water vapor plumes** that apparently blast into space from Europa's south polar region.

- Spotted in December 2012 by the Hubble Space Telescope, these plumes may provide a to sample Europa's deep ocean beneath the moon's icy shell without drilling several kilometers through the ice.
- Last July, NASA asked scientists to propose instruments to fly aboard a Europa-studying spacecraft.
- The quest to explore this moon got a boost this month when the White House allocated $30 million in its fiscal year 2016 US NASA budget request to formulate a Europa mission.
- NASA's Europa Clipper, as currently envisioned, would make 45 flybys of Europa over 3.5 years, at altitudes ranging from 25-2,700 km (16-1,700 mi).
- The $2.1 billion mission would study Europa's subsurface ocean, its depth, salinity and other characteristics. The probe would also measure and map the moon's ice shell, returning data that would be useful for a future mission to the Europan surface.
- Now **NASA would like to add feasible plume sampling** to the Europa Clipper mission's task list.
- At the earliest, Clipper could blast off in 2022 — and wouldn't arrive in the Jupiter system until 2030.
- Europe is developing its own mission called the Jupiter Icy Moon Explorer, scheduled to launch in 2022 to study Europa and two other Jovian satellites, Ganymede and Callisto.)
- The core goals of the Europa mission will be centered on assessing the moon's ability to support life.



More facts:

- Europa has more water than Earth. Europa's water would form a sphere 1,754 km (1,090 mi) wide.
- Earth's water sphere would be 1,384 km (860 mi) across. We can but wonder what it holds!
- Europa is 3,122 km (1,940 mi) in diameter, a bit smaller than the Moon.
- Surfce temperture -160°C (-260°F) - Gravity 0.134 that of Earth, a bit less than the Moon's
- Europa has a very thin oxygen atmosphere
- A probe such as Clipper could zoom through a plume, as high as 200 km (125 mi) above the surface

- The probe could snag material using an aerogel collector. The basic idea was demonstrated by NASA's Stardust mission, which returned particles of the Comet Wild 2 to Earth in January 2006.
- Bringing samples back to Earth to study in superior labs is beyond the scope of thi sflyby mission. And It may be possible to detect biomolecules onsite, using gear aboard a Clipper-like probe.
- Spotting a set of amino acids that all display the same handedness in plume material would be strong evidence of Europan life. (Here on Earth, all life uses "left-handed" versions of amino acids,)
- Collecting enough plume material to perform such analyses will be extremely challenging.
- It may require flying so low and so slowly that a lander would makes more sense.
- This discussion assumes the spacecraft will be able to find the water vapor when it gets to Europa.
- At the moment, the plume, seen only once so far in December 2012, remains unconfirmed.
- If the plume exists, it is apparently sporadic or episodic, not continuous like the powerhouse geysers that erupt from the south pole of Saturn's icy moon Enceladus.
- Europa's plumes could be continuous, but fairly weak, reaching levels detectable by Hubble rarely ##

Fish Under Ice-Cap Suggest Europa Life May Be Possible | Video

www.space.com/28346-**fish-under-ice-cap-suggest-europa-life-may-be-possible-video**.html

Fish found under Antarctica's Ross Ice Shelf **500 miles inward from open water!**

Proposal for Private Mission to Europa

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

FEB. 11, 2015 - Jupiter's icy moon Europa puzzles astrobiologists and sparks the imagination of extra-terrestrial life seekers. The is believed to have a subsurface ocean of liquid water, where life could possibly be similar to microbial life forms on Earth.

- This expectation has ignited persisting calls to send a probe there.
- Currently NASA and ESA plan their own missions to the potentially habitable moon.
- NASA's **Europa Clipper** mission has just got approved for $30 million in the 2016 NASA budget.
- ESA's **Jupiter Icy Moon Explorer** (JUICE) is scheduled for launch in 2022.

Objective Europa's Transit Vehicle concept. Image courtesy Chris Weeks.

A Private Sector Mission to Europa?

- Astrobiology expert, Christopher Impey of the University of Arizona, thinks that the private sector could also take part in the race to Europa.

  "If Google or Amazon wanted to fund a more ambition mission and 'brand' what would potentially be the first detection of life beyond Earth, it would be an enormous coup."

Private missions to Europa have been proposed before.

- In 2013, an international team of volunteers headed up by Kristian von Bengtson, founder of Copenhagen Suborbitals, an open source DIY space program based in Denmark, announced the plan of sending a crewed mission to the icy moon. A crowdsourcing campaign has begun to raise money and to look into the feasibility of a manned mission decades from now.

- However, they haven't ruled out a robotic mission.
- "The idea was not to be just three nerds meeting once in a while trying to pull this project off because that's completely unrealistic," von Bengtson said in 2013 about the Objective Europa project.
- "I think it's possible to do this - at least the research phase - if you just find everybody who finds this project appealing and interesting.
- To fully explore the Europa's subsurface ocean we must drill through the miles-thick ice layer on Europa. "lower a submersible, look around and see what's there, see what swims up to the camera lens and licks it." (words of Neil de Grass Tyson)
- There are no technical showstoppers to doing it. The issue is money.
- A true orbiter is a billion dollars or more.
- A lander and a means to drill or melt through the ice and release a hydrobot would cost $2-3 billion.
- The vision of human exploration of Europa's ocean is far more unrealistic - much more so than a manned mission to Mars.
- It won'tl happen until we have a manned Moon base and a Mars base
- Impey proposes to focus on what we have now. "The [Clipper] mission very recently got approved for $30 million in the 2016 budget, allowing it to procede.
- The proposed NASA Clipper mission would teach us a lot about Europa: It may drop a projectile onto the ice and 'snif' the composition of the material that flies off - that would reveal whether or not the ice is mixed with organic materials and life ingredients.
- The instrumentation of an orbiter would do sensitive remote sensing and if not detect life, at least show that the condition are (or are not) right.
- It will measure the ice thickness very accurately and so show the best place to eventually drill.
- It will monitor changes in the ice and so show how much energy exists in the ocean underneath.
- In general, scientists' consensus is that a layer of liquid water exists beneath Europa's surface, and that heat from tidal flexing allows the subsurface ocean to remain liquid.
- Opinions are split on the presence of life on the icy moon.
- The big unknown is the salinity and chemical balance in the ocean under that ice pack.
- But there is modest heating from the interior, and terrestrial extremophiles handle that with ease. ##

Europa's Elusive Water Plume Paints Grim Picture For Life

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

MAT. 25, 2015 - A meteorite may have been responsible for a water plume briefly spotted above Europa two years ago, implying it takes a very rare event to breach the ice on the Jovian moon.

- In December 2013, water vapor was detected in Hubble Space Telescope observations of Europa, which is considered one of the top potential locations in our solar system for life.
- However, follow-up observations of Europa have revealed no plume emanating from the moon.
- A new paper reveals that Europa's atmosphere is 100 times less abundant than claims in previous publications, and composed mainly of atomic rather than molecular oxygen.
- The magnetosphere plasma, or superheated gas, at Europa's orbit is very hot, with properties indicating that the plasma is mainly composed of ions, or charged particles, from nearby Io.
- The rate of injection of neutral gas from the surface of Europa is very low indicating a low density, and a low escape rate into its magnetic field or magnetosphere.
- Plasma, superheated gas, can consaist of different molecules, such as hydrogen and oxygen, Cassini's spectroscope was not designed to measure which species of molecules were present in the gas.
- However, a meteorite that briefly threw water aloft from Europa's surface cannot be ruled out.

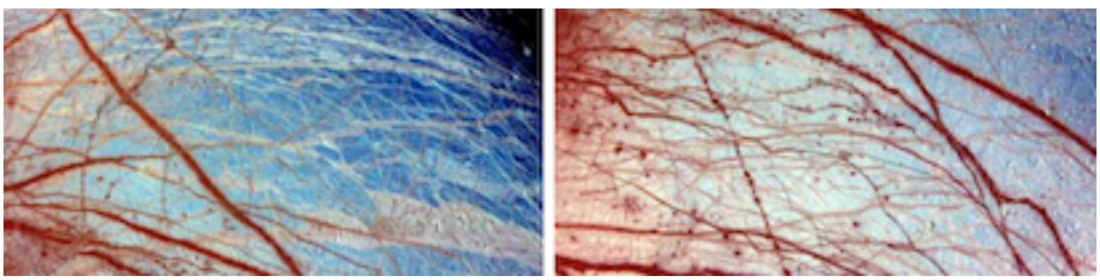
Volcanic plasma

- Scientists already knew there was superheated gas plasma, near Europa based on data from Voyager's flyby, as well as the Galileo mission, which explored Jupiter and its moons in the 1990s and 2000s.

- Those instruments, however, couldn't distinguish between different elements in the plasma and, therefore, could not determine the origin of the plasma. That's where Cassini was different.
- Cassini further detected a mix of sulfur and oxygen ions that most likely come from Io whose volcanic activity spews these elements into its orbit, creating a plasma "torus" that Europa' passes through.
- Europa would need to have fissures in its surface to allow for contact between its hypothetical under-ground ocean and the combined effects of the magnetosphere and solar input on its surface.
- The energy input would include gravitational flexure by Jupiter in addition to the sun and magneto-sphere. If the plume is a rare event, \there are likely few or no cracks in the surface. Europa might be a socked-in icy ball with a barren ocean below. [**See Editor's comment below**.]
- Three issues with the theory. There is no reason to doubt the observations but it is the only direct indication of water ejection from the surface, [**See Editor's comment below**.] the observation has not been repeated, and there was nothing unusual detected on Europa's surface at the ejection time.

Data collection problems

- Io's radiation is easy to observe as there is so much energy associated with the Io torus. The energy comes from the rotation of Jupiter's magnetic field, which whips around with a 10 hour period.
- Europa's plume reached a couple hundred kilometers above the surface, but without enough energy to escape into to the magnetosphere. The plume collapsed onto Europa's body, and that was the end."
- One theory could have been that a meteorite created a fissure in the surface that subsequently healed. There could, however, be more evidence lurking in archival data.
- Because there is so much data flowing from each mission, and inadequate resources to analyze it, of-ten information is archived without the chance to look at it.



Editor: *Arguing from the rarity of plumes is nonsense. The evidence in the highly cracked ice cap covering Europa's ocean is eloquent testimony that the ice periodically cracks, letting water escape to the surface before freezing. It is in the water ice in those cracks that we need to look for life. ##*

SATURN

A new spin on Saturn's peculiar rotation

MAR. 26, 2015 – www.spacedaily.com/reports/A_new_spin_on_Saturns_peculiar_rotation_999.html

Tracking the rotation speed of solid planets, like the Earth and Mars, is a relatively simple task: Just measure the time it takes for a surface feature to roll into view again. But giant gas planets Jupiter and Saturn are more problematic for planetary scientists, as they both lack measureable solid surfaces and are covered by thick layers of clouds, foiling direct visual measurementss.

- Saturn has presented an even greater challenge to scientists, as different parts of this ball of hydro-gen and helium rotate at different speeds.
- Saturn's rotation axis and magnetic pole are aligned.
- A new method proposes a new determination of Saturn's rotation period and offers insight into the internal structure of the planet, its weather patterns, and the way it formed.
- A new method is based on Saturn's measured gravitational field and the unique fact that its east-west axis is shorter than its north-south axis.
- According to the new method, Saturn's day is **10 hours, 32 minutes and 44 seconds long**.

- When researchers applied their method to Jupiter, its rotation period already well known, the results were identical to the conventional measurement, showing consistency and accuracy in the method.
- **Between sunup and sundown on Saturn**
For years, scientists have had difficulty coming up with a precise measurement of Saturn's rotation.
- In the last two decades, the "standard rotation period of Saturn was accepted as that measured by Voyager 2 in the 1980s: 10 hours, 39 minutes, and 22 seconds – 6 minutes, 38 seconds too long.
- It had been understood that Saturn's rotation period could not be inferred from the fluctuations in radio radiation measurements linked to Saturn's magnetic field, and was in fact still unknown.
- Cassini had measured a signal linked to Saturn's magnetic field with a periodicity of 10 hours, 47 minutes and 6 seconds long -- slower than previous recordings.

In the last few years, there have been different theoretical attempts to pin down an answer.

- We came up with an answer based on Saturn's shape and gravitational field. We were able to look at the big picture, and harness the physical properties of the planet to determine its rotational period.
- The nwe method is based on a statistical optimization method that involved several solutions.
- First, the solutions had to reproduce Saturn's observed properties (within their uncertainties): its mass and gravitational field. Then the researchers harnessed this information to **search for the rotation period on which the most solutions converged**.

Narrowing the margin of error

- The derived mass of the planet's core and the mass of the heavy elements that make up its composition, such as rocks and water, are affected by the rotation period of the planet.
- We can't fully understand Saturn's internal structure without accurate determinationof its rotation.

The bonanza

- Knowledge of Saturn's composition provides information on giant planet formation in general and on the physical and chemical properties of the solar nebula from which the solar system was formed.
- The rotation period of a giant planet is a fundamental physical property, and its value affects many aspects of the physics of these planets, including their interior structure and atmospheric dynamics
- The team was determined to make as few assumptions as possible to get the rotational period.
- If you improve your measurement of Saturn's gravitational field, you narrow the error margin.
- The researchers hope to apply their method to other gaseous planets in the solar system such as Uranus and Neptune.
- Their new technique could also be applied in the future to study gaseous planets orbiting other stars.

Editor: Kudos! Magnifico!

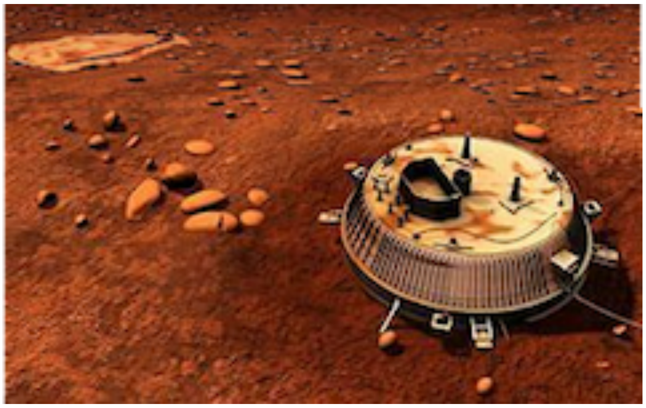
SATURN – TITAN

NASA and ESA Celebrate 10 Years Since Titan Landing

www.spacedaily.com/reports/**NASA_and_ESA_Celebrate_10_Years_Since_Titan_Landing**_999.html

JAN. , 2015 – Ten years ago, the European Space Agency's Huygens probe parachuted into the haze of an alien moon toward an uncertain fate.

- After a gentle descent lasting more than two hours, it landed with a thud on a frigid floodplain, surrounded by icy cobblestones.
- This was the first landing on a moon in the outer solar system, Titan, the largest moon of Saturn.
- The hardy probe continued to transmit data for more than an hour on the frigid surface of Titan, until its batteries were drained.
- Since then, scientists have pored over volumes of data about Titan, sent to Earth by Huygens
- Together with data from Cassini which orbits Saturn and periodically swings by Titan, data have revealed many details of a surprisingly Earth-like world.



Artist's interpretation of the area surrounding the Huygens landing site based on images and data returned by the probe on January 14, 2005. Image courtesy ESA – C. Carreau.

- **A gallery of some of the best images related to Huygens**

  http://saturn.jpl.nasa.gov/news/cassinifeatures/huygens10/

- Cassini's mission is slated to continue through September 2017.

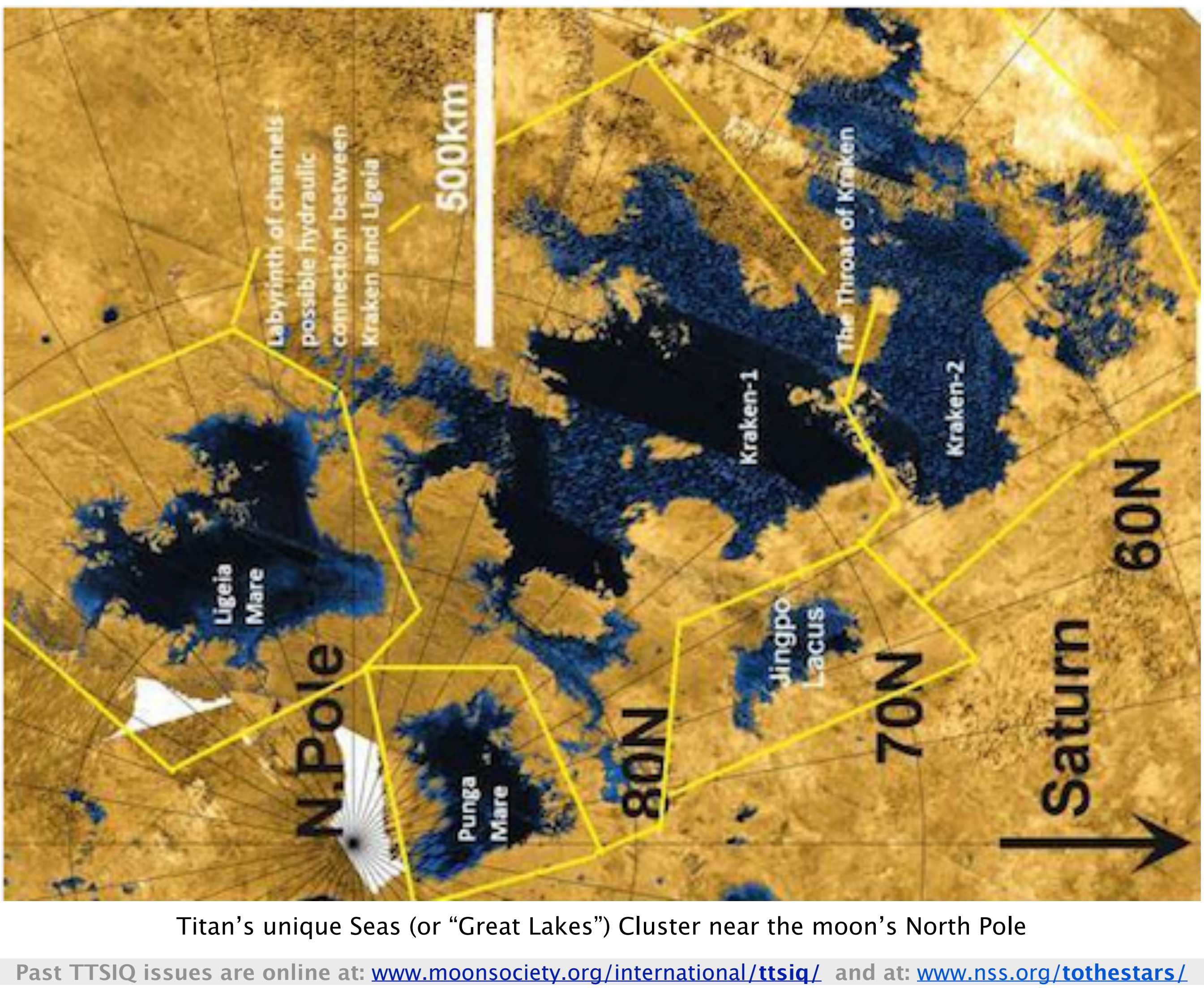
A sampling of the top discoveries at Titan includes:

- Lakes and Seas – Titan is a world with lakes and seas, made up of liquid methane and ethane. These bodies of hydrocarbons are replenished by methane and ethane rainfall from clouds in the moon's atmosphere.
- Titan is the only other place in the solar system to have an Earth-like cycle of liquids flowing across its surface.
- Active Meteorology and Surface Processes – Liquid methane drizzles onto Titan's surface.
- Just like clouds on Earth, clouds on Titan form through a cycle of evaporation and condensation, with methane vapor rising from the surface, forming clouds and falling back down as precipitation.
- Huygens data suggest the presence of layered methane clouds in Titan's troposphere, at altitudes between 8 and 30 km (about 5 and 20 mi).
- Titan's "hydrological" cycle causes visible changes on the moon's surface.
- **Organic Sand Seas – Seas of sand dunes**, like those in Earth's Arabian desert, are observed in the dark equatorial regions of Titan.
- The “sand” is not likely made of silicates as on Earth, but of solid water ice coated with hydrocarbons that fall from the atmosphere.
- Titan's **dunes** are gigantic, reaching, on average, 1-2 km (0.6-1.2 mi) wide, hundreds of kilometers (miles) long and around 100 meters (300 ft) high.
- First Determination of Depth for an Extraterrestrial Sea – Ligeia Mare, Titan's second-largest sea, was revealed to be about 170 meters (560 ft) deep – the first time scientists have been able to determine the depth of a body of open liquid on the surface of another world, possible because the liquid turned out to be mostly clear methane, allowing the radar signal to pass through it easily.
- **River Channels and Ice Cobbles** – Images taken during the Huygens probe's descent unveiling a plateau with a large number of dark channels cut into it, forming drainage networks that bears many similarities to those on Earth. The narrow channels converged into broad rivers, which drained into a broad, dark, lowland region.
- **Earth-like river rocks**, composed of water ice, were also observed at the Huygens probe landing site. Radar evidence from Cassini suggests that flash flooding has sculpted streambeds on Titan with these rounded cobbles of water ice, which likely originated in water-ice bedrock in higher terrain.
- **Titan's smog layers are coupled to a seasonal climate cycle.** The massive atmosphere of Titan is shrouded in thick layers of photochemical smog. One of the "detached" layers has fallen in altitude from about 500 km to only 380 km (over 310 mi to only 240 mi) between 2006 and 2010.

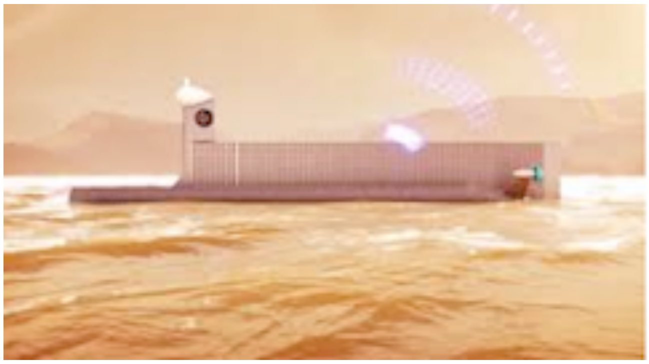
- **Rich Chemistry in the Atmosphere, including Propylene** – The Huygens probe made the first direct measurements of Titan's lower atmosphere. Data returned by the probe included altitude profiles of the gaseous constituents, isotopic ratios and trace gases (including organic compounds). Huygens also directly sampled aerosols in the atmosphere and confirmed that carbon and nitrogen are their major constituents. Cassini detected propylene, a chemical used to make household plastic, in Titan's atmosphere. This is the first definitive detection of the plastic ingredients on any moon or planet, other than Earth. Other chemicals observed indicate a rich and complex chemistry originating from methane and nitrogen and evolving into complex molecules, eventually forming the smog that surrounds the icy moon.
- Huygens' detection of Argon-40 in Titan's atmosphere indicates that the interior of Titan is still active – unusual in a moon and one of the first **clues of subsurface liquid water on Titan**.
- **Liquid Water Subsurface Ocean** – Cassini's numerous gravity measurements of Titan revealed that this moon is hiding an internal, **liquid water/ammonia ocean** underneath its surface. Huygens also detected radio signals during its descent that strongly suggested the presence of an ocean 55-80 km (35-50 mi) below the moon's surface.
- The discovery of a global ocean of liquid water adds Titan to the handful of worlds in our solar system that could potentially contain habitable environments. ##

Submarine Could Explores Seas of Saturn's Moon Titan

FEB. 18, 2015 – www.space.com/28589-**titan-submarine-robotic-saturn-shi**p.html
www.space.com/28551-**submarine-explores-saturn-s-moon-titan-in-nasa-animation**.html



Titan's unique Seas (or "Great Lakes") Cluster near the moon's North Pole




The concept was detailed during the NASA Innovative Advanced Concepts 2015 symposium, held here Jan. 27-29. NIAC sponsors cutting-edge, innovative and technically credible advanced concepts under the auspices of the Space Technology Mission Directorate at NASA Headquarters in Washington, D.C.

The extraterrestrial seas of Titan provide an ideal world for a robotic submarine to explore. A team of scientists is working on annovative mission concept that could make that vision a reality.

- A submarine on Titan would open up the lakes and rivers of liquid methane and ethane that cover the cloudy Saturn moon to exploration. In a NASA video, the robotic submarine sails the Kraken Mare, the largest northern sea on Titan. That sea is nearly 1,000 km (600 mi) wide and 300 m (1,000 ft) deep.
- The Titan submarine would use science instruments to probe a full spectrum of oceanographic phe-nomena, including measuring the chemical composition of the sea, mapping surface and subsurface currents, and making a detailed inspection of bottom features.

Why a submarine on Titan?

- A submarine provides a more efficient, on-the-spot science system.
- The sub approach makes the vessel both **highly maneuverable** and capable of very long-range du-ties, similar to autonomous underwater vehicles here on Earth.
- The ethane and methane seas on Titan have been extensively mapped by NASA's Cassini spacecraft, which has been studying the moon as part of its mission to Saturn since 2004, when the probe arrived in orbit around the ringed planet.
- In January 2005, the Huygens Titan lander probe — carried by Cassini, and built by the European and Italian space agencies landed on Titan, beaming back the first photos of that strange new world.\
- What's beneath the surface of Titan's seas remains an enigma — one that a submarine could help solve, Oleson and his team members say.
- The COMPASS team scoped out the submarine idea along with technologists and scientists from The Johns Hopkins Applied Physics Laboratory (JHUAPL) in Laurel, Maryland, and submarine designers from The Pennsylvania State University's Applied Research Laboratory.
- NIAC-funded first-look focused on just the roughly 1,400 kg (3,000-lb) submarine.
- Follow-on money would fund research into a system to drop the vessel into one of Titan's seas: a lifting-body spacecraft, an inflatable aeroshell, or a simple, extended, shaped aeroshell are options

Sailing an Extra-terrestrial Sea, Equipment

- The submarine would be powered by two Stirling radioisotope generators, using heat produced by a slug of radioactive plutonium. .
- Waste-heat-fluid loops would keep the craft's insides nice and warm.
- For topside surveying as well as undersea sleuthing, the sub would have a meteorology sensor, a light and camera system, sun sensors, a physical properties package, a depth sounder, sample-acquisition gear, and side-scan sonar arrays.
- Antennas on each side would maintain communication back to Earth, directly or via an orbiter.
- A unique ballast system would let the sub repeatedly deep-dive and resurface for many month.
- A "cruise day" for the Titan submarine would involve eight hours of submerged science and 16 hours of surfaced shore imaging and gathering of meteorological data.
- By addressing the challenges of autonomous submersible exploration in a cold, outer-solar-system environment, the Titan Sub would pave the way for even more exotic future exploration of other sub-surface water oceans, such as on Europa, a prime candidate for life elsewhere in the solar system.##

Life 'not as we know it' possible on Saturn's moon Titan

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

MAR. 2, 2015 – A new type of **methane-based, oxygen-free life form that can metabolize and reproduce similar to life on Earth** has been modeled by a team of Cornell University researchers.

A template for life that could thrive in a harsh, cold world

- Taking a simultaneously imaginative and rigidly scientific view, chemical engineers and astronomers offer a template for life that could thrive in a harsh, cold world – specifically Titan
- Titan is a planetary body awash with seas not of water, but of liquid methane,
- Titan could harbor methane-based, oxygen-free cells.
- The theorized cell membrane is composed of small organic nitrogen compounds and capable of functioning in liquid methane temperatures of 292 degrees below zero.
- The scientists asked, 'If this was your palette, what can you make out of that?'"
- With no preconceptions about what should be in a membrane and what shouldn't, the team worked with the compounds that were there,

Looking for a parallel to Earth Life

- Earth life is based on the phospholipid bilayer membrane, the strong, permeable, water-based vesicle that houses the organic matter of every cell.
- A vesicle made from such a membrane is called a liposome.

The first concrete blueprint of life not as we know it.

- What if cells weren't based on water, but on methane, which has a much lower freezing point?
- The engineers named their theorized cell membrane an "azotosome," "azote" being the French word for nitrogen. "Liposome" comes from the Greek "lipos" and "soma" to mean "lipid body;" by analogy, "azotosome" means "nitrogen body."
- The azotosome is made from nitrogen, carbon and hydrogen molecules known to exist in the cryogenic seas of Titan, but shows the same stability and flexibility that Earth's analogous liposome does.
- The engineers employed a molecular dynamics method that screened for candidate compounds from methane for self-assembly into membrane-like structures.

The most promising compound

- An acrylonitrile azotosome showed good stability, a strong barrier to decomposition, and a flexibility similar to that of phospholipid membranes on Earth.
- Acrylonitrile – a colorless, poisonous, liquid organic compound used in the manufacture of acrylic fibers, resins and thermoplastics – is present in Titan's atmosphere.

Long-term prospect of testing these ideas on Titan itself?

- To demonstrate how these cells would behave in the methane environment – what might be the analogue to reproduction and **metabolism** in oxygen-free, methane-based cells.
- Sending a probe to float on the seas of Titan and directly sampling the organics is the next step.
- The team is inspired by science fiction writer Isaac Asimov, who wrote about the concept of non-water-based life in a 1962 essay, "Not as We Know It."
- Theri concept is "Life, not as we know it." ##

How Did the Saturn Moon Titan's Atmosphere Form?

MAR. 9, 2015 – www.space.com/28765-**saturn-moon-titan-atmosphere-formation**.html

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

- A decade ago, the tiny Huygens probe descended into the soupy atmosphere of Titan, a moon whose chemistry and liquid cycle remind us of what the early Earth could have looked like before life arose.
- The probemade it to the surface and transmitted imagery all the way. It remained alive there for more than an hour, transmitting data to the orbiting Cassini probe for later analysis by scientists.
- A decade later, we are only now starting to understand how the atmosphere of Titan formed, mostly based on what Huygens observed in January 2005.

How did Titan got its atmosphere?

- Did the moon nab nitrogen, methane and noble gases that were floating in the solar system during formation?
- Or was the atmosphere was generated inside Titan through hydrothermal activity?
“**Noble gases, nitrogen, and methane from the deep interior to the atmosphere of Titan**"
http://www.sciencedirect.com/science/article/pii/S0019103515000032

Seeking noble gases

- Huygens found an isotope of argon, Argon 40 — also found in Earth’s atmosphere — that appeared to be made within Titan's presumed rocky core, formed from the radioactive decay of potassium-40.
- It originated inside of Titan and then got into the atmosphere, perhaps by venting, or through cryo-volcanism (cold volcanoes that may erupt mixtures of liquid water).
- How the gas was released is a reflection of geophysical processes that reveal Titan's internal structure. Titan is even warmer than thought and its structure would need to be differentiated.
- This suggests that Titan has (or once had) a hot rocky core surrounded by an ocean with an icy shell.
- This would be similar in structure to what we suspect on Jupiter's satellite Ganymede.
- The keyis the gravity field — how much mass separation occurred during the formation and evolution of Titan. If there is a rocky core and ocean-ice shell, there should be a great deal of separation.
- We can't be definitive yet.##

SATURN - ENCELADUS

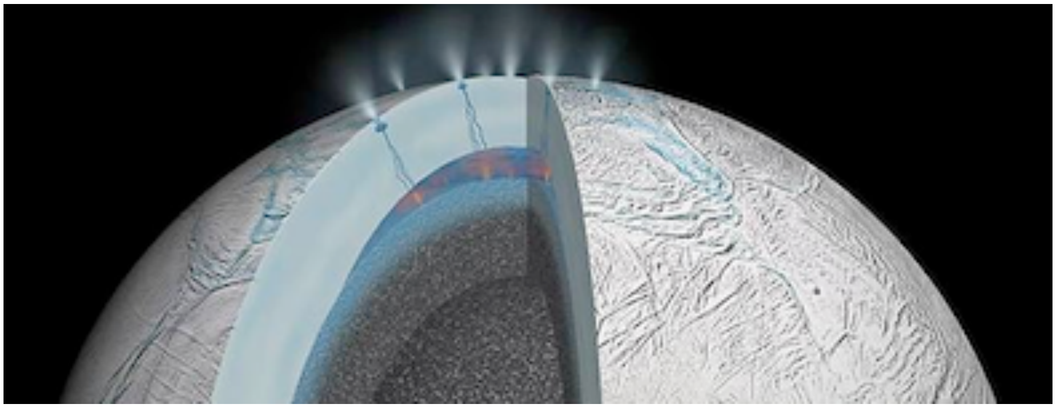
Data Suggest Enceladys Ocean May Harbor Hydrothermal Activity

www.nasa.gov/press/2015/march/**spacecraft-data-suggest-saturn-moons-ocean-may-harbor-hydrothermal-activity/**

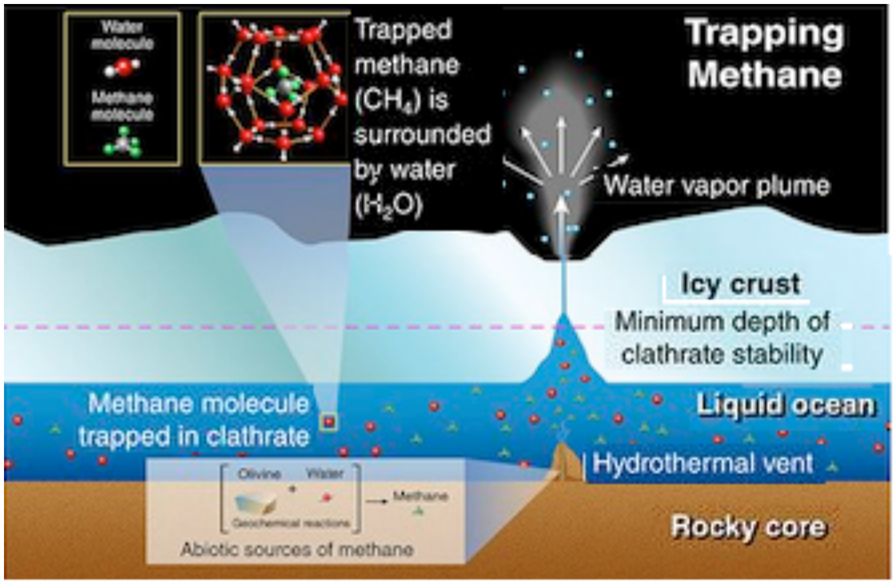
www.esa.int/Our_Activities/Space_Science/Cassini-Huygens/**Hot_water_activity_on_icy_moon_s_seafloor**

MAR. 11, 2015 - The Cassini Saturn orbiter has providedthe first clear evidence that Saturn’s moon Enceladus exhibits signs of **present-day hydrothermal activity** which may resemble that seen in the deep oceans on Earth.

- The implications of such activity on a world other than Earth open up unprecedented possibilities.
- It is possible that Enceladus, with a subsurface ocean and displays remarkable geologic activity, could contain environments suitable for living organismsn.
- Hydrothermal activity occurs when seawater infiltrates and reacts with a rocky crust and emerges as a heated, mineral-laden solution.
- The results are the first clear indications an icy moon may have similar ongoing active processes.



Artist rendering depicting possible hydrothermal activity that may be taking place on and under the seafloor of the moon's subsurface ocean



Potential origins of methane found in gas and ice particle plumes from Enceladus

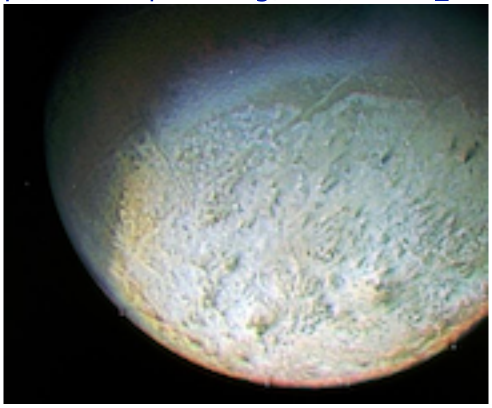
- Microscopic grains of rock have been detected by Cassini in the Saturn system.
- An extensive, four-year analysis of data led researchers to the conclusion the tiny grains most likely form when hot water containing dissolved minerals from the Enceladus' rocky interior travels upward, coming into contact with cooler water.
- Temperatures required to produce the tiny rock grains would be at least 90 °C. (194 °F)
- Cassini's cosmic dust analyzer (CDA) instrument repeatedly detected miniscule rock particles rich in silicon, even before Cassini entered Saturn's orbit in 2004.
- The CDA team concluded these particles must be grains of silica, found in sand and quartz on Earth. The consistent size of the grains, the largest of which were 6 to 9 nanometers, was the clue that a specific process likely was responsible.
- On Earth, the most common way to form silica grains of this size is hydrothermal activity when slightly alkaline and salty water is super-saturated with silica undergoes a big drop in temperature.
- The extremely small size of the silica particles also suggests they travel upward relatively quickly from their hydrothermal origin to the near-surface sources of the moon's geysers.
- From seafloor to outer space, a distance of about 50 km (30 miles), the grains spend a few months to a few years in transit, otherwise they would grow much larger.
- Cassini's gravity measurements suggest Enceladus' rocky core is quite porous, which would allow water from the ocean to percolate into the interior, providing a huge surface area where rock and water could interact.
- The second paper suggests hydrothermal activity as one of two likely sources of methane in the plume of gas and ice particles that erupts from the south polar region of Enceladus.
- At the high pressures expected in the moon's ocean, icy materials called clathrates could form that imprison methane molecules within a crystal structure of water ice. As this process is so efficient at depleting the ocean of methane, an explanation for its abundance in the plume was needed.
- One possibility is that methane is produced faster than it is converted into clathrates.
- A second possibility is that methane clathrates from the ocean are dragged along into the erupting plumes and release their methane as they rise, like bubbles forming in a popped bottle of champagne.
- Both scenarios are likely occurring to some degree, but the presence of nanosilica grains favors the hydrothermal scenario.
- Cassini first revealed active geological processes on Enceladus in 2005 with evidence of an icy spray issuing from the moon's south polar region and higher-than-expected temperatures in the icy surface there.
- Gravity science results published in 2014 strongly suggested the presence of a 10 km (6-m) deep ocean beneath an ice shell 30-40 km (19-25 mi) thick. ##

URANUS

NEPTUNE

What It would be like to live on Neptune's largest moon Triton

MAR. 24, 2015 – www.space.com/28913-**how-to-live-on-neptune-triton**.html
www.space.com/28903-**living-on-triton-neptune-moon-infographic**.html
http://en.wikipedia.org/wiki/**Triton_moon**



Editor: surely one of the top thrills of my life was to watch Voyager 2 skim over Triton"s "cantalope-textured" surface, live In the "Neptune-Triton Encounter" August 25, 1989, on NASA TV

- Triton is the largest of Neptune's 14 moons, at about 2,700 km (1,680 across.
- Its crust is composed of frozen nitrogen ice over a core of rock and metal.
- Triton was likely an object that Neptune captured. As a result, its orbit is highly inclined, and it moves in the opposite direction as most other bodies in the solar system.
- As Triton has only a trace of atmosphere, it has no weather
- Neptune would appear about 10 times larger in the sky of Triton than the Moon looks in our sky.
- Triton's gravity is about 8% that of the Earth, or half that of the Moon. The average surface temperature on Triton is −235°C (−391°F).
- Aradio signal would take 4 hours to reach it from Earth.
- If you visited Triton, you'd be subjected to the coldest temperatures in the solar system, incredibly weak gravity and retrograde sunrises and sunsets, sun rising in the west, setting in the east.
- Triton's surface is mostly made up of rock and nitrogen ice with cratered and smooth regions existing side by side. These smooth areas are (the result of plumes of dust and nitrogen gas that erupt out of the moon's crust, and then get gently blown around by Triton's tenuous atmosphere.
- It's not clear how dangerous those geysers would be to anyone standing next to them, and these plumes are poorly undrstood.
- There are slight winds in Triton's thin atmosphere, but you wouldn't feel any breeze from them.
- Duirng Neptune's 165-year-long trip around the sun, the polar regions of Triton take turns bathing in the sun for some 82+ years at a time.
- Sunlight results in seasonal changes to Triton's surface pressure. The atmosphere thickens a bit after the sun causes frozen nitrogen, methane and carbon monoxide on the surface to sublimate into gas.
- The atmospheric pressure in Triton's southern hemisphere is estimated to have quadrupled since Voyager 2s visit, but it's still 20,000 times less than Earth's surface pressure.
- Though there are slight winds in Triton's thin atmosphere, you wouldn't feel any breeze while standing on the surface.
- Triton's weak atmosphere doesn't allow for weather or sky colors. ##

PLUTO & BEYOND

NASA Pluto Probe Begins Science Observations Ahead of Epic Flyby

JAN. 15, 2015 – www.space.com/28270-**new-horizons-pluto-science-observations**.html
www.space.com/28285-**onward-to-pluto-new-horizons-epic-journey-animated**.html

- A NASA spacecraft's epic Pluto encounter is officially underway.
- NASA's New Horizons probe has begun its 6-month approach to the Pluto-Charon double planet, to culminate with the first-ever close flyby on July 14.
- The dwarf planet has remained a mystery since its 1930 discovery because it's so small and so far away. (On average, about 40 times farther from the sun than Earth.)
- The spacecraft rocketed away from Earth at more than 58,000 km/h (36,000 mph), faster than any other probe.
- New Horizons will use seven different science instruments to study Pluto and its five known moons.
- The mission's chief objectives include mapping the surface composition and temperature of Pluto and its largest moon, Charon; characterizing the atmosphere of Pluto and the geology of Pluto and Charon; and hunting for rings and additional satellites in the Pluto system.
- In the 1990s, researchers began to realize that Pluto is not a lonely misfit; but just the closest of many dwarf planets and other icy denizens of the far-flung Kuiper, which lies beyond Neptune's orbit.
- So New Horizons' observations should help researchers better understand an entire class of solar system bodies.
- Small, icy worlds like Pluto are probably the most common type of planet in the entire universe.

Pluto and Charon rotating around common center of gravity (Video)

FEB. 12, 2015 – www.space.com/28547-**pluto-charon-day-new-horizons-video**.html

The View from New Horizons: A Full Day on Pluto-Charon

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

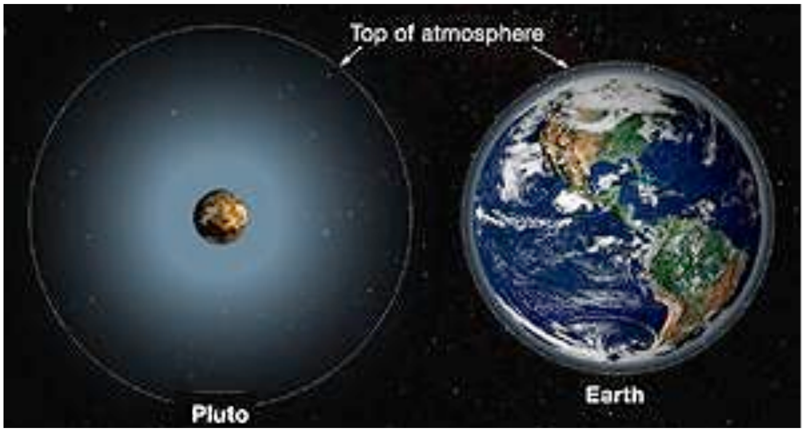
FEB 15, 2015 – This time-lapse "movie" of Pluto and its largest moon, Charon, was recently shot at record-setting distances with the Long-Range Reconnaissance Imager (LORRI) on the New Horizons spacecraft.

- The movie was taken as part of the mission's second optical navigation ("OpNav") campaign to better refine the locations of Pluto and Charon in preparation for the spacecraft's close encounter with the small planet and its five moons on July 14, 2015.
- Pluto and Charon were observed for an entire rotation of each body
- A "day" on Pluto and Charon is 6.4 Earth days. The first of the images was taken when New Horizons was just 126 million miles (203 million kilometers) from Pluto-about 30% farther than Earth's distance from the Sun.
- The last frame came 6 0.5 days later, from more than 5 million miles (8 million kilometers) closer.
- The wobble easily visible in Pluto's motion, as Charon orbits, is due to the gravity of Charon, about one-eighth as massive as Pluto and about the size of Texas.
- Faint stars can be seen in background of these images.
- Each frame had an exposure time of one-tenth of a second, too short to see Pluto's smaller moons.
- New Horizons is still too far from Pluto and its moons to resolve surface features.
- This close up look at Pluto and Charon, taken as part of the mission's latest optical navigation ("OpNav") campaign from Jan. 25-31, 2015, comes from the Long Range Reconnaissance Imager (LORRI) on NASA;s New Horizons spacecraft.

- The time-lapse frames in this movie were magnified four times to make it easier to see Pluto and Charon orbit around their barycenter, a mutual point above Pluto's surface where Pluto and Charon's gravity cancels out - this is why Pluto appears to "wobble" in space.
- Charon orbits approximately 18,000 km (11,200 mi) above Pluto's surface.
- These images allow the New Horizons navigators to refine the positions of Pluto and Charon
- They have the addied benefit of allowing scientists to study the variations in brightness of Pluto and Charon as they rotate, providing a preview of what to expect during the close encounter in July. ##

How Big Is Pluto's Atmosphere?

MAR. 2, 2015 www.spacedaily.com/reports/Science_Shorts_**How_Big_Is_Plutos_Atmosphere**_999.html



The outer limit for Pluto's atmosphere is ill-defined because of the gradual way that the atmosphere merges with the vacuum of space. It could in fact be farther than seven Pluto radii from its surface.

Earth has an equivalent thickness - if you compress the atmosphere to uniform pressure and density - of about 10 kilometers, or six miles.

- Compare this with the radius of Earth, 6,370 kilometers
- The razor-thin thickness of Earth's atmosphere is about 0.17% of its radius.
- Even if you consider the "outer limit" of Earth's neutral atmosphere, what we call the exobase, that reaches about 600 kilometers altitude, the atmosphere's equivalent thickness is only 10% of Earth's radius-still very thin.
- So the volume of Earth's atmosphere is tiny compared to Earth's volume.

Now consider Pluto.

- Its atmosphere has a near-surface equivalent thickness of about 40 kilometers, which is almost 4% of its 1,200- kilometer (or so) radius.
- But the "outer limit" of Pluto's atmosphere is very difficult to define, although we know that it is very far from the surface.
- If one defines it similar to the way we define the exobase of Earth's atmosphere, then **Pluto's atmosphere has an outer limit of at least seven times Pluto's radius above it surface**.
- The volume of Pluto's atmosphere is over 350 times the volume of Pluto itself!.

This estimate is conservative.

- The outer limit for Pluto's atmosphere is ill-defined because of the gradual way that the atmosphere merges with the vacuum of space.
- It could in fact be farther than seven Pluto radii from its surface, and thus its volume would be even larger.
- Size will be one of the central questions we answer about Pluto's atmosphere with New Horizons during the Pluto system encounter in July.
- The answer will have implications for many aspects of the atmosphere's characteristics, such as the thermal structure, solar ionization, solar wind interactions, escape rate,
- And even its interaction with Pluto's large moon, Charon. ##

Your Ideas Wanted to Help Name Parts of Pluto & Charon

MAR. 24, 2015 - www.space.com/28897-**pluto-features-names-new-horizons**.html
http://**ourpluto**.seti.org

You can help put names on the Pluto maps that scientists will draw up after the first-ever flyby of the dwarf planet this summer. Researchers working on the New Horizons mission, which will zoom through the Pluto-Charon system on July 14, are asking the public to propose and vote on names for geological features the probe will identify on Pluto and its largest moon, Charon.

- The SETI Institute is leading the "Our Pluto" naming campaign.
- The public can suggest and vote on monikers at http://**ourpluto**.seti.org through April 7, 2015.
- New Horizons team members will sift through the results and submit a batch of recommendations to the International Astronomical Union (IAU), which assigns "official" names to celestial objects and their features.
- Many names will doubtless be required after New Horizons' highly anticipated flyby.
- Pluto images captured by the Hubble Space Telescope, show extensive bright and dark areas, suggesting that this frigid world has a complex and varied surface.

Some places to look for suitable names for features on Pluto

http://en.wikipedia.org/wiki/**Pluto_mythology**
www.crystalinks.com/**pluto**rome.html
www.infoplease.com/encyclopedia/society/**pluto-greek-religion-mythology**.html
http://ancienthistory.about.com/cs/grecoromanmyth1/g/**pluto**.htm

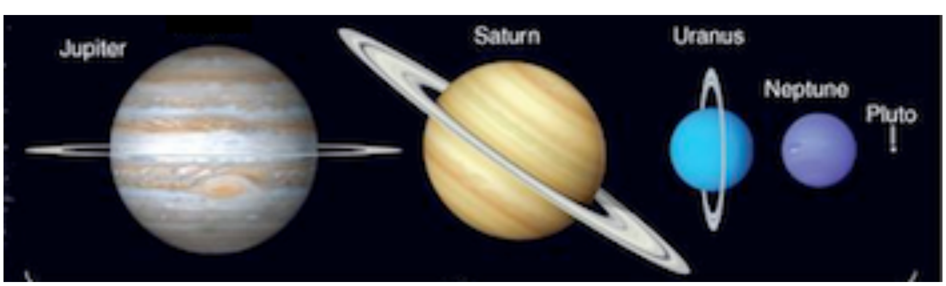
Some places to look for suitable names for features on Charon

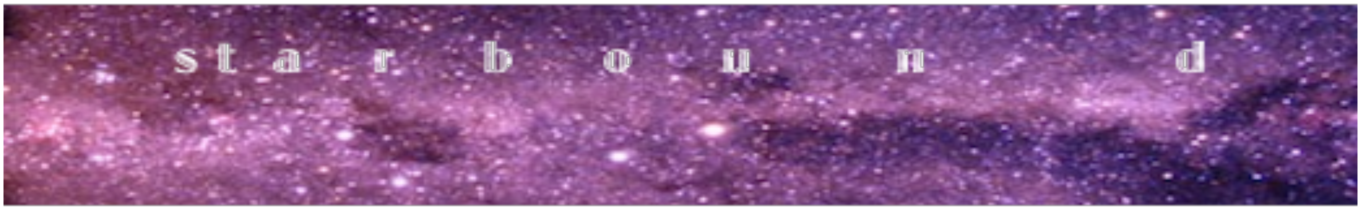
http://en.wikipedia.org/wiki/**Charon**_mythology
*www.theoi.com/Khthonios/**Kharon**.html*

Mysterious Planet X May Really Lurk Undiscovered in Our Solar System

JAN. 16, 2015 - www.space.com/28284-**planet-x-worlds-beyond-pluto**.html

- "Planet X" might actually exist — and so might "Planet Y."
- **At least two planets larger than Earth** likely lurk in the dark depths of space far beyond Pluto, just waiting to be discovered, a new analysis of the orbits of "**extreme trans-Neptunian objects**" (**ETNO**s) suggests.
- Researchers studied 13 ETNOs — frigid bodies such as the dwarf planet Sedna that cruise around the sun at great distances in elliptical paths.
- Theory predicts a certain set of details for ETNO orbits. They should have a semi-major axis, or average distance from the Sun, of about 150 astronomical units (AU). (1 AU i= distance from Earth to the Sun) 150 million km (roughly 93 million mi.) These orbits should also have an inclination, relative to the plane of the solar system, of almost 0 degrees, among other characteristics.
- But the actual orbits of the 13 ETNOs are quite different, with semi-major axes ranging from 150 to 525 AU and average inclinations of about 20 degrees.
- This excess of objects with unexpected orbits suggests that invisible forces are altering the distribution of the orbital elements of the ETNOs, and the most probable explanation is that other unknown planets exist beyond Neptune and Pluto. - at least two planets, and probably more.
- These undiscovered worlds would be more massive than Earth, and would lie about 200 AU or more from the sun — very difficult, if not impossible, to spot with current instruments. ##



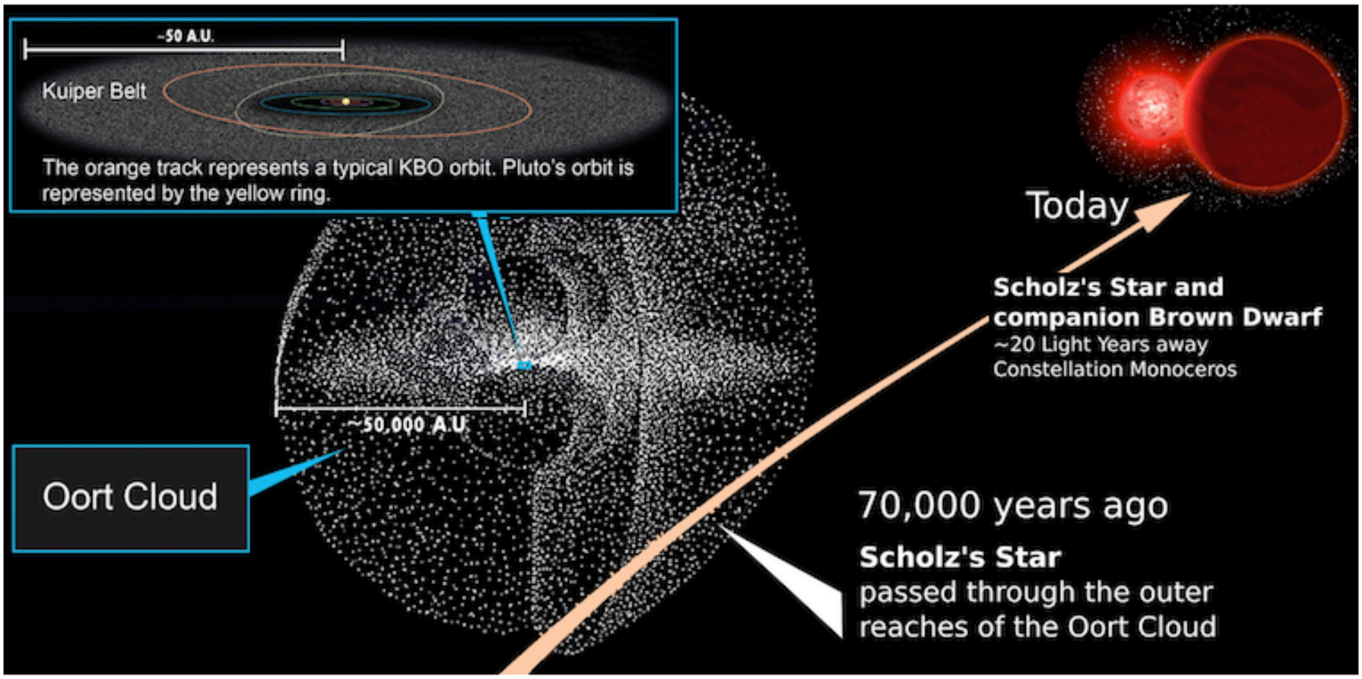


[The articles below have been bullet-summarized by the editor. For the full text, see the links cited.]

OUR CLOSEST STAR: THE SUN

Close Call! 'Scholz's Star' Grazed Our Solar System 70,000 Years Ago

FEB. 19, 2015 – www.space.com/28611-**star-flew-through-solar-system**.html



www.universetoday.com/wp-content/uploads/2015/02/**Scholzs-and-the-OortCloud.jpg**

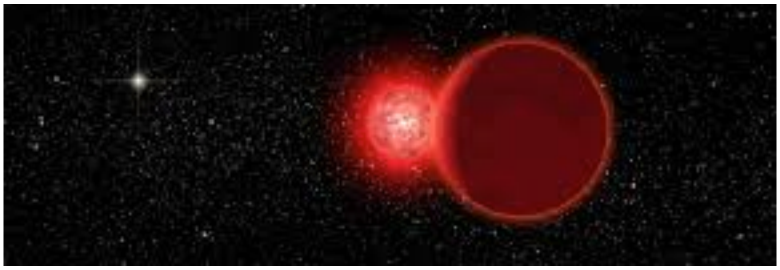
A dim red dwarf and its brown-dwarf companion likely grazed the outer edges of the solar system 70,000 years ago in what scientists say was the closest encounter ever between our sun and another star.

- The binary pair is known together as "Schols's Star, now some
- At its closest approach, the binary pair passed by the Sun at a distance of less than 1 light-year — about 10 trillion km (~6 trillion mi). The star currently closest to our Solar Systm is Proxima Centauri at 4.243 light-years from Earth, 34+ light days closer than Alpha Centauri A and B..
- Scientists made the Scholz's-star discovery by measuring its tangential velocity (the motion across the sky) as well as its radial velocity away from Earth).
- The small tangential motion and proximity initially indicated that the star was most likely either moving towards a future close encounter with the solar system, or it had recently come close to us and was moving away.
- The radial-velocity measurements were consistent with it running away from the sun's vicinity — it must have had a close flyby in the past.

Scholz's Star

- The star is named for its discoverer: astronomer Ralf-Dieter Scholz, of the Leibniz-Institut für Astrophysik Potsdam in Germany, who spotted it in 2013, in the constellation Monoceros.
- The star has less than 10 % the mass of the sun, and its companion brown dwarf is a failed star that lacked the necessary mass to begin fusion in its core.

- The red dwarf first caught the attention of the astronomers because of its unusually slow motion across the sky for such a nearby star.
- The science team traced its path backward to its position 70,000 years ago, when it had its closest brush with the solar system.
- Out of 10,000 simulated orbits, the star passed through the outer edges of the Oort cloud of comets and icy rocks that circle the solar system, 98 percent of the time, passing within 0.8 light years.
- Only one of the simulations brought it inside the Oort cloud, where it could have sent showers of comets raining down on the solar system.



An artist's concept of Scholz's star with its brown-dwarf companion in the foreground during their flyby of the solar system 70,000 years ago. The sun would appear as a bright star from the pair (left background).

Could prehistoric humans see Scholz's star?

- At its closest point, Scholz's star would have been a 10th-magnitude star — 50 times too faint to be seen with the naked eye.
- But brief flares on the star could have lit it up thousands of times brighter, making it potentially visible to early mankind for a few minutes or hours at a time.

Other close visitors

- With its goal of charting a 3D map of the galaxy, the recently launched **European Space Agency's Gaia satellite** will go a long way toward helping astronomers identify which other stars might have had a close encounter with the solar system, or will be dropping by in the near future. ##

Editor: This story is our pick for the most exciting news reported in this issue of TTSIQ

What would trump this news for me? Discovery of a Brown Dwarf (not enough mass to ignite fusion) with a Europa-like planet, **substantially closer** to us than the Alpha/Proxima Centauri system.

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VIRTUAL TELESCOPES

Introducing the "Worldwide Telescope"

http://www.**worldwidetelescope**.org

http://blogs.microsoft.com/next/2014/03/19/**at-ted-worldwide-telescope-uses-oculus-rift-to-let-attendees-experience-the-universe/**

Q. What is the WorldWide Telescope?

A. The WorldWide Telescope is a rich visualization environment that functions as a virtual telescope, bringing together imagery from the best ground- and space-based telescopes to enable seamless, guided explorations of the universe. WorldWide Telescope, created with **Microsoft's high-performance Visual Experience Engine**, enables seamless panning and zooming across the night sky blending terabytes of images, data and stories from multiple sources over the Internet into a media-rich, immersive experience. The WorldWide Telescope experience scales from a web browser all the way to multi-channel full dome in some of the world's most advanced planetariums.

Q. What is the WorldWide Telescope Web Control?

A. The WorldWide Telescope Web Control uses HTML5 to provide a rich browser-based version of WorldWide Telescope that that functions as a virtual telescope, bringing together imagery from the best ground- and space-based telescopes to enable seamless, guided explorations of the universe from within a web browser. This version contains a subset of the features that the Windows Client offers. Navigate here to learn more about the Web Control.

Q. What are some of the most compelling features of WorldWide Telescope?

A. WorldWide Telescope is an observatory on your desktop, allowing you to see the sky in a way you have never seen it before through individual exploration; multi-wavelength views; stars and planets within context to each other; the ability to zoom in and out; and the capability to create, search and view guided tours of the universe. You can view the entire solar system in 3-D with light and shadows created from the sun, and can explore the Earth and Mars in incredible detail. You also can watch planets orbit around the sun, and moons orbit around planets. The Visual Experience Engine delivers seamless panning and zooming around the night sky, now enhanced with the TeraPixel sky image that provides an unmatched panorama of the heavens. WorldWide Telescope delivers seamless integration of scientifically relevant information, including multi-wavelength, multiple-telescope distributed image and data sets, and one-click contextual access to distributed Web information and data sources.

Q. What is unique about the Terapixel sky image?

A. The Terapixel sky image is a seamlp-ess, high-resolution panorama of the night sky. This first of a kind feature provides the largest and highest-quality visual image of the sky and was created from data provided by the Digitized Sky Survey, a collection of thousands of images taken over period of 50 years by two ground-based survey telescopes. When combined and processed, the TeraPixel image is a complete, spherical, panoramic rendering of the night skies that, if displayed at full size, would require 50,000 high-definition televisions to view. Using the Project Trident Workflow Workbench and the DryadLINQ interface for .NET, Microsoft Researchers combined thousands of images and systematically removed differences in exposure, brightness, noise floor, and color saturation, and they eliminated the "tiling effect" of sharp-edged boundaries between discrete telescopic photographs.

Q. What is WWT | Mars?

A. WWT | Mars is an intricate Mars environment map with new, high-resolution imagery data that allows for an up-close and personal encounter with the Red Planet. These new high quality, high-resolution images provide the ability to navigate through space dynamically to make your own discoveries. Provided through a collaborative relationship with NASA, the WWT | Mars experience includes the most complete pole-to-pole coverage of Mars images available allowing WorldWide Telescope users to experience Mars in 3-D.

Q. Does WorldWide Telescope provide real-time data?

A. WorldWide Telescope shows you where items are in space today but all the images are from different ground- and space-based telescopes, and that content is from varying times in the past.

What are the system requirements for running WorldWide Telescope?

Refer to the system requirements section on the WWT Download page.

Is WorldWide Telescope available in other languages?

A. Yes, WorldWide Telescope offers fully-localized user-interfaces for Simplified Chinese, German, Russian, Hindi, Spanish and other language versions of the Windows Client. To change your language, install the Windows Client, then choose the "Select Your Language" option from the Settings menu.

What is the Microsoft Visual Experience Engine?

A. The Microsoft Visual Experience Engine is the technology that enables seamless panning and zooming across the night sky, blending terabytes of images, data and stories from multiple sources over the Internet into a media-rich, immersive experience.

Who are some of your partners with WorldWide Telescope?

A. We are working with a variety of partners in the academic, educational and scientific communities to make WorldWide Telescope a success.

What will WorldWide Telescope cost?

A. Microsoft Research is dedicating WorldWide Telescope to the memory of Jim Gray and is releasing WorldWide Telescope as a free resource to the astronomy and education communities with the hope that it will inspire and empower people to explore and understand the universe as never before.

When did Microsoft first starting looking at the sky?

A. For 19 years, Microsoft has invested, and will continue to invest, in long-term, broad-based research through Microsoft Research. WorldWide Telescope is built on work that started with Jim Gray's work on SkyServer and his contributions to Sloan Digital Sky Survey.

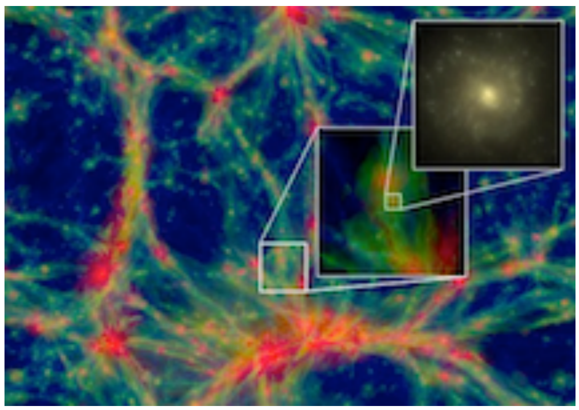
Is this an extension of Jim Gray's work?

A. Yes. Jim Gray spent his life perfecting database and transaction processing systems, and he was committed to using technology to advance education. His seminal work on the SkyServer typified his dedication to making scientific information and exploration available to specialists and laypeople alike, and WWT is an ongoing extension of this work. ##

ELESCOPES

New Universe Evolution Simulation Is Most Realistic Yet | Video

www.space.com/28140-**best-galaxy-simulation-eagle-video.html**
www.space.com/28119-**new-universe-evolution-simulation-is-most-realistic-yet-video**.html



Unlike previous visualizations, the **E**volution and **A**ssembly of **G**a**L**axies and their **E**nvironments (EAGLE) simulation incorporates galactic winds into the equation to mold the Universe. An individual galaxy can be resolved from within the large-scale cosmic web, in this still image from the EAGLE simulation of the universe. EAGLE generates a more accurate picture of galaxies than any simulation of this size before it.

- A massive new simulation of the universe has captured that galactic variety with more accuracy than any simulation before it, according to a new study. Galaxies come in all different shapes and sizes
- A simulation called EAGLE (Evolution and Assembly of GaLaxies and their Environments), produces a simulation of the universe that contains tens of thousands of galaxies (a very tiny fraction).
- For a simulation this size, researchers say theirs is the most accurate representation of galaxies yet.
- Other galaxy simulations often produce galaxies that are different than those seen in nature – too massive, too spherical, too small and with too many old stars,. ##

Hubble Space Telescope Could Survive Through 2020

FEB. 02, 2015 – www.space.com/28422-**hubble-space-telescope-mission-2020**.html

Scientists working with the long-lived Hubble Space Telescope say that the intrepid eye on the sky could continue functioning through 2020, and even beyond.

- Hubble is currently in good shape. The instruments repaired during the last Hubble servicing mission in 2009 have operated longer since the repairs than they did with the original hardware.
- Many of the other systems on Hubble are functioning well, even with the telescope reaching its 25th year in space in 2015. NASA did a study in 2013 evaluating Hubble's engineering and subsystems that ultimately showed a good likelihood that the telescope would continue functioning at least until 2020.
- That would allow Hubble some time to work in tandem with the James Webb Space Telescope to be launched in 2018. ##

1,000 Alien Planets! The Kepler Space Telescope Hits Big Milestone

JAN. 6, 3025 - http://www.space.com/28105-nasa-**kepler-spacecraft-1000-exoplanets**.html

- A number of these future finds are likely to be small, rocky worlds with temperate, relatively hospitable surface conditions — planets a lot like Earth.
- In fact, at least two of the newly confirmed eight Kepler planets appear to meet that description.
- The first world beyond our solar system wasn't confirmed until 1992, and astronomers first found alien planets around a sunlike star in 1995.
- The $600 million Kepler mission launched in March 2009, with the aim of determining how frequently Earth-like planets occur around the MIlky Way galaxy..

NASA's Kepler spacecraft has discovered its 1,000th alien planet.

Kepler has found more than half of all known exoplanets to date, and the numbers will keep rolling in: The telescope has also spotted 3,200 additional planet candidates, and about 90 percent of them should end up being confirmed.

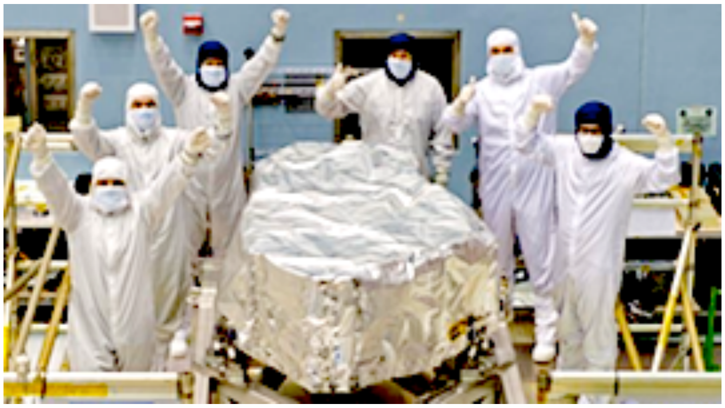
- The telescope spots alien planets using the "transit method," watching for the telltale brightness dips caused when an orbiting planet crosses the face of its host star from Kepler's perspective.
- The instrument generally needs to observe multiple transits to flag a planet candidate, which is part of the reason why the most intriguing finds are expected to come relatively late in the mission.\
- Several transits of a huge, close-orbiting "hot Jupiter" with no potential to host life, can be observed relatively quickly, while it may take years to gather the required datafor a more distantly orbiting, possibly Earth-like world.
- Kepler candidates must confirmed by follow-up observations using other instruments.
- Kepler has not yet discovered a true Earth twin — an Earth-size planet in the habitable zone of a sun-like star — but we are on track to figure out just how commonly these worlds occur in the galaxy.

A new mission

- Kepler's original planet-hunting campaign, designed to last for 3.5 years, called for the spacecraft to continuously monitor **about 150,000 distant stars in the constellations Lyra and Cygnus.**
- The data-gathering part of that mission came to an end in May 2013, when the second of Kepler's four orientation-maintaining reaction wheels failed, robbing the spacecraft of its super-precise pointing ability. A repair mission is not going to happen; as Kepler orbits the sun, not the Earth.
- But Kepler is still at work. In May 2014, NASA approved a new two-year K2 mission extension for the space observatory, during which a compromised Kepler continues to hunt for exoplanets but also observes other cosmic objects and phenomena, including supernova explosions and star clusters.
- K2 observations continue to September 2017 and should spot a number of relatively nearby exoplanets that can be observed in detail by NASA's $8.8 billion James Webb Space Telescope (JWST), which is scheduled to launch in late 2018
- Sometime around September of 2016, we'll probably have our final catalog.
- But NASA could extend K2 for another two years And even if the spacecraft shuts its sensitive eyes in 2016, its observations will keep researchers busy for a long time to come. ##

Improved Vision for the James Webb Space Telescope

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



Left: Mission accomplished. The final taping of the protective cover is applied and theJames Webb Space Telescope NIRSpec instrument is in its final flight configuration and ready to go back into the Integrated Science Instrument Module. Right: Low light test on micro-shutter array

FEB. 25, 2015 Key science elements of the James Webb Space Telescope have been upgraded ahead of the observatory's launch in 2018.

- The JWST, is **a joint project of NASA, ESA and the Canadian Space Agency**.
- It carries a 6.5 m (256")-diameter telescope and four state-of-the-art science instruments optimised for infrared observations.
- Europe has led the development of two of the instruments.

As a general-purpose observatory, the JWST will tackle a wide range of topics:

- Detecting the first galaxies in the Universe and following their evolution over cosmic time
- Witnessing the birth of new stars and their planetary systems,
- Studying planets in our Solar System and around other stars.

Assembly schedule

- Installation of the four instruments in the telescope's Integrated Science Instrument Module, or ISIM, was completed last April.
- Since then, the module has undergone extensive testing to ensure it can withstand the stresses of launch and operation in space.
- The instruments completed cryogenic testing in a round-the-clock campaign running for 116 days last summer.
- Several months were dedicated to replacing key components of some of the instruments already known to require additional work before the next stages.
- ESA's 'NIRSpec', the near-infrared multi-object spectrograph, was one of the instruments upgraded.
- NIRSpec will split infrared light from distant stars and galaxies into its colour components - a spectrum - providing scientists with vital information on their chemical composition, age and distance.

Need for replacement

- The first generation of JWST's highly sensitive near-infrared detectors were found to suffer from a design flaw that resulted in a progressive degradation of their performance.
- New detectors have now been installed in all three near-infrared instruments. ##

New Space Telescope Tech could be 1,000 times sharper than Hubble

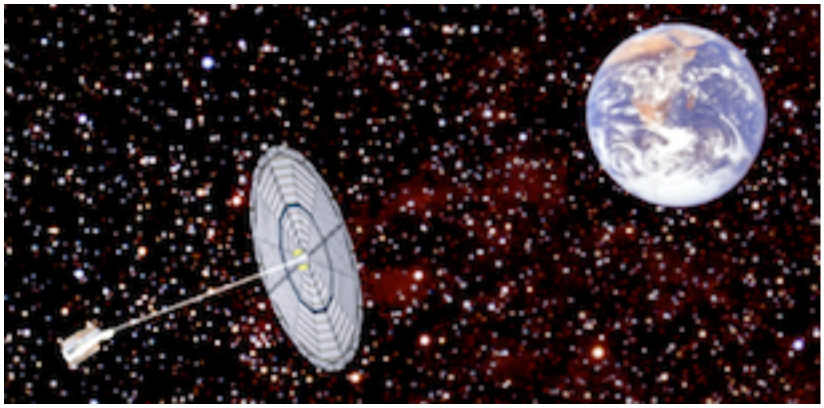
FEB. 26, 2015 - www.space.com/28650-**space-telescope-tech-aragoscope**.html

A new type of orbiting telescope could take images more than 1,000 times sharper than those snapped by NASA's famous Hubble Space Telescope.

- Researchers have dubbed their concept the "**Aragoscope**," after French scientist Francois Arago, the first to discover that light waves diffract around a disk.

- The Aragoscope would consist of an orbiting space telescope sitting tens or hundreds of miles behind an opaque disk up to 0.8 km (0.5 mi) wide.

Light waves from stars and other objects in space would bend around the disk and come together at a single, central point behind it. That light would then be sent through the telescope, resulting in a high-resolution image.



Artist's illustration of the Aragoscope, a space telescope concept that would use a light-diffracting disc to produce ultrasharp images.

- The Aragoscope could take images of plasma swaps between stars and of black hole event horizons, the points beyond which nothing, not even light, can escape a black hole's gravitational pull.
- The instrument could also pinpoint an object on the Earth's surface as small as a rabbit, making the telescope useful for search and rescue efforts here on Earth.
- The Aragoscope's disc would launch in a compressed form and unfurl in space.
- It would be made of a lightweight, plasticlike material similar to a garbage bag, for low launch costs.
- The heavier the space telescope, the more expensive the cost of the launch,but that problem can be solved by putting large, lightweight optics into space that offer a much higher resolution.
- The Aragoscope is stilla concept, but a scaled-down version will be tested in alab soon.
- They plan to use a 3.3-foot (1 meter) disc sitting several meters in front of a telescope.
- The Aragoscope concept was funded through the first phase of the NASA Innovative Advanced Concept (NIAC) program, aimed at developing bold ideas that could make the impossible possible. ##

EXO-PLANETS AROUND OTHER SUNS

Stars Slow Down Over Time, Revealing their Age | Video

http://www.space.com/28168-**stars-spin-slows-down-over-time-revealing-age**-video.html

Zap! Laser Blasts Shed Light on Cores of Alien Planets

JAN.22, 2015 - www.space.com/28340-**exoplanet-cores-laser-blasts**.html

Using laser blasts, scientists have recreated the extreme temperatures and pressures found inside large rocky planets known as super-Earths as well as in icy giant planets such as Neptune and Uranus, shedding light on what the interiors of these exotic worlds are like.

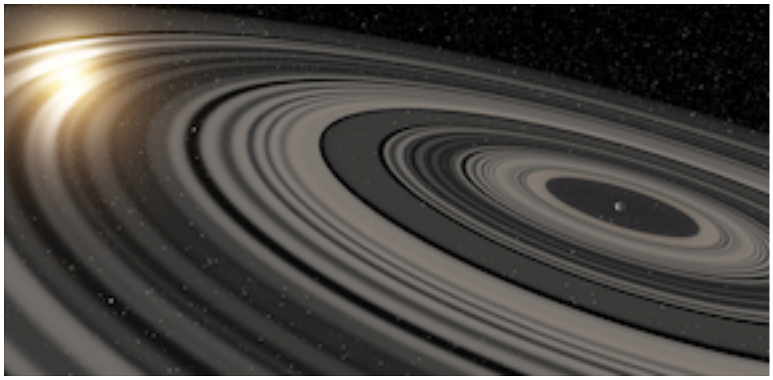
- The interiors of super-Earth exoplanets may consist of oceans of molten rock that generate magnetic fields, and giant planets may contain solid, rocky cores.
- Of more than 1,800 planets orbiting distant stars, many are very different from those in or solar system, such as “super-Earths,” which are rocky planets that are up to 10 times the mass of Earth.
- Much remains unknown about these alien worlds: how they form and evolve, and what kinds of cognditions they might impose on life over time.
- A major factor in a planet’s evolution is how ingredients such as silica melt, "main constituent of rock.

- Melting is arguably the most important process that determines how the interiors of planets evolve.
- Melting determines whether or the innards of a rocky planet separate into a crust, mantle and core.
- The magnetic fields of planets result from the churning of electrically conductive fluids such as molten iron. Magnetic fields could help protect he atmospheres of planets from getting stripped away by winds of particles from their host stars, and therefore may prove vital to the evolution of live.
- Extreme pressures found inside planets can greatly modify the melting temperatures and other properties of their constituent materials, aqueezing atoms together, modifying their properties in ways that can be quite hard to predict.
- The innards of super-Earths and giant planets experience much higher pressure than Earth's because their greater mass squeezing inward.
- However, it was uncertain what effects such conditions might have on the properties of the interiors of these planets, as it is very difficult to generate such extraordinarily high pressures on Earth.
- Until now, the highest pressure at which scientists had melted silica was about 100 gigapascals, roughly 1 million times the atmospheric pressure of Earth at sea level.
- Now scientists have discovered the melting temperature and other key properties of silica when the substance is exposed to a pressure of 500 gigapascals, nearly twice that of the Earth's core, comparable to the pressure at the boundary of the core and mantle in a super-Earth five times Earth's mass
- This is the level of pressure generated by giant impacts in the violent, final stages of planet formation.
- We're not able to drill deep into planets, so we recreate planetary interiors in the laboratory.
- To learn how silica behaves at 500 gigapascals, researchers started with crystals of a very dense form of silica known as stishovite, usually found only in minute amounts near meteor impact craters.
- Scientists used laser blasts to subject these crystals to extraordinarily high temperature & pressure.
- They discovered that at 500 gigapascals, the melting temperature of silica rises to about 8,025 °C (14,480 °F). The melting point of normal silica on Earth is c. 3,000 degrees F, or 1,650 degrees C.)
- Large, rocky exoplanets may have magma oceans of liquid silicates coexisting with liquid iron, which is not something that has been considered before when modeling such planets
- Investigators also found that high-pressure liquid stishovite is electrically conductive, and generate magnetic fields. (Silicates are generally considered electrically insulating, not conductive)
- These findings suggest that silica is solid inside icy giants such as Neptune and Uranus as well as in gas giants such as Jupiter and Saturn. If rock in these cores is solid, it won't contribute to a magnetic field. As a solid, it likely will not mix with surrounding materials as easily as if it were liquid."
- The researchers are now investigating how other planetary constituents such as hydrogen, helium, water and ammonia behave under very high temperatures and pressures.
- The challenge now is to study how mixtures of materials behave at very high temperatures/pressures.

This Super-Saturn Alien Planet Might Be the New 'Lord of the Rings'

FEB. 03, 2015 – www.space.com/28435-**super-saturn-alien-planet-rings**.html

- **A newly discovered alien planet's ring system puts Saturn's collection to shame.**
- Called J1407b, this “exo-planet” (around another “sun”) could even harbor at least one Earth or Mars-sized moon, judging by a large gap in the rings, scientists have found.
- This is the first time researchers have found this kind of ring system outside of the solar system.
- This planet is much larger than Jupiter or Saturn, and its ring system is **roughly 200 times larger than Saturn's rings** are today, "You could think of it as kind of a super-Saturn."
- Exoplanets reveal themselves in their host star's light. If a planet passes directly in front of its host star as observed from Earth, then the planet will block part of the star's light.
- But in 2007, the young star 1SWASP J140747.93-394542.6 (some 433 light-years from Earth, toward the constellation Centaurus) showed a complex series of dimmings that lasted 56 days.
- The ring system itself was first spotted in 2012.



An artist's conception of the extrasolar ring system circling the alien planet.

Editor: Note the small size of the planet in the middle of the rings, compared to how Saturn dominates the view of its rings. But this “mega-Saturn” is much larger than ours - that gives an indication of how much more vast this Exo-planet ring system is compared to that of our Saturn

- At the time, the dimming pattern suggested a ring system with at least four large rings.
- But further analysis indicates that the system is much more extensive with a total of 37 rings.

"The details that we see in the light curve are incredible. The eclipse lasted for several weeks, but you see rapid changes on time scales of tens of minutes as a result of fine structures in the rings. The star is much too far away to observe the rings directly, but we could make a detailed model based on rapid brightness variations in the starlight passing through the ring system."

- Typically, when anexoplanet crosses in front of its host star, the effect is tiny. A Jupiter-like planet, might block 1% of a sun-like star's light. Here, the rings block as much as 95% of the star's light.
- The data even show a clear gap 0.4 astronomical units (37 million miles) away from the super-Saturn. "One explanation is that a satellite with a mass between Earth and Mars formed and carved this gap
- Earth-size might prove to be promising abodes for habitable life.
- Half the planets in our system have rings, but we don’t fully kn ow how they were formed.
- Last year, astronomers even spotted a distant asteroid with rings, for the first time.

1. Rings might be ancient, having formed with the planet itself.
2. Or they might be relatively new, created from the debris of objects that fell toward the planet.
3. Or maybe they form and then quickly disintegrate into moons.

- The team thinks that the third scenario might be the most likely one in this case. They expect the rings will become thinner in the next several million years and eventually disappear as moons form from the material in the disks

"The planetary science community has theorized for decades that planets like Jupiter and Saturn would have had, at an early stage, disks around them that then led to the formation of satellites. However, until we discovered this object in 2012, no one had seen such a ring system. This is the first snapshot of satellite formation on million-kilometer scales around a substellar object." ##

Planets Orbiting Red Dwarfs May Stay Wet Enough for Life

FEB. 17, 2015 - www.space.com/28535-**red-dwarf-planet-life**.html

The Prevailing View

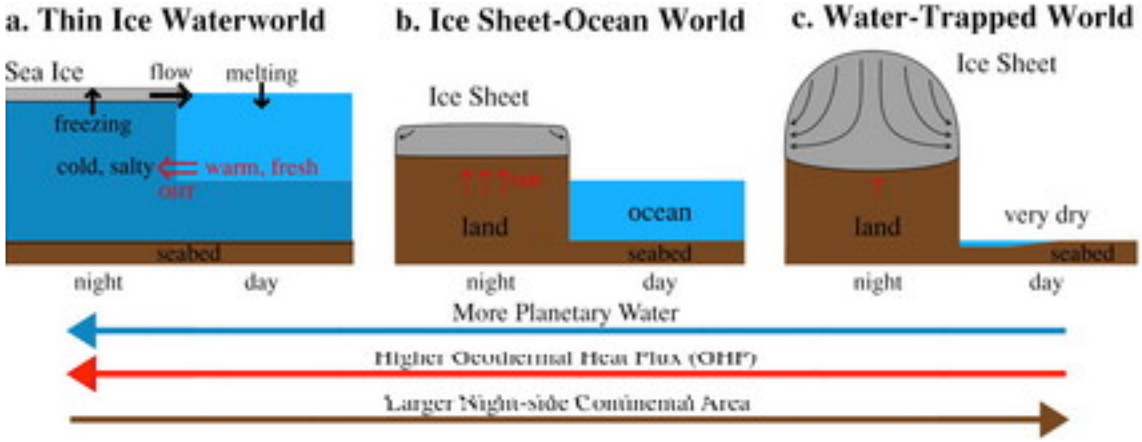
Small, cold stars known as red dwarfs are the most common type of star in the Universe, and the sheer number of planets that may exist around them potentially make them valuable places to hunt for signs of extraterrestrial life.

While they may be warm enough to host life, they might also completely dry out, with any water they possess locked away permanently as ice on the planet’s farside.

[**Ed**. Planets close enough would be tidally locked with one side permanently facing its sun, any water boiled off with some to be deposited on the farside as ice. Red Dwarfs also typically flare up to radiate the near side. Not an inviting prospect for life.]

A Second Look

- New research published on the topic finds that these planets may stay wet enough for life after all – if they have enough water.
- Red dwarfs (or M stars) are roughly one-fifth as massive as the Sun and up to 50 times fainter.
- These stars comprise up to 70 percent of the stars in the cosmos
- NASA's Kepler space observatory has discovered that at least half of these stars host rocky planets that are **one-half to four times the mass of Earth.**
- Both because there are so many of them and because they are very long lived compared to our Sun, Red Dwarf systems are potentially key places to search for life as we know it
- Recent findings suggest that planets in red dwarf habitable zonescould accumulate significant amounts of water. In fact, each planet could possess about 25 times more water than Earth's oceans.



- Habitable zones of red dwarfs are close to these stars because of how dim they are, often closer than the distance Mercury orbits the Sun.
- This closeness makes them appealing to astrobiologists, since planets near their stars cross in front of them more often, making them easier to detect than planets that orbit farther away.
- However, when a planet orbits very near a star, the star's gravitational pull can force the world to become "tidally locked" to it. When a planet is tidally locked to its star, it will always show the same side to its star with one permanent day side and one permanent night side.
- The dark sides of tidally locked planets would become so cold that any water there would freeze. Sunlight would make water on the sunlit side evaporate, and this water vapor could get carried by air currents to the night sides, eventually leading to sheets of ice miles thick on the night sides and removing all water from the sunlit sides.
- Life as we know it could not develop on the day sides of such planets. Although they would have sunlight for photosynthesis, they would have no water to serve as the primordial soup for life to swim in.

But!

- To see how habitable tidally-locked planets are, scientists simulated a red dwarf with a temperature of 3,125 °C (5,660 °F), to see whether all the water would indeed get trapped on the night sides.
- The researchers simulated planets of Earth's size and gravity that experienced between 63 percent and 77 percent as much sunlight as Earth.
- They also modeled a super-Earth planet 50 percent wider than Earth with 38 percent stronger gravity, (Astronomers have discovered super-Earth worlds around red dwarfs.)
- Gliese 667Cb, a super-Earth c. 4.5 x Earth's, orbits Gliese 667C, a red dwarf about 22 light years from Earth. They set this world on an orbit where it received about 2/3rds as much as sunlight as Earth.

Three different arrangements of continents for these planets.

1) A water world with no continents and global oceans of varying depths.
2) World with a supercontinent covering the night side and an ocean covering the day side.
3) A world mimicking contitnent configuration.

- The planets also had atmospheres similar to Earth's, but the researchers also tested lower levels of the greenhouse gas carbon dioxide, which traps heat and helps keep planets warm.

- When it came to super-Earths covered entirely in water, and super-Earths with continent arrangements like ous, it was unlikely that all the water would be trapped on their night sides because surface winds transport sea ice to the day side where it is melted easily.
- Moreover, ocean currents transport heat from the day side to the night side on these planets. Ocean heat transport strongly influences the climate and sea ice thickness
- If a super-Earth has very large continents covering most of its night side, the scientists discovered ice sheets of at least 1,000 m (3,300 ft) thick could grow on its night side.
- However, the day sides of these super-Earths would dry out completely only if they received less geothermal heat from volcanic activity than Earth, and had 10 percent of the amount of water on Earth's surface or less.
- Similar results were seen with Earth-sized planets.
- "The important implication is that it may be easier than previously thought to keep liquid water on the dayside of a tidally locked planet, where photosynthesis is possible"
- These results suggest at least that water-trapping on the night side will only be a problem for relatively dry planets with large continents on their nightside and relatively low geothermal heat flux.
- Based on present and near-future technology it would be very difficult for astronomers to gauge how thick the sea ice or the ice sheets are on the night sides of red dwarf planets.
- it may be possible to know whether the day sides are dry or not. ##

Planetary System More than Twice The Age Of The Sun Discovered

FEB. 2, 2015 – www.asianscientist.com/2015/02/in-the-lab/**planetary-system-age-sun-discovered/**
Star **Kepler-444** is 11.2 billion years old and orbited by five planetsbetwee Mercury and Venus in size. This is the oldest star with “earth-sized” planets found to date

- The find proves that such planets have formed throughout the history of the Universe.
- "It is extraordinary that such an ancient system of terrestrial-sized planets formed when the universe was just starting out, at a fifth its current age.”
- Kepler-444 is two and a half times older than our solar system (a youthful 4.5 billion years old.}
- This discovery proves that planets this size have formed for most of the history of the universe
- We now know that Earth-sized planets have formed throughout most of the Universe's 13.8-billion-year history, which “could provide scope for the existence of ancient life in the Galaxy."
- Asteroseismology was used to determine the age of the star and planets. This technique measures oscillations—natural resonances of the host star caused by sound waves trapped within it. They lead to minuscule pulses in the star's brightness and allow measurement of its diameter, mass and age.
- The presence and size of the planets is detected by the dimming that occurs when the planets pass across the face of the star. This fading in the intensity of the light received from the star enables scientists to accurately measure the sizes of the planets relative to the size of the star.
- For the smallest planet in the Kepler-444 system, slightly larger than Mercury, its size was measured with an uncertainty of only 100km.

Something very unusual

- We had five planets orbiting a very bright star—one of the brightest Kepler has observed. We can use asteroseismology to date the star and determine just how old it is.
- Kepler-444’s planets orbit their parent star in less than ten days, at less than one-tenth the Earth's distance from the Sun.
- This closeness to the host star indicates that they are uninhabitable because of the lack of liquid water and high levels of radiation.
- Discoveries like Kepler-444 put us another step closer towards finding the astronomers' holy grail—an Earth-sized planet with a one year orbit around a star similar to our Sun."

Rocky 'Tatooine' Planets with 2 Suns May Be Common

MAR. 31, 2015 – www.space.com/28976-**rocky-tatooine-planets-two-sun-common**.html

Earth-like worlds with two suns in their skies, like Luke Skywalker's home planet of Tatooine in the "Star Wars" films, may be widespread throughout the Milky Way galaxy.

- Although a number of gaseous exoplants have already been spotted in two-star systems, many astronomers had thought that rocky, potentially habitable worlds could not take shape in an environment with such “complex and chaotic orbital dynamics.”
- But mathematical simulations suggest otherwise.
- It may be just as easy to make an Earth-like planet around a binary star as it is around a solatary sun.
- That means “Tatooines” may be common I the galaxy

Fictional “Tattoine” is a favorite subject for Science Fiction Artists

Making rocky planets

- Planets coalesce from the disk of dust and gas that surrounds a newborn star.
- Rocky worlds like Earth are built up by repeated mergers of asteroidlike objects called planetesimals.
- The situation has long been thought to be quite different around newborn binary stars.
- For over a decade, it has been thought that planets like Earth could not form around most binary stars, at least not close enough to support life;
- The paths of planetesimals in such systems get tangled up by the to-and-fro pull of the two sunsl even crossomg each other's paths at high speeds, in danger of destructive collisions.
- But modeling work shows that, in binary systems, rocky building blocks get into oval paths.
- If the planetesimals get into oval orbits, their orbits can be nested, and twon't bash into each other,
- Where do gaseous two-star planets form?
- Bromley and Kenyon also analyzed the seven exoplanets that NASA's Kepler space telescope has discovered to date in or near the "habitable zone" of their two-star systems. (The habitable zone is the range of distances from the host star or stars where liquid water could exist on a world's surface.)
- Read the stydt free at http://arxiv.org/abs/1503.03876

Galaxy Merger Caught in Stunning Hubble Telescope Photo, Video

FEB. 18, 2015 - www.space.com/28583-**galaxy-merger-hubble-telescope-photo**.html

A spiral galaxy gets twisted out of shape after coming too close to a cosmic neighbori

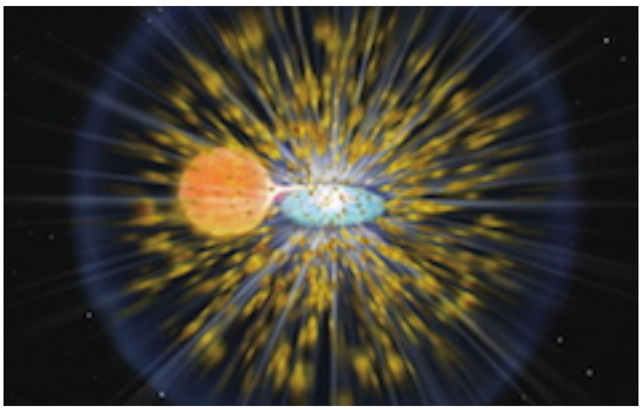
- A Hubble Space Telescope photo shows merging galaxies about 100 million light-years from Earth.
- Between 100 and 200 million years ago, NGC 7714 drifted too close to a smaller, neighboring galaxy called NGC 7715.

- The resulting galaxy merger has been violent and dramatic, changing the structure and shape of both NGC 7714 and NGC 7715.
- Note NGC 7714's strangely shaped arms, and in the smoky golden haze that stretches out from the galactic center.
- Known as NGC 7714, it lies about 100 million light-years from Earth.
- Between 100 and 200 million years ago, NGC 7714 drifted too close to a smaller, neighboring galaxy called NGC 7715.
- The resulting galaxy merger has been violent and dramatic, changing the structure and shape of both NGC 7714 and NGC 7715.
- Signs of this “brutality” can be seen in NGC 7714's strangely shaped arms, and in the smoky golden haze that stretches out from the galactic center.
- The influx of new material has spurred bursts of star formation in NGC 7714.
- The majority of starbirth activity can be seen at the bright center of the galaxy, although new stars are forming throughout NGC 7714.
- Scientists have named the NGC 7714/NGC 7715 pair Arp 248.
- NGC 7714 is classified as a Wolf-Rayet starburst galaxy with most of its newborn stars of the Wolf-Rayet type: big, hot and bright and dozens of times more massive than the sun
- Powerfull winds quickly carry away most of their material. ##

Star Explosions Help Solve Mineral Mystery of the Universe

FEB. 18, 2015 - www.space.com/28588-**star-explosions-mineral-mystery**.html

An explosion on the surface of a dying star is helping clear up a mystery behind the abundance of lithium seen in the universe. By studying **Nova Delphini 2013 (V339 Del)**, astronomers were able to detect a precursor to lithium, making the first direct detection of the third lightest element whose abundance had long remained in the theoretical realm.



A classical nova such as Nova Delphini 2013 occurs when material flows from one star in a close binary to the surface of its companion white dwarf.

While many scientists have predicted lithium production in novas, there has been no direct observational evidence before now.

- When V339 Del was spotted by an amateur astronomer on Aug. 14, 2013, it was just beyond the limit of being visible to the naked eye, though visible in binoculars. Within two days, it had brightened enough to be seen without instruments in dark sky areas
- This was the first naked-eye nova since 2007.
- Novae form when material from one star in a close binary surface is dumped onto the surface of its white dwarf companion. The runaway thermonuclear reaction causing the surge in brightness creates more complex elements than the hydrogen and helium that dominate the inside of most stars.
- One element predicted to form in the outburst is the most abundant isotope of lithium, lithium-7 (Li-7). While most heavy elements form inside of stars and through supernovae, lithium-7 is too fragile to withstand the high temperatures found within most stellar cores.

- Together with beryllium and boron, Lithium is one of the so-called 'light elements much less abundant in the Milky Way and in the Solar System than neighbor elements on the periodic table.
- These elements are not formed inside of stars like the others. Their synthesis relies on processes less efficient than nuclear reactions inside the stars.
- Some of the lithium in the universe formed when the universe first got started, during the Big Bang. Cosmic rays interacting with stars and interstellar matter may have formed more.
- But these events do not provide enough lithium to equal the amount of the element present today.
- In the 1950s, scientists suggested that an isotope of beryllium (Be-7) could form near the surface of the star. If the fresh Be-7 was transported to the cooler outer regions before it decayed into Li-7, the temperatures would not destroy the new element.
- But the difficulty in observing lithium from the ground made it a challenge to verify observationally — until this Nova.

The importance of this discovery

"All the chemical elements play an important role in galactic evolution, because they determine the chemical composition of the galactic gas from which stars form." ##

Best 3D View of Deep Universe Reveals Astonishing Details (Video)

FEB. 26, 2015 – http://www.space.com/28658-**best-3d-deep-universe-video**.html

The Cosmic Chemistry That Gave Rise to Water

FEB. 20, 2015 – www.space.com/28582-**water-chemistry-star-nurseries**.html

Earth's water has a mysterious past stretching back to the primordial clouds of gas that birthed the Sun and other stars. By using telescopes and computer simulations to study such star nurseries, researchers can better understand the cosmic chemistry that has influenced the distribution of water in star systems across the Universe.

- Much water takes the form of the familiar formula H2O; 2 hydrogen atoms, one oxygen atom.
- But some water is the less familiar “heavy” or “deuterated” water with the chemical formula HDO. “D” stands for “Deuterium” which is compsed of one hydrogen” atom, one neutron plus 2 electrons.
- That ratio of H2O to HDO represents a unique signature that can reveal the history of water within star nurseries, the clouds of gas that eventually spawn star systems and their respective planets.
- The HDO/H2O ratio is very important as it indicates the water formation conditions and mechanisms,
- By looking at water ratios, H2O/HDO, scientists have been tryg to better understand a star nursery called G34.26+0.15 - a region leading to the formation of stars more massive than our sun.
- The processes leading to the formation of such high-mass stars are not yet fully understood.

Interstellar fingerprints

- The new study aimed to shed new light on high-mass star formations by looking at how the water ratios changed within high-mass star-forming regions such as G34.
- This required ground and space telescopes capable of detecting the light signatures of water and other chemicals in G34 at a distance of 11 light-years from Earth.
- The most crucial telescope data came from Europe's Herschel Space Telescope. Herschel was able to look at the far-infrared light of distant star-forming regions unfiltered by Earth’s atmosphere.
- The telescope was able to observe water and other chemical molecules in space based on their light emissions by using the HIFI spectrometer— an instrument that can detect the light wavelengths and display them as spectral lines representing the "fingerprints" of each molecule.
- The team detected 10 HDO spectral lines to derive the HDO abundance, and three $H_2{}^{18}O$ spectral lines (used to derive the H2O abundance.
- Some of the lines dgave their telltale signatures in the colder regions of G34.
- Others required higher temperatures in the inner, warmer region of G34 to reveal their signature.

- To determine the water distribution, it isimportant to have a lot of lines with different excitation levels to probe the different regions.
- The spectral line profiles also reveal details on the motion, temperature and other characteristics of such molecules.
- Broader lines often mean higher temperature or turbulence.
- Brighter lines signal a greater abundance of molecules.

Simulating star nurseries

- The study results revealed that the HDO/H2O ratio decreased within the hot, inner core of G34 over time as various chemical reactions destroyed and reformed the water molecules.
- By comparison, the HDO/H2O ratio is higher in the colder outer envelope of G34.
- Such results suggest strong similarities in water distribution between high-mass and low-mass star-forming regions, because the latter also have a decreased HDO/H2O ratio in the core and an increased HDO/H2O ratio in the outer envelope.

Still looking to the stars

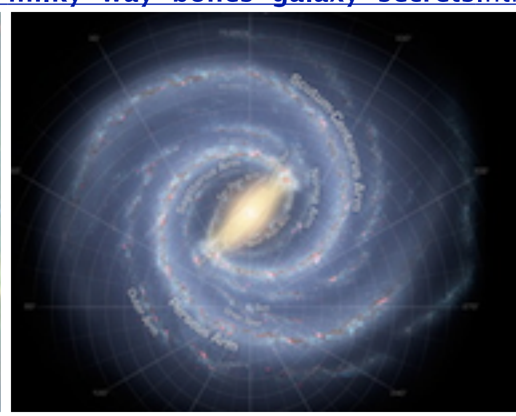
- The findings involving G34 could boost scientific understanding of the interstellar chemistrythat creates water in high-mass star forming regions.
- It has also helped refine the simulations used to predict water distribution among the stars.
- Researchers still need to look at more examples of similar regions to make sure that G34 represents the norm for high-mass star nurseries rather than an exception. ##

OUR HOME GALAXY – THE "MILKY WAY"

Note; from a planet inside any spiral galaxy, there will be a "Milky Way" girdling the sky. "Milky Way" is then just as common a name as is "the Sun'

Milky Way 'Bones' Could Reveal Secrets About Our Galaxy

JAN. 20, 2015 – http://www.space.com/28303-**milky-way-bones-galaxy-secrets**.html



Left: An image from the Spitzer Space Telescope of a possible "bone" from the galactic skeleton.
Right: An artist's rendition of the Milky Way galaxy shows the major arms that have been identified by scientists, though they're not able to observe the galaxy face-on

SEATTLE — Scientists are finding more evidence of a galactic "skeleton" lurking inside the appendages of the Milky Way, and studying these massive "bones" could help researchers get **a better idea of what our galaxy looks like from the outside**.

- In 2013, researchers suggested that long, thin, dense clouds of gas may form inside the spiral arms of the Milky Way, creating a sort of galactic skeleton that traces the shape of these massive structures.
- At the time, only one such "bone" — known as Nessie — had been identified.
- Now, new research shows that Nessie is not alone.

From the inside, looking out

- Living inside the Milky Way, we cannot see what this galactic house looks like from the outside.

- We know that the Milky Way is a spiral galaxy, meaning multiple "arms" sprout from a central region and then swirl around it, like streams of water spiraling down a drain.
- These arms coil around each other in a flat plane, so the galaxy is like a pancake:
- When it's viewed face-on, it is circular, but when it's viewed edge-on, it's a straight line.
- The Earth is nestled inside this pancake, toward the outside of the disc.
- As a result, the Milky Way appears as a ribbon running down the middle of the night sky.
- The Sun and the Earth are elevated just slightly above the galactic plane, giving scientists a small boost when they're trying to look at the larger galactic structure
- Scientists have identified the large spiral arms that make up the galaxy, but there is still debate about the exact location of those arms, as well as the location of smaller branch spirals
- But the "bones" that scientists have now identified — long, thin, highly dense clouds of gas that can also be identified by the light they absorb — would be significantly easier to spot, and could help scientists create a more precise sketch of what the Milky Way looks like from the outside.

http://www.space.com/9978-**big-picture-milky**.html (Video)

Huge Milky Way Gas Bubbles Clocked at 3.2 million kmh, 2 million mph

JAN. 22, 2015 - www.space.com/28333-**fermi-gas-bubbles-milky-way-core**.html

Giant bubbles of gas that erupted from the core of the Milky Way galaxy millions of years ago are expanding out into space at mind-blowing speeds, according to new observations that may help reveal how the strange balloon-like lobes formed.

- The Hubble Space Relescope has clocked the speed of "Fermi gas bubbles", at 3.2 million km/h.
- The giant structures now extend 30,000 light-years above and below the plane of the Milky Way.
- A few million years ago, there was a very energetic event at the galactic core: we're seeing a remnant.

Piercing the dust and gas

- "Fermi Bubbles" were first discovered in 2010 by scientists using NASA's Fermi Large Area Telescope, which revealed two lobes of material protruding from the center of the Milky Way.
- Since then, the features have been studied in the X-ray and radio wavelengths.
- Hubble's Cosmic Origins Spectrograph was paired with a distant quasar to measure the speed and composition of the billowing bubbles.
- A quasar is a very bright source of light generated by fast-moving particles near a supermassive black hole inside a distant galaxy. Light from the quasar is so strong that it outshines its parent galaxy.
- Scientists measured how the ultraviolet light from quasar PDS 456 shifted as it passed through the base of the northern bubble.
- The team determined that material on the near side of the northern lobe is streaming toward the sun, while material on the far side is zipping away. The material is gushing out of the Milky Way at approximately 900 to 1,000 kilometers per second, about 2 million mph.
- The event that created the lobes occurred between 2.5 and 4 million years ago.
- The new Hubble observations also determined that the material swept up by the gas was made up of silicon, carbon and aluminum.
- This composition suggests that the gas is enriched by heavy elements that are forged within stars, and represents the fossil remnants of star formation.
- This gas sreaches temperatures of 9,700 °C (17,500 °F), far cooler than the rest of the gas in the outflow, which reaches temperatures of around 10 million °C (18 million °F), the cooler gas may be interstellar gas from the Milky Way that has been swept up in the hot outflow.
- In other galaxies, starbursts drive outflows of gas that resemble Fermi bubbles, difficult to study from so far away. The Milky Way's Fermi bubbles provide an up-close look at these formations.
- PDS 456 is the first of 20 quasars whose light passes through the lobes. Studying the entire sample allows astronomers to further narrow down the source of the event that generated the Fermi bubbles.
- One potential cause of the outflows is rapid star formation at the galactic center. This birth of stars produced a series of supernovas that blew out a significant supply of gas.

- Another explanation involves the fall of a star or group of stars into the supermassive black hole at the center of the galaxy, causing superheated gas to be blasted into space.
- Whatever the cause, the short-lived nature of the bubbles (when compared with the 13.2-billion-year-old age of the galaxy) suggests that they may be repeating phenomena, occurring frequently throughout the life of the Milky Way.
- The outflows are “hiccups." There may have been repeated ejects of material that have blown up, and we're catching the latest one. By studying the light from the other quasars in our program, we may be able to detect the fossils of previous outflows. ##

Telescope detects Galaxy’s oldest known Solar System

http://news.sciencemag.org/physics/2015/01/**telescope-detects-galaxy-s-oldest-known-solar-system**

www.asianscientist.com/2015/02/in-the-lab/**planetary-system-age-sun-discovered/**

JAN. 27, 2015 –The **five known planets** tightly orbiting the **11.2-billion-year-old star Kepler-444**, a star that lies **c. 117 light-years from Earth**. The oldest known set of planets in the Milky Way, they are a quintet of **hot and presumably rocky** worlds **more than twice as old as our solar system**.

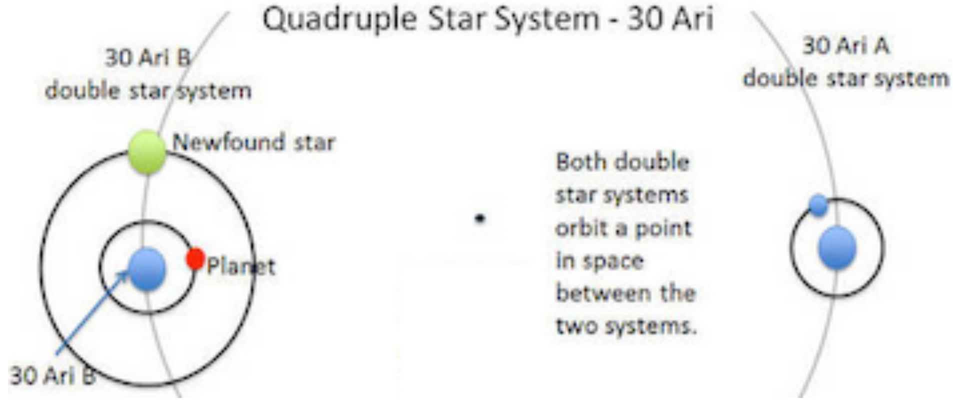
- Study of this ancient system may shed light on the early days of planetary formation in the galaxy.
- The parent star, Kepler-444, is sunlike and about 117 light-years from our Solar System.
- Colleagues analyzed several years’ worth of data gathered by NASA’s Kepler mission, surveying a region of the galaxy for signs of Earth-size and smaller worlds.
- Kepler-444 seems to be a jackpot. Five planets pass in front of the star, creating minieclipses that betray the presence and size of the planets as well as how quickly they orbit their sun. All five planets lie within 46 million km from their sun.)
- That’s too close to the star to be in the “Goldilocks zone” of habitability (far enough for water to be liquid but not boil), so theo planets likely don’t host life.)
- These worlds have surface temperatures much hotter than Mercury, so any atmospheres or oceans probably have long since been boiled away, leaving nothing but a scorched, rocky surface.
- The closest planet of the five to Kepler-444 is **about the size of Mercury**, and the farthest is **slightly smaller than Venus or Earth**. The other **three are about the size of Mars**. “Finding five planets all smaller than Earth in the same distant system, is pretty incredible.
- What’s unusual about this find is **Kepler-444’s great age**: The star is **about 11.2 billion years old**.
- (The universe is about 13.8 billion years old, while our own solar system is about 4.6 old.)
- To assess the star’s age, the team analyzed subtle variations in its brightness, as revealed in data samples taken **as often as once every minute for a year**.
- Those variations allow astrophysicists to calculate the speed of sound inside the star, which in turn enables the researchers to infer the ratio of hydrogen and helium inside the star—the key to determining how far along the star is in its evolution.
- Astronomers assume that, as in our solar system, the planets formed quickly after the star did.
- The immense age of the Kepler-444 system suggests that Earth-class planets could have formed very early in the life of the universe.
- Spectroscopy of Kepler-444 reveals that the star is iron-poor, so presumably the planets are as well.
- The planetsare likely predominantly made of lighter than iron elements such as carbon, nitrogen, silicon, and sulfur.
- Further analyses of this ancient system, and others like it, will help scientists better model how and when planets formed in our galaxy and throughout the universe. ##

Giant Alien Planet Has 4 Suns in Its Sky

MAR. 27, 2015 – www.space.com/28925-**giant-alien-planet-four-suns**.html

Planets with four suns in their sky may be more common than previously thought.

- Astronomers have spotted a fourth star in a planetary system called **30 Ari**, bringing the number of known planet-harboring quadruple-sun systems to two.
- Numerous two- and three-star exoplanets have been identified.
- There are single stars, binary stars, triple stars, even quintuple star systems,
- 30 Ari lies 136 light-years from the Sun in the constellation Aries.
- Astronomers discovered a giant planet in the system in 2009.
- This world is about 10 times more massive than Jupiter and orbits its primary star every 335 days.
- A second pair of stars lies approximately 1,670 times distance between Earth and the Sun.
- The discovers used the new "**Robo-AsO**" adaptive optics system at the Palomar Observatory (California) to sweep the sky, examining hundreds of stars each evening for signs of multiplicity.
- This search identified a fourth star in close proximity to 30 Ari's primary star.



A diagram of the newfound system show the two pairs of stars in orbit together, while a planet circles one of them.

- The newfound star circles its companion once every 80 years, at a distance of just 22 AU, but it does not appear to affect the exoplanet's orbit despite such proximity.
- (For comparison, Uranus' average distance from Earth varies from 17.3-21.2 AU)
- To a hypothetical observer cruising through the giant planet's atmosphere, the sky would appear to host one small sun and two bright stars visible in daylight.
- With a large enough telescope, one of the bright stars could be resolved into a binary pair.
- The discovery marks just the second time a planet has been identified in a four-star system. The first four-star planet, PH1b or Kepler-64b, was spotted in 2012.
- Planets with multiple suns have become less of a novelty in recent years, as astronomers have found a number of real worlds that resemble Tatooine (Luke Skywalker's home planet in the Star Wars films)
- Indeed, binary (2) star systems are more common than single star systems like our own.
- The new study suggests we will find more 4-sun systems in the future..
- About 4% of solar-type stars are in quadruple systems, up from previous estimates because observational techniques are steadily improving.##

SEARCH FOR EXO-PLANETS & LIFE

8 Newfound Alien Worlds Could Potentially Support Life

JAN. 6, 2015 - www.space.com/28185-**rocky-alien-planets-habitable-zone**.html

Astronomers have discovered eight new exoplanets that may be capable of supporting life as we know it, including what they say are the two most Earthlike alien worlds yet found.

- All eight newfound alien planets appear to orbit in their parent stars' habitable zone — that just-right range of distances that may allow liquid water to exist on a world's surface
- And all of them are relatively small, with a good chance of being rocky, like Earth. ##

Search for the First True Alien Earth Heats Up

"We're now closer than we have ever been to finding a twin for the Earth around another star."
JAN. 7, 2015 – www.space.com/28190-**alien-earths-search-kepler-mission.**html

The first true alien Earth may not elude planet hunters for much longer.

Astronomers announced that NASA's Kepler space telescope had discovered eight more relatively small planets that may be capable of hosting life as we know it, describing two of the new finds as the most Earth-like alien worlds known.

- Some 554 new unconfirmed Kepler "planet candidates" were announced on January 6; six of them orbiting sunlike stars, close to Earth-size and are possibly habitable.
- These candidates are the closest analogues to the Earth-sun system found to date,

Elusive alien Earths

- The $600 million Kepler mission launched in March 2009, with **the primary goal of determining how commonly Earth-like planets occur throughout the Milky Way galaxy**.
- Kepler hunts for alien worlds by **searching for "transits," noting the tiny brightness dips caused when a planet crosses the face of its host star from the observatory's perspective**.
- The spacecraft carried out its original planet hunt until May 2013, when the second of its four reaction wheels failed, robbing Kepler of its precision pointing ability.
- The observatory began a new mission called K2 last year, but **all of the planets and candidates discussed in this story were spotted during the spacecraft's first four years of operation.**)
- Kepler discovered 1,004 alien planets to date, along with nearly 3,200 other candidates, the vast majority of which will likely be confirmed eventually.
- But Kepler has not yet found an Earth twin, and neither has any other telescope.
- The known exoplanets most similar to Earth may be **Kepler-438b, just 12 percent larger than Earth**, and **Kepler-442b, 33 percent wider**. Both exoplanets are **probably rocky**, and **both apparently orbit in their host stars' "habitable zone**" — the range of distances that could support liquid water on a world's surface.
- But Kepler-438b and Kepler-442b circle **a red dwarf and an orange dwarf, respectivel**y — stars smaller and dimmer than the sun — so they cannot be true Earth twins.

Why most Kepler planets circle smaller and cooler stars than our Sun

- Many of Kepler's confirmed habitable-zone planets orbit red dwarfs. 1) because about **70 % of the Milky Way's stars are red dwarfs**: 2) Potentially habitable red dwarf planets **transit more frequently** than do their counterparts that circle sunlike stars, because the dimmer red dwarfs' habitable zones lie closer in. For example, Earth completes one orbit every 365 days, while the orbital period of Kepler-438b is just 35 days.

Probing sunlike stars

- But scientists have now analyzed four years of Kepler data, giving them the ability to start seeing bona fide Earth twins at last.
- The 554 newly announced candidates were pulled from observations the spacecraft made between May 2009 and April 2013.
- Two newfound candidates — known as **KOI** (**Kepler Object of Interest**) 5737.01 and KOI 2194.03 — are particularly intriguing, he added. **Both circle sunlike stars, and to lie in the habitable zone**.
- KOI 5737.01 is about 30 percent wider than Earth and completes one orbit every 376 days.
- KOI 2194.03 has an orbital period of 445 days, and we think it's about 40 percent larger than Earth.
- "We still feel we can refine and improve the way that we search for these candidates ... and hopefully dig out a few more."
- The quest to notch this milestone continues to enlighten scientists about the nature and variety of worlds beyond our solar systemsystem.
- "By continuing to fill in the neighborhood around Earth-like conditions, we're not only closing in on an Earth twin, but we're better understanding the diversity in this special neighborhood of planets." ##

How Did Life Become Complex, and Could It Happen Beyond Earth?

JAN. 20, 2015 – http://www.space.com/28308-**complex-life-beyond-earth**.html

When astrobiologists contemplate life on nearby planets or moons, they often suggest such life would be simple, **more like a microbe**.

- What happened here on planet Earth, could happen in other locations as well.
- How did the chemistry evolve to get life to where we are today?
- What transitions took place?

H**ow does life evolve complex traits that influence everything from lifespan to biodiversity?**

- What are the genetic bases of adaptation?
- How do coomplex exommunities evolve from single clones?
- How do the genetic 'starting point' and ecological setting influence the tempo and trajectory of evolutionary change."

Shopping for life in the Solar System

- To date, complex life is only found on Earth, but scientists aren't ruling out moon Titan's hydrocarbon chemistry is considered a precursor to a living system.
- Understanding how tholins and other substances are formed on Titan could give researchers a picture of how early Earth evolved life.
- Also, studying how Earthly life-forms and their biochemical precursors evolved from simple subunits to successively more complex and interdependent systems could give hints of how life might evolve on other moons or planets.
- Competing microbes come together to form cooperative systems, such as microbial mats in hot springs and microbial biofilms lining the human gut.
- Each of these transitions results in increased bio-complexity, interdependence and a certain degree of autonomy for a new whole that is more than the sum of its parts.
- It might be worthwhile trying to convince NASA to add to its research portfolio a set of proposals focused on understanding the genetic basis underlying major evolutionary transitions that have led to higher-order complexity"
- Four areas where a complex system has arisen from simpler elements: **metabolism**: the **eukaryotic cell**, **mutualism (cooperating species)** and **multicellularity**.

A **fifth area — mutations and gene interactions** — critically determines how quickly such complex systems can arise.

- Lab experiments aimed at replicating key aspects of the evolution of life on Earth can better inform how we search in life-friendly locations on Mars, Europa, Saturn's moon Titan, or elsewhere.

Applications beyond Earth

- An unexpected finding: **stress may increase the frequency with which genome sequences are rearranged. Stress introduces new chromosomal variants into the species; population that could prove beneficial under challenging circumstances.**
- Previous studies have indicated that **new chromosomal variants are stress resistant**.
- Yeast containing stress-adaptive genomic rearrangements become "reproductively isolated" from their ancestors, suggesting that, at least in lower fungi, **geographic isolation may not be required to generate new species**.
- T**he yeast are studied under near-starvation conditions.** This kind of severe stress may be a closer analog to what real species face in nature as populations genetically adapt to drastically altered circumstances.
- By **studying evolutionary processes in the laboratory using simple unicellular species, we can uncover rules that govern the tempo and trajectory of evolution in any population of self-replicating entities whose structure and function are programmed by information molecules.**
- Differentiation opens the door not only to competition but also to cooperation between variants, enabling a division of labor.
- **However they may be encoded, lifeforms are likely to have differentiated on other worlds.** Therefore, we should be alert to the signatures left by these more complex forms of life." ##

What Makes an Earth-Like Planet? Here's the Recipe

JAN. 21, 2015 – www.space.com/28312-**earth-like-planets-recipe**.html

How do you make an Earth-like planet? The "test kitchen" of Earth has given us a detailed recipe, but it wasn't clear whether other planetary systems would follow the same formula.

- There is evidence that the recipe for Earth also applies to terrestrial exoplanets orbiting distant stars.
- Earth is a unique, life-supporting world, but new research shows that the "recipe" for Earth might also apply to terrestrial exoplanets orbiting distant stars.
- The new research suggests that other rocky, Earth-like planets follow the same basic mix of elements and likely formed the same way Earth did.
- Rocky exoplanets use the same basic ingredients.
- These potentially Earth-like exoplanets need the right mix of chemicals and must be in a relatively young star's habtable zone— the orbit where liquid water could theoretically exist on a planet's surface. Then, if an asteroid delivers water and the right kind of organic compounds, the planet can potentially host life.
- The new findings come from the High-Accuracy Radial Velocity Planet Searcher (HARPS)-North instrument mounted on a telescope called the Telescopio Nazionale Galileo in Spain's Canary Islands.
- The instrument is specially designed to study exoplanets and differentiate between the terrestrial, Earth-like exoplanets and the more gaseous alien worlds.
- The HARPS device can accurately determine a planet's mass by measuring how much light it blocks when it passes in front of its neighboring star. The mass of a planet can be used to calculate its density, and the density reveals what the planet is made of and if it's potentially habitable.
- Dressing and a team of researchers focused on Kepler-93b, a planet about 1.5 times the size of Earth. The HARPS-North telescope measured Kepler-93b's mass as about four times that of Earth. This means that the planet is most likely a rocky, Earth-like planet.
- The team then measured the mass of the 10 other exoplanets, all with diameters of less than 2.7 times Earth's diameter. The results show that the five smallest planets have a very close relationship between mass and size, and are likely rocky, like Earth.
- The five larger planets had much lower densities, meaning they're likely made of a large portion of low-density materials like water, hydrogen or helium, the research team added.
- Astronomers using HARPS-North have focused their efforts on planets less than twice the size of Earth, but the cutoff size for Earth-like planets might be even smaller.
- To find a truly Earth-like world, we should focus on planets less than 1.6 times the size of Earth, because those are the rocky worlds.##

'Sideways' Alien 'Earths' May Still Be Able to Support Life

MAR. 13, 2015 – www.space.com/28819-**sideways-alien-earth-exoplanet-habitable**.html

> "Oceans on the Earth are the big regulator of the climate system. Naturally, the question is how you would apply that knowledge to the planets that are in a different astronomical state than Earth. One would expect oceans in such planets would be a strong regulator on the climate as well, and a factor in habitability."

An Earth-size waterworld tilted on its side may still be able to support life. – "

- **if"** the entire world is covered in oceans at least 50 m (165 ft) deep,
- temperatures were moderate enough at the poles to support life
- Even at the equator, which would be the chilliest part of that world since it only would receive a bit of sunlight in spring and fall, life could still exist.
- But if the ocean's depth were just 20 m (65 ft) the risk of a runaway cold is much greater.
- Should even a thin veneer of ice develop in the ocean, it's possible the climate would collapse into an ice block in just a few hundred years.
- With deeper oceans, a collapse into a global snowbal is still possible, but a bit harder.
- With s big, deep ocean, the chances finding life or a climate that is habitable are higher.

The “Giolkdilocks” zone

- The traditional view of "habitable" planets considers those in a star’s "Goldilocks zone," the region where water can exist above the freezing point, but not so hot that the water begins to boil away.
- The conditions for life, however, are more complicated than that.
- If the planet is too large, the pressure of the gas will likely make it too tough for life to survive.
- If the planet is too small, its gravity could be too low to hold on to an atmosphere.
- Thus the opinion that habitable planets in the Goldilocks zone must be close to Earth's size.
- On a planet-size scale, a global ocean could keep temperatures moderate.
- For simplicity's sake, the simulation assumed an Earth-size planet orbiting a sunlike star at the same distance our planet does 150 million km (93 million mi).

The researchers, however, changed two major parameters.

- The first was the planet’s tilt. Earth's axis is tilted at 23.5°, which makes enough of a difference across the planet to produce the seasons.
- The simulation instead made the tilt 90 =° so that the planet was spinning on its side.
- The second variable was the presence of oceans. Earth is 70% covered by ocean. The simulation assumed 100 % cover (no continents to interfere with circulation patterns)
- This global ocean has different depths, ranging from 10-3,000 m (33-9,840 ft).
- It was the threshold of 165 feet (50 m) that interested researchers the most, as a minimum depth to have a stable climate suitable for life.
- On such a world, he poles would seem to be the toughest place to live on this theoretical world. During the summer, they would face the sun directly, while in the winter they would face away.
- But even in the coldest part of the year, the surface temperature in those zones would be no less than 50 to 59 °F (10 to 15 ° Celsius), the study found.
- "It's a bit like the Earth's Arctic in the summer," Ferreira said.
- The summer, by contrast, would see temperatures soar to 95 to 104 °F (35 to 40 degrees °C)..
- The equators would be the coldest parts, but remain above freezing, at 2 to 4 ° C (36-39 °F).
- The study did examine the role of thermal currents, finding similar current systems to Earth’s.

Mapping for future planet-hunters

- Also ripe for consideration are "Super-Earths" — planets slightly larger than our own — and "mini-Neptunes," planets a bit smaller than the smallest gas planet in our own solar system.
- Researchers also want to look at the case of “tidally locked” planets with one side always facing its sun, the other side always facing away, much as the Moon always turns the same face towards Earth, and as the major Moons of Jupiter and Saturn also do. ##

BEYOND OUR GALAXY

The Tumultuous Heart of the Large Magallenic Cloud

www.esa.int/spaceinimages/Images/2015/03/**The_tumultuous_heart_of_the_Large_Magellanic_Cloud**

http://en.wikipedia.org/wiki/**Large_Magellanic_Cloud**

MAR. 30, 2015 - “Jagged fiery peaks, turbulent magma-like clouds, fiercely hot bursts of bright light.” lNot a raging fire or the heart of a volcano, but actually a cold cosmic clump of gas, dust and stars.

- The rregularly shaped Large Magellanic Cloud (LMC) is one of the nearest galaxies to our own.
- It is actually considered **a satellite galaxy of the Milky Way.**
- The **LMC** is slightly less than 163,000 light yeas away and **prominent in southern skies**.
- The dark, orange-tinted patches throughout the galaxy are plumes of murky dust.
- The hints of deep red and green mark areas of particularly cool dust
- White and blue tones highlighti hot regions of furious star formation.
- These pale pockets of gas are heated by the very stars they are creating, which push hot winds out into their surroundings.

- The LMC is also home to a giant cosmic spider – the Tarantula Nebula – hot cloud of gas and dust ieasily visible as the brightest region in this image, located towards the lower left of the frame.
- This nebula is very well studied by the NASA/ESA Hubble Space Telescope.
- Thhe LMC is close enough to us that we can pick out individual nebulas – including the Tarantula – and study how stars form, evolve and die in other galaxies.
- The LMC is populated by a mix of old and young stars, many of which are lined up along the galaxy's central 'bar', which slants from the bottom left to the top right of this image.
- The data making up this image are from Herschel's Spectral and Photometric Imaging Receiver (SPIRE) and Photoconductor Array Camera and Spectrometer (PACS), and Spitzer's Multiband Imaging Photometer (MIPS).
- This image was previously published by NASA/JPL.

Gamma-Ray Signals from Beyond Our Galaxy Pinpointed for 1st Time

Jan 22, 2015 – www.space.com/28339-**gamma-ray-signals-beyond-milky-way**.html

Scientists have detected the origins of three bright gamma-ray signals from objects beyond our own Milky Way galaxy for the first time, including one signal from a strange "superbubble" of gas.

- The gamma-ray signals from 3 very different astronomical objects were detected in the Large Magellanic Cloud (LMC) — the biggest satellite galaxy of the Milky Way — by a telescope netrwork in Africa.
- Two of the newfound gamma-ray sources, a pulsar wind nebula and a supernova remnant, are far more powerful than similar sources in the Milky Way.
- The third object, a superbubble, is an entirely new source of gamma-rays in space.

Gamma-rays from the great beyond

- For gamma-ray astronomy, this discovery in the LMC is a major step forward.
- When gamma-rays slam into Earth's upper atmosphere, they emit a brief, faint burst of blue light thatastronomers can then use to trace the rays back to some of the most violent phenomena in the universe, including winds streaming off of pulsars and supernova remnants.
- Researchers used the High Energy Stereoscopic System (HESS) — four 13-m (43 ft) telescopes in Namibia, Africa — to observe the largest star-forming region within the LMC.

- Over the course of 210 hours, the images lit up with a faint blue light, every photon revealing a single gamma-ray, traceable back to three distinct sources in the LMC.
- This is the first discovery of more than just one stellar-type gamma-ray source in an external galaxy.
- The first source, PSR J0537-6910, is a pulsar, the dense, rapidly spinning remnant of a supernova Explosion, emiting far more gamma-rays than its Milky Way counterpart, the Crab Nebula that had been the brightest high-energy source in the sky, outshining the Crab Nebula by an order of magnitude.
- The 2nd source, a supernova remnant known as N132D, is between 2,500 and 6,000 years old, a "middle-age" supernova remnant and yet is brighter than any of its galactic counterparts.
- But the most interesting source is the superbubble 30 Dor C, a massive shell of gas. Until now, we had never seen gamma-rays of any kind from a superbubble object.

Superbubble oddity

- 30 Dor C is far from small. Its cavity expands 270 light-years across and is thought to have been carved by multiple supernovas and strong stellar winds. It's now the first of its kind to be a known source of gamma-rays, and its large size seems to be the culprit.
- The LMC's supernova rate relative to its stellar mass is five times that of our galaxy. The researchers think that its quick ability to turn over stars has likely caused it to breed so many extreme objects.

Gamma Rays and Cosmic Rays

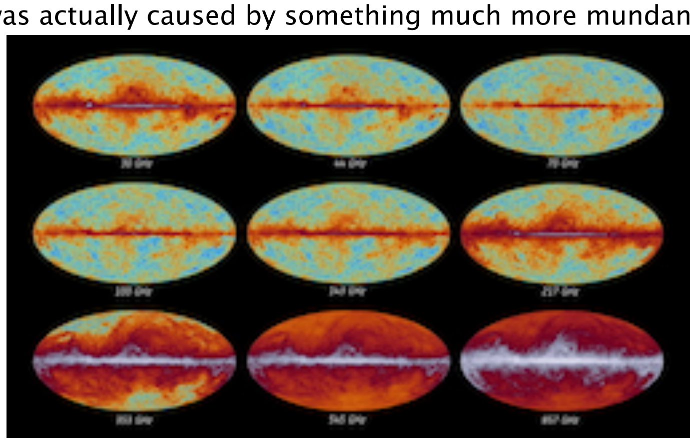
- High-energy gamma-rays may help us better understand cosmic rays, charged particles that whiz throughout the cosmos. Researchers still don't know where these particles, which are mostly protons stripped from hydrogen atoms, receive their energy boost.
- Because cosmic rays are charged, they feel the push and pull of any magnetic field they come across. By the time they reach the Earth, they're hitting it from all vantage points.
- But cosmic rays produce gamma-rays, which don't have this problem, so astronomers can use gamma-rays to probe likely sites of cosmic-ray acceleration.
- We've already linked cosmic rays to supernovas. These results are the first observational hint that superbubbles might also be a source of cosmic rays.
- A better understanding of the origins of gamma-rays and cosmic rays will further shed light on the dramatic stellar explosions across the galaxy and beyond. ##

EVOLUTION OF THE UNIVERSE

Evidence for Cosmic Inflation Theory Bites the (Space) Dust

JAN. 30, 2015 - http://www.space.com/28423-**cosmic-inflation-signal-space-dust**.html
http://news.sciencemag.org/physics/2015/01/c**urtain-falls-controversial-big-bang-result**

It is the announcement no one wanted to hear: The most exciting astronomical discovery of 2014 has vanished. Two groups of scientists announced today (Jan. 30) that a tantalizing signal — which some scientists claimed was "smoking gun" evidence of dramatic cosmic expansion just after the birth of the universe — was actually caused by something much more mundane: **interstellar dust.**



All-sky maps of the cosmic microwave background (CMB) from the Planck satellite give a better idea of how interstellar dust conflicts with the CMB. The results suggest that a signal seen by the BICEP2 collaboration, purported to be evidence of inflation in the early universe, was largely contaminated by dust. Credit: ESA and the Planck Collaboration

- Scientists with the BICEP2 experiment, claimed to have found patterns in light left over from the Big Bang that indicated that space had rapidly inflated at the beginning of the universe, about 13.8 billion years ago. The discovery also supposedly confirmed the existence of gravitational waves, theoretical ripples in space-time.
- But scientists with the European Space Agency said that data from the agency's Planck space observatory has revealed that interstellar dust caused more than half of the signal detected by the Antarctica-based BICEP2 experiment.
- The Planck spacecraft observations were not yet available last March when the BICEP2 science team made its announcement.
- The conclusion is the result of a collaborative analysis by scientists with both BICEP2 and Planck, using data from both telescopes as well as the Keck array at the South Pole. ##

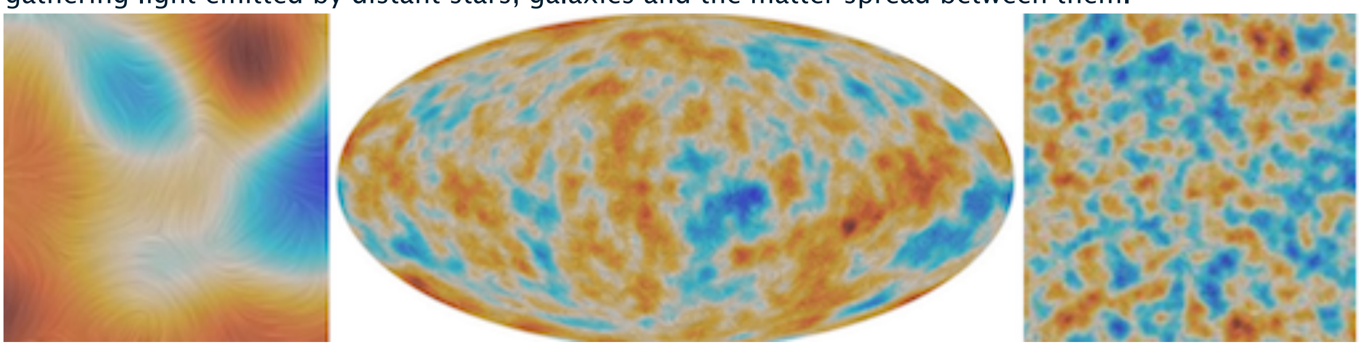
Plank Satellite Reveals First stars Were Born Late

www.esa.int/Our_Activities/Space_Science/Planck/**Planck_reveals_first_stars_were_born_late**

http://en.wikipedia.org/wiki/**Planck_(spacecraft)**

FEB. 2015 - New maps from ESA's Planck satellite uncover the 'polarised' light from the early Universe across the entire sky, revealing that the first stars formed much later than previously thought.

The history of our 3.8 billion-year old Universe is a tale that scientists endeavour to read by studying by gathering light emitted by distant stars, galaxies and the matter spread between them.



Polarisation of the Cosmic Microwave Background (center)- Details Left, Right

- A major source of information used to piece together this story is The Cosmic Microwave Background, or CMB, the fossil light resulting from a time when the Universe was hot and dense, only 380 000 years after the Big Bang.
- We see this light today covering the whole sky at microwave wavelengths.
- Between 2009 and 2013, Planck surveyed the sky to study this ancient light in unprecedented detail. Tiny differences in the background's temperature trace regions of slightly different density in the early cosmos, representing the seeds of all future structure, the stars and galaxies of today.

The results from the analysis of these data in scientific papers over the past two years

- The CMB carries additional clues about our cosmic history that are encoded in its 'polarisation'
- "Planck has measured this signal for the first time at high resolution over the entire sky, producing the unique maps now released
- Light is polarised when it vibrates in a preferred direction, something that may arise as a result of photons – the particles of light – bouncing off other particles.
- This is exactly what happened when the CMB originated in the early Universe.

"Initially, photons were trapped in a hot, dense soup of particles that, by the time the Universe was a few seconds old, consisted mainly of electrons, protons and neutrinos. Owing to the high density, electrons and photons collided with one another so frequently that light could not travel any significant distant before bumping into another electron, making the early Universe extremely 'foggy'"

- As the cosmos expanded and cooled, photons and the other particles grew farther apart, and collisions became less frequent.
  1. Electrons and protons could finally combine and form neutral atoms without them being torn apart again by an incoming photon
  2. Photons had enough room to travel, being no longer trapped in the cosmic fog.
- Once freed from the fog, the light was set on its cosmic journey that would take it all the way to the present day, where telescopes like Planck detect it as the CMB.
- But the light also retains a memory of its last encounter with the electrons, in its polarisation which shows minuscule fluctuations from one place to another across the sky, reflecting the state of the cosmos at the time when light and matter parted company

  "This provides a powerful tool to estimate in a new and independent way parameters such as the age of the Universe, its rate of expansion and its essential composition of normal matter, dark matter and dark energy."

When were the first stars born?

- After the CMB was released, the Universe was still very different from the one we live in today, and it took a long time until the first stars were able to form.
- Planck's observations of the CMB polarisation indicate that these '**Dark (starless) Age**s' ended some 550 million years after the Big Bang – more than 100 million years later than previously thought.

More insights into the history of the universe follow in this article. Read the original – Ed.

Mystery of the Universe's Gamma-Ray Glow Solved: Findings from the Fermi Gamma Ray Telescope

FEB. 6, 2015 – **www.space.com/28457-gamma-ray-glow-mystery.html**

The steady glow of high-energy gamma-ray light that spreads across the cosmos has puzzled astronomers for decades.

Best Explanation yet?

- After six years of observing with NASA's Fermi Gamma-ray Space Telescope, scientists say the majority of the gamma-ray glow they have seen can be explained by known objects. If there are any as-yet unknown sources out there, their contribution to the glow would be very small.
- Fermin snaps pictures of the entire observable universe — from end to end — in gamma-rays showing a diffuse glow coming from the universe – the extragalactic gamma ray background, or EGB.
- We've known about this gamma-ray background since the late 1960s
- It's a long-standing mystery, with each gnew gamma-ray telescope giving a little more information.
- The Fermi telescope can identify where some of this high-energy background light is coming from, very energetic galaxies called blazars.
- The Energetic Gamma Ray Experiment Telescope (EGRET), which preceded Fermi, detectrd some 300 gamma-ray sources.
- So far, the Fermi telescope has identified more than 3,000 sources, "only a drop in an ocean"
- Every galaxy is producing gamma-rays at some level
- Fermi telescope scientists have calculated how much gamma-ray light both the detected and modeled sources would produce together, matching closely with the actual gamma ray-background that Fermi observes — the entire EGB.
- Roughly 50% of the gamma-ray background comes from extremely energetic galaxies – blazars.
- Ten-30 % emanates from star-forming galaxies like the Milky Way, which can collectively contain many smaller gamma-ray sources such as supernovas.
- Another 20% is from radio galaxies, blazars pointed away from the Earth, and thus harder to see.
- There could be new gamma-ray sources out there, but their total contribution would be small."
- It's also possible that dark matter — the mysterious material that makes up 80 percent of all the matter in the universe — is producing gamma-rays, and the Fermi results may help usfigure out what kind of particle or particles make up "dark matter.

Two large uncertainties remain

- It is difficult to measure the gamma-ray glow of the universe without improvising.
- Scientists are making estimates about objects they cannot directly observe, most extragalactic.
- The simplest explanation involving known astrophysical sources seems to work just fine

Light from back in time

- Fermi's success had depended largely on its increased sensitivity to gamma-rays and its detection of more gamma-ray sources than previous telescopes.
- Fermi scientists have worked to gain a better understanding of how gamma-ray emissions have changed throughout the history of the universe.
- We're literally measuring the light output over the history of the universe,
- We're seeing all different time periods throughout the last 13 billion years at the same time.
- All the light from all those different periods is added together to form the gamma ray background.
- The cosmic output of gamma-rays has likely differed at various times throug the last 13 billion years.
- Fermi has solved a long-standing puzzle, but there are still other mysteries.
- Other gamma-ray telescopes can detect even higher energy gamma rays
- There are sources of gamma-rays that scientists don't know about yet.
- “History has shown us that, sometimes, there's more to the story,"
- “As we start to look at higher energies, there will start to be some surprises. ##

Monster Black Hole Is the Largest and Brightest Ever Found

FEB. 26, 2015 - www.space.com/28664-**monster-black-hole-largest-brightest-ever**.html

Astronomers have discovered the largest and most luminous black hole ever seen — an ancient monster with a mass about **12 billion times that of the Sun** — that dates back to when the universe was less than 1 billion years old.

- The newfound black hole SDSS J010013.02+280225.8 is the largest and brightest ever found. It remains a mystery how a black hole could have grown so huge in such a relatively brief time after the dawn of the universe.
- Supermassive black holes are thought to lurk in the hearts of most, if not all, large galaxies.
- The largest black holes found so far in the nearby universe have masses more than **10 Billion** times that of the sun.
- The black hole at the center of the Milky Way is thought to have a mass only **4-5 Million** times that of the Sun, 2 thousand times smaller.
- **Although not even light can escape** the powerful gravitational pulls of black holes — (hence, their name) — **black holes are often bright because they're surrounded by features known as accretion disks**, made up of gas and dust that heat up and give off light as it swirl into the black holes.
- Astronomers suspect that quasars, the brightest objects in the universe, contain supermassive black holes that release extraordinarily large amounts of light as they rip apart stars.
- Astronomers have discovered 40 quasars — each with a black hole about **1 billion** times the mass of the sun — dating back to when the universe was less than 1 billion years old.
- Now, the discovery of a supermassive black hole **12 billion** times the mass of the sun about **12.8 billion light-years from Earth**
- That dates **back to when the universe was only about 875 million years old**.
- This black hole is about 429 trillion times brighter than the sun and seven times brighter than the most distant quasar known.
- This black hole dates back to a little more than 6 % of the universe's current age, 13.8 billion years.
- This presents serious challenges to theories of black hole growth in the early universe,.
- Accretion discs limit the speed of modern black holes' growth.
- As gas and dust in the disks get close to black holes, traffic jams slow down any other material that's falling into them.
- As matter collides in these traffic jams, it heats up, emitting radiation that drives gas and dust away from the black holes.

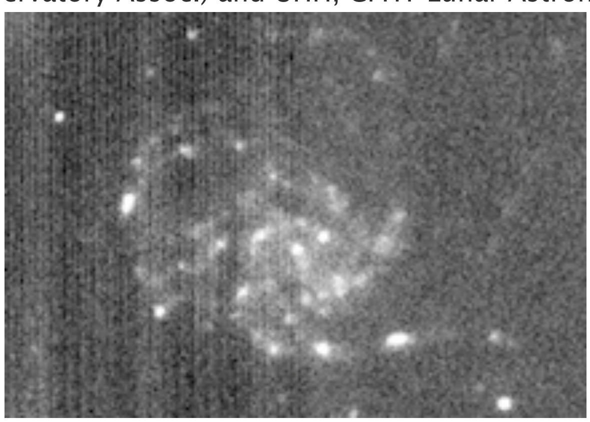
- We have no satisfactory explanation how such supermassive objects formed in the early universe.
- A recent study suggested that because the early universe was much smaller than it is today, gas was often denser, obscuring a substantial amount of the radiation given off by accretion disks and thus helping matter fall into black holes.
- Light from this black hole could help provide clues about the dark corners of the distant cosmos.
- As the quasar's light shines toward Earth, it passes through intergalactic gas that colors the light.
- By deducing how this intergalactic gas influenced the spectrum of light from the quasar, scientists can deduce which elements make up this gas.
- This knowledge, in turn, provides clues to the star-formation processes that were at work shortly after Big Bang that produced these elements.
- "This quasar is the most luminous one in the early universe, which, like a lighthouse, will provide us chances to use it as a unique tool to study the cosmic structure of the dark, distant universe,"

ASTONOMY FROM THE MOON

Moon-Based Telescope Observation Of M101 Spiral First Galaxy Imaged From The Moon

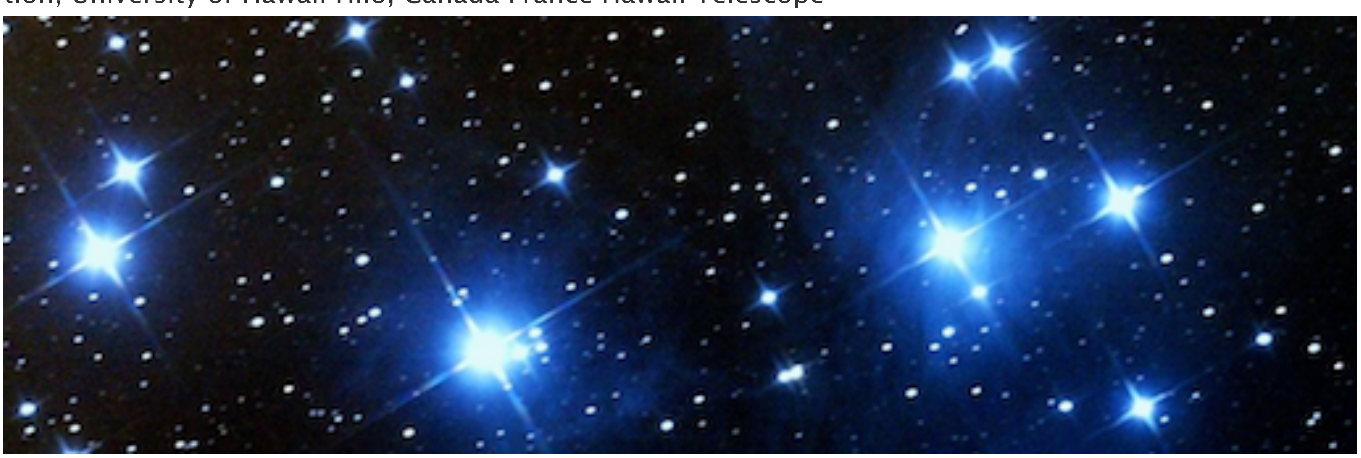
JAN. 1, 2015 - Great Astronomy From The Moon Potential Confirmed By China **Chang'e-3 Lunar Ultraviolet Telescope LUT** Observations On 2 December at beginning of Lunar Day 13;

Iconic 2014 photo to be refined further by NAOC astronomers In Beijing, In collaboration with ILOA {International Lunar Observatory Assoc.) and UHH, CFHT Lunar Astronomy Team, Hawaii Island.



www.lunarenterprisedaily.com/wp-content/uploads/2014/12/**m101GalaxyFromMoon**1214.jpg

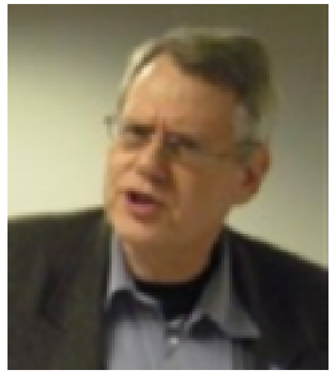
Image Credit: National Astronomical Observatories of China & International Lunar Observatory Association; University of Hawaii Hilo, Canada France Hawaii Telescope



To The Stars International Quarterly Editorial Team

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





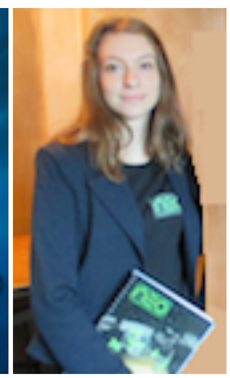

L>R: Peter Kokh – kokhmmm@aol.com – http://www.lunarpedia.org/index.php?title=Peter_Kokh
President Milwaukee Lunar Reclamation Society – Editor of Moon Miners' Manifesto – Life member National Space Society – Past president the Moon Society 2004-2011, Milwaukee, Wisconsin US

Madhu Thangavelu – thangavelu-girardey@cox.net – Mother from Kerala, Father from Tamil Nadu – grew up in Delhi – now teaching at the University of Southern California – Conductor, Graduate Space Exploration Concept Studio USC School of Engineering & Architecture – co-author of "The Moon: Resources, Future Development, and Settlement".– Los Angeles, California US

David A. Dunlop – dunlop712@yahoo.com – Moon Society Director of Project Development – Executive Director of LUNAX (LUnar National Agriculture eXperimnet) – University of Luna Project – Chair NSS International Committee – Green Bay, Wisconsin US

Al Anzaldua – alanzaldua706@yahoo.com – – President Tucson L5 Space Society, Tucson, Arizona, US





L: Srinivas Laxman – moonshotindia@gmail.com – Mumbai – author "MoonShot India"
M: Lynn Zielinski, NSS Educational Committee – lzielinski@comcast.net – Chicago, Illinois, US
R: Student Reporter: Aleksandra Voinea – aleksa.voinea@gmail.com – Bucharest, Romania / Yale U. Ithaca, NY

NOTE: Opinions expressed in the Articles & Essays section below
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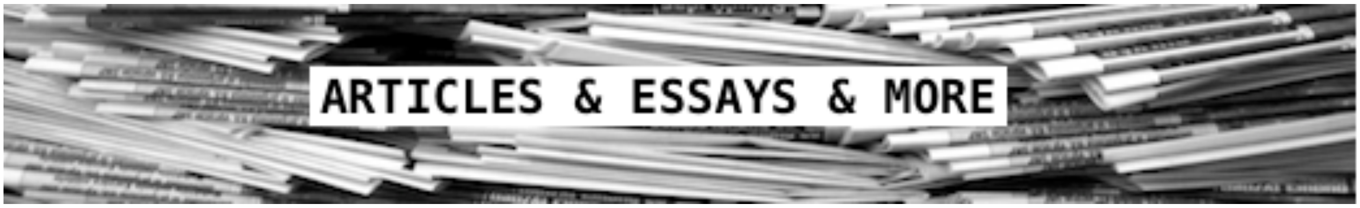


Fun Time About Names, continued: "Astronaut"

By Peter Kokh

Note: In the lsst issue of TTSIQ, we played with suggested "proper names" for the Sun "Cpernica", Earth "Terrestra", and the Moon "Selene". Here we want to find a better word for "astronaut."

"Astronaut" vs. "SPACER"

The word "astronaut" means one who navigates among the **stars**.

Whoa! The furthest any human has been from Earth is 1.5 **light <u>seconds</u>** and the closest star, Proxima Centauri, is 4.24 **light <u>years</u>** away, or **134 million times further** than any "astro"naut has yet ventured.

Spacionaut, the French term, is much more appropriate. "**Spacers**" **is shorter, and to the point.** It is "distance neutral" as space includes everything beyond Earth's atmosphere, whether it be within our Solar System, out among the stars, or among clusters of galaxies. "Systemnauts" seems awkward. PK

The "Sexual" Origin of some Solar Systems and many Galaxies

By Peter Kokh

In the MMM #247 article "**Our Planets may be the offspring of a tryst between our ProtoSun and another Protostar**," we explained how it was that the isotopic "DNA" of the Sun and its Planets do not match!

The percentages of the isotopes of Oxygen and Nitrogen in our sibling planets do not match those in the Sun.

The answer seems simple.

The disk of matter around our parent protostar, the condensing Sun, intersected the disk of gas and dust in the process of forming another solar system. Stars frequenly form in groups from a com–mon cloud. The two embryonic stars did not touch or exchange matter, but their two surrounding disks did, and in the process of exchanged gas and dust, each disk peppered or seasoned the other with their unique signatures of elemental and isotope ratios = without any exchage between the stars themselves.

The above isketch is the writer's attempt to illustrate what such a tryst might look like.

Sex among galaxies

We have photos of myriads of galaxy pairs in the process of collision. Our own **Milky Way** and the beautfiul, somewhat bigger, Andromeda Galaxy, M31, will merge in a few billion years. Thier planes differ as is quite clear: we do not see M31 edge on and in the plane of the Milky Way.

"Sex" in the universe is apparently quite common.

Sexual exchange among Oort Clouds

Oort clouds – we know only of the one surrounding our solar system – being so extended, must quite frequently pass through oort clouds surrounding other passing stars

> **The idea that comets in our own Oort cloud could somehow, anyhow, lose very close to 100% of their angular momentum, so as to drop down upon the defenceless inner Solar System planets is so obviously absurd that how it is that this idea prevails among "reputable" astronomers is beyond understanding.** Embarrassing!

If there ever was a rain of Oort cloud objects upon Earth and our sister planets, it was almost certainly a case of **our Sun passing through the Oort cloud of another star.** How could anyone not have realized this!

Yet no one seems to have thought of this. It is almost as if astronomers did not suspect that other stars should have Oort clouds as well (if indeed we do, and if this too is not a myth!)

Differing hydrogen/deuterium ratios

This counter proposal explains why our solar system could have been bombarded by cometary objects with hydrogen/deuterium ratios different from what we see in the planets close in to the Sun.

Some astronomers are now proposing that it was the asteroids that brough water to the inner system planets, rather than comets. We do not know yet. PK

What the Mars One Project Must Do – if – it is to Succeed

By Peter Kokh

In this article, we are not betting on the Mars One Project to actually become real. Instead, we are attempting to **list things that could significantly decrease odds of failure and increase the odds of success.** The points made here would hold for any Mars Settlement Beachead effort.

1. **Site Selected for local resouces** that can be tapped ASAP to defray as much of inmport burden as possible:
   A "border" site where two or more types of resources converge: highlands and mare plains, for example. This will accelerate local production of items that won't need to be shipped from Earth.
   - **Basalt;** other near-term building materials; **3-D printer raw materials**
   - **Nearby sites with complementary resouces:**
   - **Climate:** Air pressure will be highest in the Hellas Basin, but the summers are longer and winters shorter in the Northern Hemisphere: Mars is a world where it is always cold. "Room temperature" outdoors will be rare.
   - Mars' humongous **Valles Marineris canyon is deep enough to offer greater air pressure, and runs E-W along the equator and so will be warmer.**

2. Site Selection for visual interst:
   - **A visually interesting site, or one near visually interesting areas (to minimize likelihood of boredom) – For example, on high or mid-level ground within the vast and long Valles Marineris canyon.**
   - **Site central to a wide selection of sites of tourist interest**, as well as of resource development
   - **Nearby scenic attractions:** hills, rilles, overlooks, lavatube skylights, etc.

3. Construction Desigb and Methods: Poor choices in the published designs
   - **Connecting corridors** "through" the landing modules makes no sense and wastes all the space on the upper deck: The modules should be "T"-d to an ample width external corridor with place along the sides for storage lockers, art, living wall plants (greenery, flowers, fruit, water features such as water falls, fish tanks, etc.
   - **Shielding: direct or indirect** (under a shielded hangar) – No shielding is shown in "promo" illustrations
   - **Modular biospherics,** vegetation-based life support throughout, not just in some modules – for example, living walls along one side of pressurized tubes connecting the various habitat and activity modules, not just in food production modules.
   - **Scenic windows** to the surrounding Marsscapes

- **Ways to bring the sunshine inside**

4. **Automated, teleoperated agriculture & industry, saving manpower for what only people can do.** Let's not repeat the mistakes of Biosphere 2 where crew had to work 11-12 hours a day just to maintain a starvation diet
5. **Early industries chosen to minimize shipments from Earth** as much as possible
   - **Automated 3D printers could be stockpiling replacement parts before the first crew arrives!**
   - **Industries to serve Geosynchronous installations** such as "touch of Mars" hotels
   - **Establish trade relations with any early settlements on the Moon**
6. **Design Competitions for the Mars One starter complex**
   - Give interested and supporting people (especially space architecture students) the chance to come up with superior design elements and overall layout
   - **A mockup of the complex should be built here on Earth first, where we have time to rearrange and add and modify,** so that the prioneers are not guinea pigs, stuck with an untested complex straight off the drawing boards that does little to keep the crew happy and engaged.
7. **Free time activity options**
   - **Recreational facilities** will be important, both "indoors" and out **Commons areas** where all can gather
   - Scattered **mini "park" spaces** should be worked into pocket farms to increase diet variety
   - **Facilities for experimenting on Martian materials - Arts & Crafts are critical for morale**
   - **Facilities for making artifacts out of discarded materials** and items, etc. ("trashure"}
   - **An infirmary/hospital/isolation wards,** etc.
8. **Outlying facilities: manufacturing, warehousing, laboratories, observatory, mini-factories, sports, hiking**
   - **Recreation variety:, hiking trails, exploring parties, astronomy**, local arts and crafts, colors, etc.
   - **Experiment with "sports" that play to the reduced Martian gravity requiring space for that purpose**
   - **Anti-"cabin fever" measures,** sited in MMM #276, built into the design, out structures and out-turf
9. **Pioneer Selection**
   - **Crew "depth" - Each selected crew member should have several supportive talents**
   - Multiple persons with critical key talents (**talent redundancy**)
   - Social compatability, teamwork, willingness to accept challenge and risk,
   - Building **a Mars One Analog Facility here on Earth**, will allow correction of design flaws in time, possibly in some arid area in Europe (Spain?) or Africa, but anywhere will be better than nowhere. Here, those vying for a position on the crew can get a better sense of what the venture will really be like. Design flaws will stand out.
   - **Older teens should be among the crew, as well as seasoned survive-anything old-timers**
   - **Crew members should be single, free to explore relationships**
   - Deaths may occur, hopefully only for medical causes.
10. Promoting individual Creativity and "Cottage Industry"
    - **For many prioneers, the opportunity to create artwork, accessories and furnishings, specialty foods, and much more will be a morale booster not just for themselves, but for their fellow pioneers**
    - "Creations" can be made of local materials ("Mars dust" and rocks, etc.) or from "scrap" (unneeded parts of spacecraft that brought them there, packaging etc., discarded or worn clothing - "Trashure: treasure from trash" - and garden plants and by-products.
11. **Feedbck from Earth with suggestions how to expand, do things better, live more productively**

The above is a start towards a "Mars One check list. "
The published design has many shortcomings


Above left: connecting corridor and airlocks **through the upper floor** of landed modules, when if they were "T"-d off that floor with airlocks along this network, living space within would be nearly dobbled.

Above right: Inflatable Bigelow 330 units have more interior space per shipping weight, plus some hull-shielding

Long cylinders could serve many functions: agriculture; workshops; assembly and recreation; dining area, laboratories, workshop and fabrication areas; a mini-hospital; storage warehouse, even a mini-market for crew creations.

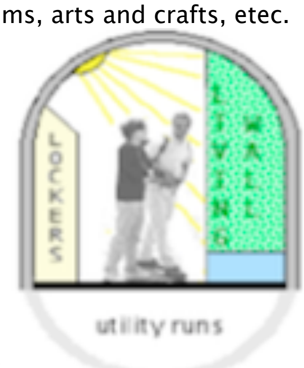
Shielding Options

√ Direct Mars soil shielding of each module as it arrives

√ A pre-built shielded "Hangar "- the advantage of shielded hangers being built first is that it makes expansion much easier underneath and allows rearrangement of modules to suit a growing population and expanding needs.

Making maximum use of commons areas

√ **Corridor design:** plants, artwork, storage, rest space, "mini markets" for food items, arts and crafts, etc.

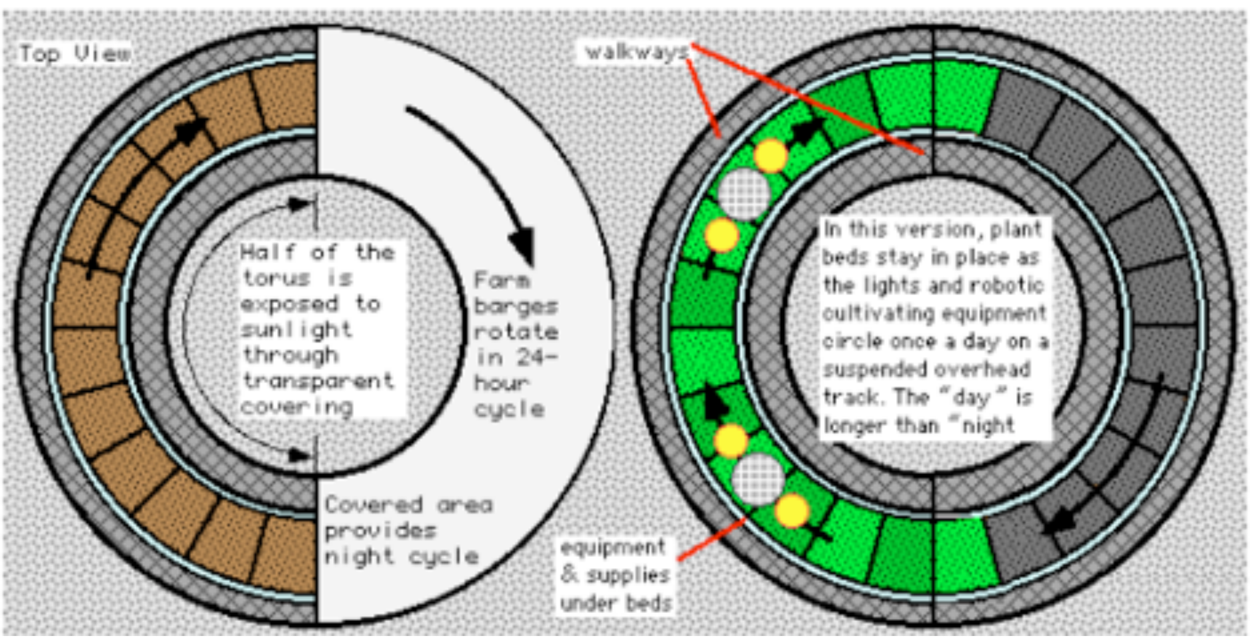


L: Living Walls can line one side of hallways/corridors

R: Storage lockers and art display spaces could line the other side

Agriculture Farm Space

It is vital that Mars One does not repeat the failures of the Bisophere II project in which the crew had to spend 11 hours a day to eek our a starvation diet. Agriculture can be automated. Circular farm units are ideal.



Two plans for automation: the design at right seems most promising. Even with time delays of 6-40 minutes, Adjustment instructions could be teleoperated from Earth.

A design contest or a set of design contests could come up with the best plans?

√ **Involving the public** is a policy that will get far more publicity, and even financial help for the Mars One project while hedging the company's bets on published, poorly thought out designs.
√ **Mars One is already conducting contests** to come up with science projects to conduct at Mars One.
√ **The current design may catch the eye, but "simple" is not always the best choice.**
√ **A series of design competitions** should come up with a plan that is much more likely to be successful.
√ **We don't need to strand well-intentioned but naive volunteers**

One thing is for sure

Mars will be much more thoroughly explored by settlers who go to make it their home world, than by a few short term round trip exploration crews.

So we choose to encourage Mars One to rethink everything so that **success is more likely and Mars will have its first of many settlements.**

Settle new lands! – It's what we humans do! PK

The Future of Astronaut Activity

By Madhu Thangavelu | Nov. 24, 2014 – Reprinted with permission
www.spacenews.com/article/opinion/42647**the-future-of-astronaut-activity**

The astronaut corps is a unique group of people, handpicked from a wide range of scientific and technical professions, winnowed down through very rigorous selection methods, after which the select few are trained for complex space missions that involve a lot of risk, nail-biting and adrenalin at both the space crew and mission control ends. The human spaceflight crews at NASA, Russia's Roscosmos, the European Space Agency and the China National Space Administration are still considered the pinnacle of human and technological achievement and prestige in the world's leading spacefaring economies and their space agencies.

Many nations today aspire to join and participate in this exclusive club of advanced technology-savvy professionals who exude a unique kind of aura, a mix of skills, talents and yearning for high-wire drama. This select group of humans has seen the wholeness, oneness and richness of Earth from above, liberated from the air and gravity, completely free and floating, even removed from our earthly experience of night and day. They return to Earth as global ambassadors of sorts, with an expanded worldview and a refined sensitivity toward our planet's fragile biosphere.

Activity is a demanding endeavor in every aspect, requiring the physical and mental rigor, agility and dexterity of the crew, the interdisciplinary technologies and skillsets involved, organizational planning with seamless cross-cutting, the meticulous following of reliability and safety protocols, not to mention the monetary resources to back up and support development and operations that are essential for success. A flight task checklist alone runs into volumes of material, making one wonder how they accomplish all this during a short mission that lasts just a few weeks. Flight crew and mission control, impeccable teamwork and organization at its best, aided by agile technologies — this is what makes astronaut activity possible today.

But this effort has paid off handsomely across several other challenging national and global pursuits for those economies that have chosen to exercise it, applying the lessons learned in human space activity to other complex endeavors here on Earth.

A recent, often-forgotten example occurred in 2010 when 33 miners were trapped deep underground in a Chilean copper mine. The Chilean government sought NASA's help, among others, to alleviate their misery and find ways to keep their morale up for the 10 weeks it took to extricate and bring them up safely, in a mission that taxed the deep isolation skills of human spaceflight professionals.

However, the past decade has seen some of the most drastic changes and adjustments in the various astronaut corps, including disproportionate budget cuts and rapid attrition in their numbers. And as private space industry and private spaceflight activity ramp up, including space tourism, government-trained astronauts are actively moving into newly created positions in this new arena, to create, supervise and evolve new and more capable systems.

Despite these changes, and during this current period of loosely defined destinations and mission goals, a new generation of NASA astronauts is being trained for deep-space missions. And while these changes are afoot, leapfrogging technologies like robotics and communications are changing the landscape for future astronaut activity.

Fifty years ago, at the dawn of the Space Age, technologies were minted just to make spaceflight possible. But now, mature commercial technologies employed on Earth, from the prosaic to the profound, are finding their way into the astronaut's tool chest. These range from prospecting and mining to 3-D printing, ground- and altitude-based remote sensing and hyperspectral imaging, combined with adaptive optics and a range of laser-based applications, which include precision analyses of chemicals, separating minerals from ores, purification and welding — and we are fast approaching the development of high-energy death rays for planetary protection and missile defense alike. Nanotechnology materials, precisely crafted by 3-D printers and laser technology to form metamaterials and shapes, may soon provide more efficient thermal and radiation protection for astronauts and may even be used to create nutritious, complex foods from simple chemicals.

High-fidelity simulations are a dependable way to test and ferret out issues and resolve them well in advance of mission deployment. NASA uses neutral buoyancy tanks to simulate astronaut activity in zero gravity. However, partial gravity conditions are hard to simulate on Earth, especially for the substantial periods of time that are needed to test full-up assembly or other construction activities. Virtual reality and gaming applications including massively parallel computer platforms operating on cloud networks, employing visualization headgear like Oculus Rift along with haptic feedback and tactile sensitivity, could be used to seamlessly mesh real subjects in various space and extraterrestrial environments, totally immersing astronauts in virtual mission environments with realistic visualization of partial gravity reaction scenarios. Supercomputers used to simulate nuclear explosions may be used, along with real radiation exposure data being gathered about Mars, to recreate whole body effects of interplanetary expeditions on crew and systems.

Synthetic biology and advances in genetics too may offer innovative ways to combat radiation damage to human tissue, which is a crucial concern, and techniques and processes from the biotechnology industry may find application in space agriculture and closed-cycle ecological life-support systems, both vital technologies for long-duration missions.

Photovoltaics, the nonpolluting technology that converts solar energy into renewable power atop our homes, when coupled with high-density power storage systems, is already making compact and portable devices that are changing the way we live and work, from cellphones to emergency equipment in hospitals and in disaster management to warfighting machines and systems, and space missions are employing them regularly.

Many of these technologies are being evolved and employed routinely for innovation, research and development, not only in the national labs but also in universities and private companies and conglomerates, for profit.

Our romance with robots initially found a commercial home decades ago in the computer industry. Then they became an agent of change in the automobile industry and took over critical operations in heavy industry. Today robots are employed in expert systems for medical diagnostics and in delicate surgical procedures sometimes deemed too risky for the surgeon's trained hands. Nanotechnology-based products and allied systems are in the pipeline, already offering designer materials that may be suitable for space systems like astronaut suits and gloves, helmets and related critical life-support gear.

Will robots and robotic systems take over all space activity? Are they capable of all human tasks? Can they operate autonomously, without human support?

The answer seems to depend on the task at hand.

Professional explorers, prospectors and geologists alike seem to think robots can never replace humans. The rovers that are roaming the surface of Mars over 200 million kilometers away do many tasks by themselves but are supervised from mission control at the Jet Propel-sion Laboratory in California. The Cassini spacecraft orbiting Saturn 1.5 billion kilometers away is given instructions and its systems tweaked in the same manner. And much closer to home, the international space station has a humanoid robot called Robonaut 2 that is being tested and prepped to help the crew with their chores. It too is supervised from mission control. Detailed engineering studies have shown that complex projects like the last Hubble service and upgrade or previous satellite rescue missions could not have been accomplished by robots alone.

Advances in communication technology will allow wideband, teleoperated supervision of robots for complex assembly of large space structures and systems as well as closely coordinated co-robotic manipulations. For example, crew and robotic assistants working to build infrastructure in tandem in the same physical domain is an expanding area of investigation. This co-robotic approach is already seen as a natural and efficient extension of human capabilities in extreme environments here on Earth, and space activity provides another realm for expanding this application. One of the reasons for astronaut crew to be in the vicinity of action is to circumvent the time lag associated with operating a robot from Earth.

Depending on planetary positions, it takes between 8 and 45 minutes to send a command to the Mars rover and receive a signal back that it has executed the task, and it takes Cassini 2.5 hours to do the same. A lot of unintended things can happen over such long periods, especially when impromptu control is required for tasks that involve construction or other anomalous situations that may arise.

The future of human space activity in general and the niche arena of human space exploration that space agencies focus on today are fast approaching a synergetic and explosive growth period because investors see profit to be made in space activity — building orbiting solar power stations; enhancing communications platforms and maintaining that infrastructure; keeping track of and decommissioning old and failing stations by deorbiting them rather than mothballing them in graveyard orbits where they pose a potential debris hazard; and providing station-keeping fuel and propellants to outbound vehicles and other services including correcting the orbits of spacecraft in deviant or wrong orbits. It is well known among space architects and engineers alike that human supervision on site is essential for large and complex assembly and service operations in space in order to speedily resolve anomalies that may arise during execution.

Humans and robots together are ready to begin knitting space activity in our solar system into the mainstream of humanity's economic sphere of influence, making astronaut activity a routine part of our lives in which science and technology are integral to our culture, as much as progressive commerce and industry play a part in modern civilization.

Does the future hold peril or promise for our astronaut corps as we expand this enterprise? Peril, for space is the ultimate unforgiving environment, as it reminds us when things go wrong and we lose the brave men and women engaged in that exo-environment. Nature never intended us in our fragile frames, evolved over a few million years, to live and work in space. Cocooned and nurtured on the mild surface of a watery world, blanketed by a thin but soothing atmosphere and shielded from the sun's wrath by an invisible magnetic field, we evolved in a biosphere like no other we know of. Even today, as we are freshly reminded, entering space, just escaping the clutches of Earth's gravity, requires complex and precision technologies and systems with extremely narrow tolerance for error.

And more peril too, for the 20th-century image of the government-employed astronaut who appears a daring suited figure, braving the extreme environment, all alone in the vast, silent and treacherous darkness of space. Even today, nearly 50 years since we began spacewalking, extra_ vehicular activity is perhaps the most strenuous astronaut activity. The suits, once inflated, are cumbersome to work in, and the astronaut has to fight the stiffness of the suit and gloves to make normal movement possible. Like the capsule technology that is being superseded, the days of the Pillsbury Doughboy- or Michelin Man-shaped astronaut are numbered.

Hardsuits, or rigid suits molded from aluminum alloys, are being used in deep-sea diving missions today and may be adapted for space, employing tough and radiation-resistant materials like boron carbide to allow astronauts to move between spacecraft and the vacuum outside without the lengthy prebreathing protocol that is needed today to make the suits more flexible for movement. This slow process allows the human body to adjust to the low pressure and altered atmosphere inside the suits without risking the bends, a condition where dissolved nitrogen in the blood may bubble out and cause severe painful problems and or even death. Strategies employing semi-rigid suits are proposed to allow gradual pressure reduction while crew members are being transported to the work site as well. A new generation of suits for extraterrestrial activity on the Moon and Mars will effectively neutralize the threat posed by dust, especially on the Moon, that was quite debilitating to Apollo crew and rovers. Exoskeletal suits that help augment strength, combat fatigue and allow power amplification are being put to the test for soldiers in the battlefield and may also find application for the future astronaut. Meanwhile, the U.S. Defense Advanced Research Projects Agency is putting competing robot assistants to the test and offering prizes for winning designs.

And so there is promise for an entirely new vision of humans working alongside sophisticated robotic agents, as supervisors and directors and anomaly resolvers. They will be comfortably nested in cabins within spacecraft in a shirtsleeve environment, teleoperating swarms of robots, building huge solar power satellites and assembling massive spaceships from materials dug up and processed among the asteroids, as we expand outward into the solar system to use resources that lie scattered all over the asteroid belt, to settle our Moon and planets. A far more sophisticated and refined U.S. astronaut corps is in the making, and these 21st-century professionals may yet spring from our newly home-grown commercial and private space enterprise.

Among policymakers, where logically sensible ideas often die a fiery death because of partisanship, space activity is a rare arena where all agree. Above the din and acrimony of political theater, beneath the cloak of it all, both aisles of Congress and even fringe groups among the leadership support a vibrant space program. The space station partnership has built a venerable coalition of international partners and could be extended into a global effort with the blessing of the State Department that could use it as an instrument to enhance the U.S. image, not just among partners but around the world.

Astronauts' training and mission expertise, combined with their unique aura and refined sensitivity about our biosphere and the rich and complex interweave of humanity in it, make them a new generation of 21st-century global ambassadors, the few who have experienced a global view of things, literally, with a stamp that says "made in America." They may hold the key to switch the fear-and-greed paradigm that seems to run rampant in the world today with hope, awe and wonder of nature and keep alive humanity's noblest aspirations, including our place in the universe, the raison d'etre for human spaceflight.

* **Madhu Thangavelu** is the conductor of the graduate Space Exploration Architectures Concept Synthesis Studio in the Department of Astronautical Engineering within the University of Southern California's Viterbi School of Engineering. He is also a graduate thesis adviser in the School of Architecture at USC. He is also a member of the To The Stars Editorial Team. ##

Implementing the Vision of the National Space Society

2013 White Paper on Future Space Development

Sacramento Chapter, National Space Society/Sacramento L5 Society

Forward

We, a consensus of the members of the Sacramento L-5 Society, local Chapter of the National Space Society, endorse the NSS Vision: "People living and working in thriving communities beyond the Earth, and the use of the vast resources of space for the dramatic betterment of humanity". To implement that Vision, we believe it is incumbent upon the NSS to develop high level action items. At a minimum we believe those action items need to:

1. **Extoll the benefits of the space program.**

Properly funded, implementation of the NSS Vision would create prosperity and jobs in vast profusion across the globe. We in the NSS know that the U.S. space program has always more than paid its own way, both with tangible and intangible benefits to the country and the world. However, we are convinced that the general populace has not been properly informed of the exact magnitude of these many past benefits, and how future equally vast benefits may be gained by adequate funding and implementation of the NSS Vision.

Tangible past and future benefits include:

Enhanced national security; long-lasting, good-paying jobs in private industry, R&D, space tourism, and education; satellite technology, including communication and information distribution, GPS, weather, mapping, and environmental observation and monitoring; many useful spin-offs (see http://spinoff.nasa.gov/index.html for examples); gaining access to unlimited space-based mineral and energy resources; development of the capacity to protect the planet from space debris; development of the potential to ensure the survival of the human race in the event of a cosmic catastrophe.

Intangible past and future benefits include:

Aiding in the education and inspiration of the young; creating ambition and optimism for the future; spurring innovation and creativity; expanding the boundaries of human knowledge; uniting us as a species (when a U.S. astronaut first stepped out onto the surface of the moon, the whole world rejoiced).

2. Expand space-related education. Our children are the hope of the future.

We call for: Expanded astronomy and STEM (Science, Technical, Engineering, Math) curriculums in schools; development of a new curriculum dedicated to the history of human space exploration; increased space-related educational programming on TV and media; introduction of the foundations of STEM and space education at an early age; increased space-related hands-on learning.

3. Work toward standardized space property rights.

Colonization and utilization of space and space resources will depend on the standardization of property and asset rights in space. We believe it is essential that the governments sponsoring the development of space resources share the opportunity for using these resources with the world at large as well as with those private individuals and companies who take risks in the development of those resources.

4. Define the roles of NASA and the private sector.

As a means of increasing budgetary efficiency, NASA should focus on space science and on long-term solutions of hard problems and enabling technologies, such as protection from radiation during space flight, developing processes for Moon/Mars/asteroid mining and in-situ resource utilization, and long term R&D on advanced propulsion technologies and space transportation infrastructure.

At the same time, NASA should increase its support of and collaboration with private space industry. Private industry should become more responsible for exploring and developing new launch capabilities and services for increasingly cheap access to LEO and beyond as well as investing in large-scale commercial projects, such as space tourism and mining in space.

Besides advancing the cause of space settlement, these private industry projects would create many well-paid private sector jobs and earn billions of dollars for the country through an expanded tax base, technology transfer payments, and income from the granting of outer space mineral rights.

5. Support nonprofit space development.

We call for establishing a nonprofit space development clearinghouse as a support platform for ongoing objective analysis of proposed space development technologies. The clearinghouse would operate in an "open-source" manner, with all data, analysis, and simulation tools available to anyone who wants to independently verify and/or correct others' conclusions.

All contents, including ranking of alternatives, would be constantly updated as new data becomes available. The clearinghouse would become a reputable "advisory board" for decision-makers and all major players involved in space-related development, and specifically would work in conjunction with and “feed” specialized crowdsource funding operations, whether for-profit or nonprofit.

6. Broaden political support for space efforts.

Finally, we contend that the space program has become too much of a political hostage, which is bad for the space program, for the country, and for the world. If we are to create a sustained commitment to space development, it is essential to find effective ways to cooperate politically.

To this end, we believe it's time to formulate and insist on a long term national strategy on space that is agreed to by both major political parties and not subject to the vagaries of whichever political party happens to be in power. Accordingly, we call for the introduction of a bill supported by both political parties that would guarantee an enhanced, sustained, generational commitment to space development and the implementation of the NSS Vision.

Contact: Joseph Barrett Bland, President, Sacramento L5 Society – **www.sacl5.org**
7482 Greenhaven Drive, Sacramento, CA 95831, 916-429-6252, josephanddonna@earthlink.net

Moon to Moon to Mons: Synergies for Lunar and Mars Development

By Al Anzaldua and Dave Dunlop – March 15, 2015

Background

A number of authors have proposed Lunar and Mars exploration strategies that focus on in-situ resource utilization (ISRU) at stepping stones from the Earth to the Moon. (Spudis, et al. 2011 & Schrunk 2007) This envisioned chain leads from the Earth to LEO with propellant depots refueling reusable in-space cycling vehicles (ferries) from LEO to an Earth-Moon Lagrange gateway (either E-M L1 or E-M L2) with cycling vehicles down to and back from the Moon's surface, where a base would be located. While the propellant for LEO depots would be supplied from Earth, propellant for E-M Lagrange fuel depots are hoped to be supplied from volatiles found in polar cold traps in lunar craters. (Spudis 2010)

Aside from the renowned “Mars Direct” approach (Zubrin 1996) a parallel strategy for Mars begins at E-M L2 Gateway, reaching Mars orbit with a cycling supply chain connecting to a Mars orbiting infrastructure, then to basing and fuel production on the Martian surface leading to settlement there. (Milestones 2014) This creates essentially the same essential strategic architecture for both the Moon and Mars destinations.

Rethinking Mars Settlement via Two Moons plus Mons Volcanos

First Step: Integrate ISRU into Cislunar/Lunar-Surface System

A new lunar processing technology developed by Peter Schubert, a solar-powered regolith separator he calls a “super-sonic dust roaster,” suggest another wrinkle on the way to Mars. Schubert’s processing plant would heat lunar regolith into conductive liquid and separate it into oxygen for life support and propellant. His lunar separator would also produce silicon, iron, aluminum, titanium, and slag for construction and additive manufacturing. (Schubert et al. 2010) Such ISRU products would greatly increase lunar and cislunar self-sufficiency. Moreover, dealing with the Moon’s sharp-edged and clinging “dust from hell” will give solar system pioneers experience for other dusty-surfaced celestial bodies, such as minor moons and asteroids.

Just concerning propellant, at a regional conference presentation in St. Louis on November 8, 2014, Dr. Schubert indicated that his proposed dust roaster, delivered on one mission to the lunar surface, could produce sufficient oxygen to combine with hydrogen for refueling its lander four times a year. Because the molecular weight of hydrogen versus oxygen is 1:8, even hydrogen brought from Earth would be feasible. Schubert’s regolith separator would provide pragmatic “lunar ferry” capability based on lunar in-situ production of resources for E-M L1/L2 locations. A number of such production facilities could provide ever more local oxygen production for life support and a higher flight rate.

Second Step: Integrating Deimos ISRU

Why Deimos?

The potential extraction of resources from Deimos regolith makes that moon a particularly tempting target. First, Deimos is easier to get to energetically from LEO than the lunar surface (Logan et al. 2015) The moon is also easier to reach than Phobos by a delta V of 400 m/sec (Hopkins et al. 2011). At around 20,000 km from the Martian surface, telerobotics from Deimos would be very near real-time. Even better, because Deimos orbits just above Mars synchronous orbit (MSO), from the perspective of Deimos, Mars would appear to slowly rotate eastward at only 2.7 degrees per hour, thus offering a generous line-of-sight telerobotics time, unavailable from Phobos. In fact, if several Deimos surface assets were placed at regularly spaced longitudes, Deimos-based human teleoperators could circulate westward or rotate control from one to the next and explore 24/7. Over a period of nearly five and a half days, the entire planet could be seen except for extreme Polar Regions (Logan et al. 2015 and Hopkins et al. 2011).

Deimos as a resource also goes far beyond being an ideal telerobotics platform. Deimos, measuring 15 x 12.2 x 10.4 km, is much bigger than the near-Earth asteroids (NEAs) NASA is considering visiting at considerable expense. Yet escape velocity from Deimos would still only be 5 m/sec (Logan et al. 2015), making it a fuel-sparing staging platform for solar system transit. In addition, several meters of Deimos regolith between a Deimos-based crew and interplanetary space, would provide shelter from cosmic radiation equivalent to the protection provided by the Earth’s atmosphere at sea level.

Better still, although the origin of both Deimos and Phobos is yet unsettled, both appear to have the characteristics of dark carbonaceous asteroids, with assemblages of anhydrous silicates, carbon, organic compounds and ice (Bell et al. 1992). If this bears out, Deimos' regolith would be able to provide water and other volatiles for life-support and propellant. Besides silicates, Deimos regolith will also likely contain metals and other valuable materials for construction and manufacturing (Norton 2002).

Simple heating in an enclosed environment could recover Deimos volatiles (Nichols 1993). For non-volatile material extraction, Dr. Schubert has developed an "Isotope Separator" with three patents for various configurations. One of these configurations could be the basis for a device to separate Deimos regolith into components for life support and fabrication (Schubert 2008). Other ideas and devices may also work well. Because the light intensity reaching Mars PhD is only around 44% as strong the intensity reaching Earth's Moon, powering a Deimos regolith separator will be harder, but not impossible. Luckily, Deimos does not have a light-scattering atmosphere like Mars. Adequately large solar panels could therefore be constructed to power the separator.

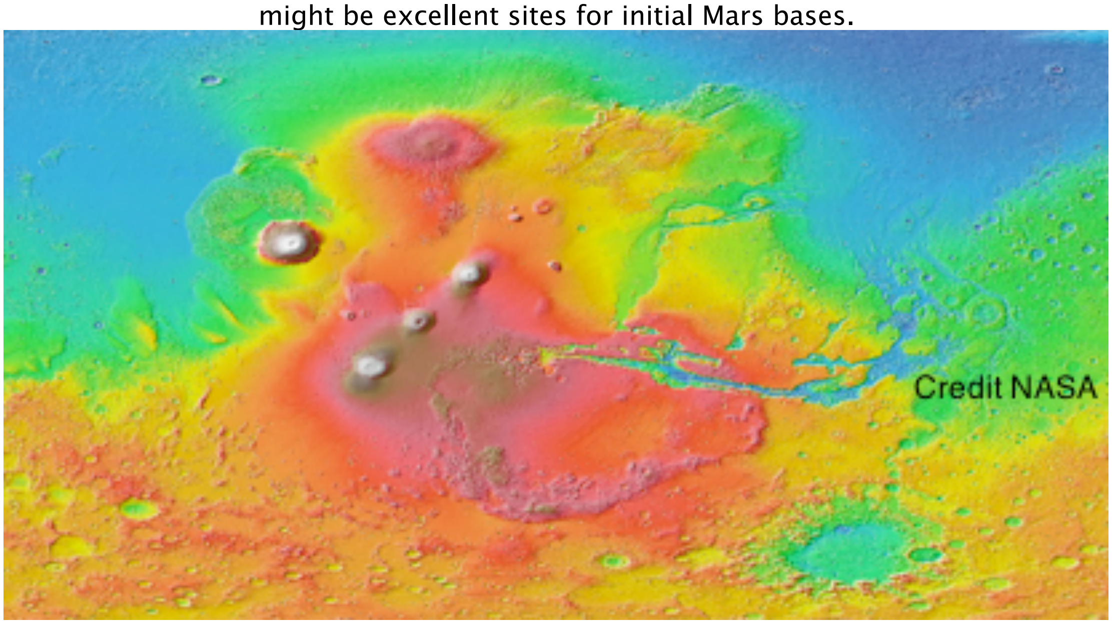
Deimos-sourced propellant could power 1) reusable spacecraft (ferries and tankers) going to cislunar space from the Mars-Deimos-Phobos (MarsPhD) system and back; 2) similar reusable spacecraft to Mars and back, and 3) similar spacecraft bound for solar system destinations beyond Mars and back.

To sum up, the resources potentially provided by Deimos includes telerobotics, oxygen and water for life support, vehicle staging and fueling, shelter from cosmic radiation, and construction/manufacturing materials. Deimos would be the best ISRU site for a Mars Orbital Complex (MOC), Mars settlement, and further solar system expansion.

Third Step: Basing on the Mars Equatorial Mons Complex

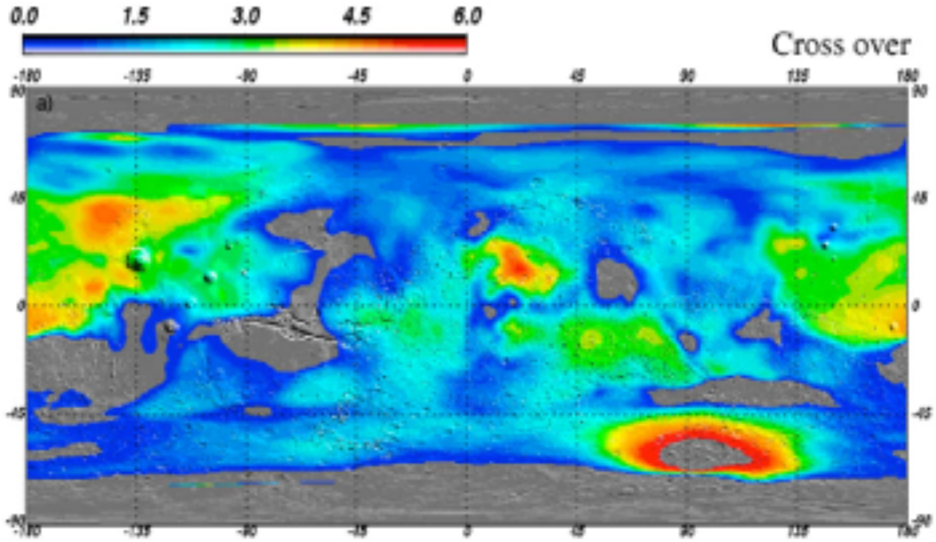
Why the Mons Equatorial Complex?

Effective Mars surface exploration will require a phased strategy, which will include access to shelter and natural resources for life support and construction/fabrication, while respecting both forward and back planetary protection. In this regard, the shield volcanos of the Tharsis Montes ridge (Arsia Mons, Pavonis Mons, Ascraeus Mons), as well as Olympus Mons and outlying Elysium Mons, might be excellent sites for initial Mars bases.



Olympus Mons and the Tharsis Montes volcanos, in particular, would provide relatively close access to shelter, natural resources and equatorial sites. These basaltic shield volcanos are laced with many cubic miles of lava tubes containing useful frozen volatiles. (Wall 2012 & Bleacher 2011) Judging from lava tubes on Earth, the yields for science, life support and infrastructure development on both the Moon and Mars will be significant. Moreover, our experience exploring the lava tube environments on the Moon (Redd 2014) will likely advance settlement strategies for Mars. The Moon could therefore be a major engineering on-ramp for the practical experience of robotically exploring and modifying lava tube environments on Mars.

About 600 km wide, the top of Olympus Mons reaches an altitude of 25 km (16 miles) and is very cold. Nevertheless, the north and western sides of this majestic volcano plunge to below Mars zero-elevation or datum, offering relatively warm sites for exploration. Moreover, near-surface ice is likely on the western side. (See map below.)



Dr. William Feldman of PSI in 2012 analyzed data from NASA's Mars Odyssey Neutron Spectrometer & found evidence of massive amounts of water ice just beneath the surface. (>4.5 % of water equivalent hydrogen in orange & red areas)

The typical atmospheric pressure at the top of Olympus Mons is about 12% of the average Martian surface pressure, which in turn is less than 1% Earth atmospheric pressure at sea level. Even so, high-altitude orographic clouds frequently drift over the Olympus Mons summit, and airborne Martian dust is still present. (Hartmann 2003). Analogous to how our experience with lunar lava tubes will inform us about how to utilize Martian lava tubes, our experience dealing with dust on the Moon should inform us on dealing with dust on Mars.

The middle Tharsis volcano, Pavonis Mons, lies smack on the equator. However, because it also lies on the Tharsis bulge, its base remains at a high altitude. Pavonis Mons is the smallest of the Tharsis Montes volcanos. Yet it is still 367 km across and its summit 14 km high (Scott 1998 & Gazetter). The summit experiences an atmospheric pressure of about 21% of Mars' mean surface pressure. Data from the Mar Global Surveyor and Mars Odyssey suggest that glaciers once existed on Pavonis Mons and significant amounts of near surface, equatorial ice may remain within the deposit today. (Shean 2005)

Occupying the "high ground" on Mars from any of the Mons volcanos would provide a springboard for human expansion into lower altitude sites of interest, including the Echus Chasma, Valles Marineris and the lowlands west of Olympus Mons. In sum, Olympus Mons, Pavonis Mons, and the other Mons volcanos are potential base sites with readymade shelter from radiation, materials for fabrication and construction, and volatiles for propellant and life support.

Assuming we are able successfully to establish a permanent base on Earth's Moon and on Deimos, the conditions (in terms of near vacuum and high radiation) at the summit of the Mons volcanos should allow for similar, by-then Moon-proven, infrastructure and life-support technologies. These technologies should include waste recycling to produce useful products, like fertilizer and fuels. (Schubert 2011). In the latter case, for instance, NASA Ames has produced a small bioreactor that uses urine as a feedstock to produce, with the help of microbes, electricity, methane, and clean water. (Verger 2014) Thermal management in these cold locations will also be critical.

With regard to mission sequencing, the appropriate volatile heater-extractors and element separator systems could begin robotically producing water and oxygen for life support and propellant, as well as metals and other fabrication materials -- before humans arrive. As on Deimos, however, a Schubert-type isotope separator on a Mons volcano will require a great deal of energy from very large solar arrays. Assuming the lack of atomic power, fabrication of large arrays from silicon and other Mons materials would therefore be a critical first step.

Reaching a Mons volcano from forward orbital base Deimos would give us supporting infrastructure that can back-up Martian surface operations. Surface operations can “abort to orbit” if needed, or conversely, a rescue from orbit could also be realized. The ability to provide precursor surface missions with the assistance of real time telepresence from orbit will also be of great advantage in setting up surface accommodations for a sustained presence, whether on a Mons volcano or elsewhere. Robotic and human exploration sorties will be easier and more effective after a Mars ferry system fueled and maintained with Deimos resources is operating.

There is still another advantage. A base on the Mars surface and on Mars orbit will need resupply of some Earth-sourced materials, especially in the beginning. There will also likely be need to pass back materials such as soil samples or possibly even life-form samples to Earth-Moon Lagrange points, lunar-surface, or terrestrial labs for analysis. However, that will only be the beginning. The movement of people and materials beyond samples is inevitable, and complete protection from forward and back contamination will become impossible. Nevertheless, the planetary protection protocols that should really count to us are those that might present risk to human and other terrestrial life. For this reason, the sequestration of potential life-form samples arriving from Mars should be restricted to isolation within the life-hostile context of Deimos and the lunar surface. A Mons-summit base might provide an additional way at least to minimize forward and back contamination of life forms.

Lessons Learned

To underestimate the challenges of Moon and Mars settlement is to fail in overcoming them. Somehow Antarctica with a relatively low profile has for decades successfully drawn the kind of sustained support we need for the settlement of both the Moon and Mars. Apollo, although started with huge national effort, did not create a sustainable political constituency for the settlement of the Moon. Our government sold the Apollo Program like a football game between the U.S. and Soviet Union. This time around, space development advocates must sell “season tickets" to a sustainable Moon, Mars PhD, and solar system settlement program.

A long-term commitment to an Antarctic-style research station will not do. Nor is the simple goal of exploration sufficient. For self-sufficiency and sustainability, the selling of goods and services must be an integral part of the settlement mix. Tourism will undoubtedly be one of the first services companies will provided for profit, and the nascent space-tourism industry has already taken off. Mining of water and mineral resources will run a close second. Eventually, refined goods and sophisticated services will also evolve. A “Moon to Moon to Mons” strategy could rapidly extend engineering, technological, and commercial advances from cislunar spaces to the Mars PhD system, greatly facilitating solar system development for the benefit of humankind.

Conclusion & Summary

NASA has plans to spend a considerable sum on an Asteroid Retrieval Mission (ARM). Meanwhile, Deimos is an orbiting "platform" already in place and ready for staging, communications, and telepresence to explore and sustainably settle Mars. In addition, the vast resources on Deimos are likely similar to those found on carbonaceous asteroids, and Phobos is nearby for continued resource utilization. Deimos is relatively accessible compared to most other solar system sites. Methods and technologies for utilizing asteroidal resources could be tested and developed on Deimos, while we otherwise use that moon to enhance lunar and Martian infrastructure. In other words, a Moon to Moon to Mons campaign is “just the ticket” for developing asteroid utilization technologies, and in the so doing, vastly accelerate sustainable solar system settlement. It is time to replace the ARM with a “Moon to Moon to Mons” strategy

We do not argue that our proposed architecture will be the fastest way for humans to step on the Martian surface. We argue instead for sustainability and cooperation. We urge that various competing camps for destinations such as the Moon, Mars, asteroids, and orbital spaces drop their "us first" postures and see a compelling case unifying their priorities in the context of a "Moon to Moon to Mons" strategy. We believe that pioneers from Earth can use such a strategy to undertake a rational, cooperative, sustainable campaign for the expansion of human space settlement throughout the solar system.

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“Towards an Earth-Moon Economy - Developing Off-Planet Resources”
Moon Miners’ Manifesto
& The Moon Society Journal www.MMM-MoonMinersManifesto.com

The inspiration and driving premises behind MMM

By Peter Kokh, Editor of Moon Miners’ Manifesto - December 1986 to current

I have been known for more than two and a half decades as a “Moon Man.” But I have a confession to make. In the post World War II years (I was going on 8 when the War was over) I read all I could about new aircraft technology (ramjets for example) and visions of the coming space age.

By the mid-to-late 1950s, (my late teens and early twenties) I had become “a passionate Mars person.” I was fascinated (infected?) with the Red Planet from my youth, thanks to the science fiction novels by Ray Bradbury (“Martian Chronicles”), Arthur C. Clarke (“The Sands of Mars”) and Edgar Rice Burroughs (“John Carter on Mars” series). Then there was Sputnik in 1957 (just before my 20th birthday) and the Space Age burst upon us faster than anyone has expected, thanks almost entirely to the Cold War rivalry between the Unites States and the Soviet Union (Russia and 15 lesser Republics, now each independent).

I watched, read, listened avidly to reports of the Apollo Moon Landings, and was devastated when the last three planned missions (18, 19, 20) were cancelled. Apollo was a J. F. Kennedy thing, and when this leadership (carried on after his assassination by Lyndon N. Johnson) passed into the hands of JFK’s long time rival Richard Nixon in 1969, key programs accredited to Kennedy were eventually cancelled.

By the late 1970s, I was already a member of the L5 Society and of the National Space Institute (Life member #2 after its founder Wernher von Braun who was life member #1) which eventually became the National Space Society after the merger with L5. I wanted to express how I felt, and I started taking notes for an “alternate history novel” detailing where we would be (I had hoped to publish the book in the early 1980s) had we not turned our back on the Moon. I would never finish that novel, but let’s get back to the story.

We would have been on Mars “by now,” of course, or so I reasoned, but we would have had to “do the Moon” first, establishing both science outposts and a pioneer settler frontier, and I wanted to sketch how this pre-Mars chapter would unfold. My lunar “innocence” was quickly shattered as I quickly learned that the Moon’s economic promise was severely handicapped by a lack of key volatiles: hydrogen, nitrogen, and carbon, as well as some key metals, copper, zinc, gold silver, platinum, etc. But not at all discouraged, I would attempt to show how “we would do the Moon anyway” and in doing research along those lines, became thoroughly enchanted with the Moon’s challenges and promises.

In short, I saw the Moon to be the Japan of Space: lacking many key resources needed to build a technological civilization, but with a population of energetic, bright, enterprising individuals, and a key location on the Pacific rim. Japan would go on to develop the whole Pacific rim: Korea, Manchuria, all of coastal China, SE Asia, and the Philippines. The Moon is like that, at the hub of key low energy “cis-lunar” gravitational sweet spots. The Moon might not have key resources, but it had something else, like Japan: “Location, location, location.” And if its pioneers were resourceful and enterprising, the Moon could quickly become the Japan of the inner solar system “rim.”

But I never lost my fascination with Mars. Every year, the March (“is for Mars”) issue of Moon Miners’ Manifesto has been a Mars-Theme issue. And, in my seven years as President of the Moon Society, 2004-2011, I shaped Moon Society policy to include Mars. A Moon-Mars economy would be essential to the economic viability of both worlds. And there were so many technological issues that faced the pioneers of both that there is enormous room for collaboration on many fronts.

I wrote many Moon Society web pages and documents related to Mars, including many, many articles in Moon Miners’ Manifesto. You can find links to all of these on this one page:

www.moonsociety.org/mars/ & in the **Mars Theme issue**:
www.moonsociety.org/publications/mmm_themes/mmmt_Mars.pdf

A "Eureka" moment

In May of 1985, I had the opportunity to tour a unique underground home – "**Terra Lux**" – in the northern Kettle Moraine region 20-some miles northwest of my home in Milwaukee, Wisconsin. The inspiration of its design, something we could duplicate on the Moon or Mars, charged my batteries.

This visit convinced me that ingenious and resourceful pioneers could create settlement environments that would be as satisfying and pioneer-friendly as any towns or cities on Earth. A year plus later, I was ready.

www.moonsociety.org/chapters/milwaukee/mmm/**mmm_1.html**

MMM #1 December, 1986

On Saturday, September 15, 1986, **the Chicago and Twin Cities chapters of the L5 Society** invited area members to meet at the Triangulum Science Fiction Convention in Milwaukee and encouraged us to organize a chapter. We did.

I launched "Moon Miners' Manifesto" in the fall of 1986 as the newsletter of the "Milwaukee Lunar Reclamation Society," at first a chapter of the L5 Society, but within three months, the first fully merged chapter of the L5 Society and the National Space Society before the two organizations officially merged at the 1987 L5 International Space Development Conference in Pittsburgh.

In the fall of 1995, towards the end of MMM's 9th year, the newly formed Artemis Society International contracted our Milwaukee NSS chapter to have MMM become its newsletter as well. In July 2000, ASI memberships (and MMM subscriptions) were transferred to the new, more broadly-focused Moon Society.

"**Moon Miners" "Manifesto**" **and Mars**

Don't be mislead by the name! Known as "Moon Miners" to most readers, a cornerstone of "the Manifesto" (as I refer to it) is that pioneering either the Moon or Mars, one without the other, would be a foregone doomed effort. Neither the Lunar or Martian Frontiers can be viable long term except as mutual trading partners. If you want one of the two, you owe it to yourself to support settlement of the other. So while the name has not changed, **you would not be amiss to call it the Moon/Mars Miners' Manifesto!**

I understand that many space enthusiasts are interested in both Moon and Mars, and in the rest of the solar system (and beyond) to boot. Well so am I, and as long as I am editor of MMM that broader focus will be evident.

MMM's "Inspirational Goals" – from the outset, MMM has aimed to "**re-imagine the Moon.**"

MMM's primary goal is not to inform readers about what NASA is planning, and how its plans are progressing, nor about what other national space agencies are doing – though we do report on that. Rather, our focus goes well beyond the short term, even beyond the long term goals of NASA and other national space agencies. At best, these official or unofficial and unstated goals are confined to a "continuing" outpost and the minimal development and use of lunar resources needed to sustain it.

In contrast, MMM's mission is to unfold the possibilities of establishment of true civilian pioneer frontier settlements, and **how lunar pioneers will learn to make themselves "at home" on the Moon**, despite the daunting, would-be life squelching conditions of the surface of this world of "magnificent desolation." We try to show how pioneer life, hard at first to be sure, can become very satisfying.

Science Fiction in general, has not tried to show how we can do this. Robert Heinlein, in "The Moon is a Harsh Mistress," correctly pointed out that pioneers would have to live "underground" (in tunnels or under an overburden of moondust shielding) to be insulated both from the thermal extremes of dayspan heat and nightspan cold, and from the incessant cosmic radiation that washes the exposed lunar surface. It was a determined but unrewarding existence his rebel pioneers endured. But on that one day in May 1985, Heinlein's vision would be forever shattered in my mind, replaced with a vision much more encouraging.

To this day, MMM is not about how we will one day build small Spartan outposts on the Moon where courageous pioneers will endure much privation – no, it is about how, with resourcefulness and determination, lunar pioneers can look forward to satisfying, rewarding lives. MMM's vision is not of a few dozens of astronauts in small outposts for short terms of duty, but of a day when hundreds of thousands of people will live satisfying lives, raising families, earning their keep by producing products from the elements in moondust that they can ship to stations in Low Earth Orbit, Geosynchronous Earth Orbit, the various Lagrange point stations, and to pioneers on Mars and out among the asteroids at a strong competitive advantage, simply because the Moon is gravitationally "uphill" from these locations, and as a result, it takes much less fuel to ship things there from the Moon's surface than from Earth's surface.

With resourcefulness, ingenuity, and determination, all the Moon's "have nots" can be circumvented. Indeed, with the right attitude, they can be turned into assets. It's all about outlook and vision. NASA does not have it. MMM does.

MMM does not necessarily reflect the policy or vision of The Moon Society, but serves as a source of inspiration for its leadership and members, as well as to many other subscribers.

MMM spin-offs – www.moonsociety.org/publications/

How to get MMM: options:

- **Join the Moon Society – www.moonsociety.org/register** – you may opt to get MMM as hardcopy (20 pages, monthly except January and July) or as a download pdf file – those who chose black and white hardcopy in their mailbox can still download the color pdf file
- As **member of one of several National Space Society chapters** who use MMM as their newsletter: Chicago, Minnesota (Twin Cities), Sheboygan WI, Denver CO, Los Angeles (OASIS), Oregon L5 (Portland), Philadelphia/PASA – check with these chapters
- Direct through the Lunar Reclamation Society – $15 (hardcopy) P.O. Box 2102, Milwaukee, WI 53208

Back Copies of single issues are generally not available, but .....

Introducing the MMM "Classics"

All the "non-time sensitive" articles of past issues have been collected in the "MMM Classics" volumes, freely downloadable color pdf files, one per publication year, lagging 2-3 years behind current, to maintain incentive to join the Moon Society or an MMM-serving NSS chapter.

www.moonsociety.org/publications/mmm_classics/

And the MMM "Theme" Issues

This same material has also been republished in collections according to themes (currently 17) and these are also freely downloadable color pdf files

www.moonsociety.org/publications/mmm_themes/

MMM and the National Space Society

While MMM has been the official newsletter of the Artemis Society October 1995 to June 2000, and of its successor in membership services of the Moon Society since August 2000, it remains the product of the National Space Society's Milwaukee chapter, and its editor remains Life Member #2 of the National Space Society (#1? Wernherr von Braun, the founder of the National Space Institute which became the National Space Society after the merger with the old L5 Society in March 1986.)

NSS takes pride in MMM and offers MMM products, the **Classics** and the **Theme** issues on its website: www.nss.org/settlement/**moon/library/index.htm**

At ISDC 2009 in Orlando, NSS gave out this award for "twenty plus" years of MMMs:

http://www.nss.org/awards/**oneill_award.**html

http://www.nss.org/**settlement/moon/library**/index.htm

"MMM the Book" ?

Yes, That has been the plan from the very start. Indeed, I had planned to write a novel showing where we could be "now" has we not retreated after the Apollo Program was prematurely cancelled with three planned missions to significant lunar sites scrapped in the process.

I would like to put out a book one day, sooner rather than later, provisionally titled

"Reimagining the Moon: A Pioneer's Guide to Earth's 8th Continent"

The MMM Theme issues have been compiled in preparation for this. Should I not be able to write "The Book," hopefully someone else will be able to do so using the Theme issues as a guide.

The current plan is that MMM #301 – the 30th anniversary issue due December 2016, will be the last issue that I edit, a 79th Birthday present to myself.

But if a replacement editor can be found, I will want to contribute fesh articles now and then.

PK

ONLINE OP-ED ARTICLES FROM OTHER WRITERS WORTH READING

[Editor: We invite readers to read these articles: kokhmmm@aol.com]

Is Moon Mining Economically Feasible?

www.space.com/28189-**moon-mining-economic-feasibility**.html

By Leonard David

'Shoot For the Moon': This Short Film Longs for Space Exploration

www.space.com/28178-**shoot-for-the-moon-short-film**.html

By Leonard David

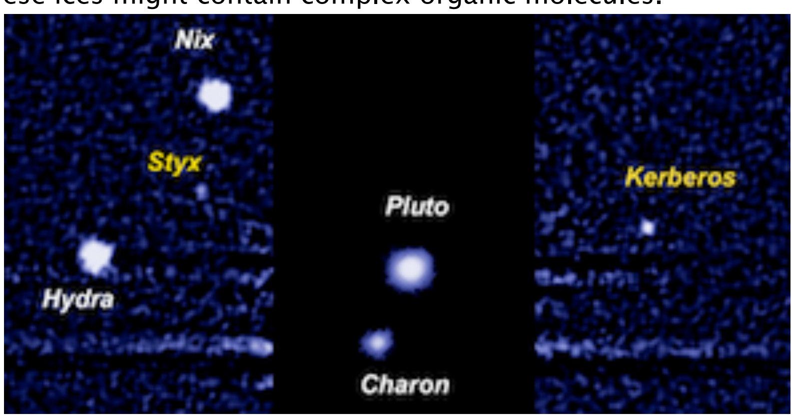
It's Time to Restore Pluto's (& Ceres') Good Names

www.space.com/28656-**its-time-to-restore-plutos-good-name**.html

By David A. Weintraub

Points Cited:

- Ceres and Pluto are both spheroidal objects, like Mercury, Earth, Jupiter and Saturn. That's part of the agreed upon definition of a planet.
- They both orbit a star, the Sun, like Venus, Mars, Uranus and Neptune. That's also part of the widely accepted definition of a planet.
- Were the Earth placed in the Kuiper Belt, it would not be able to clear its neighborhood and thus would not be considered, by the IAU definition, a plane
- location shouldn't matter
- The intrinsic properties of the objects themselves should matter more.
- Ceres is rich in water - as much as one-third of Ceres might be water - and may have a thin atmosphere. Bright, white spots on its surface might even be large frozen lakes. Ceres may, in fact, have as much fresh water as Earth, have Earth-like polar caps, and might even have a sub-surface liquid ocean layer, like Jupiter's moon Europa and Saturn's moon Enceladus.
- Pluto has one large moon, Charon, and at least four small moons: Nix, Hydra, Kerberos and Styx. It has an atmosphere that expands and contracts as Pluto warms and cools during its 248 year orbit around the Sun. The surface is likely rich in water ice, enriched with methane and nitrogen and carbon monoxide frosts; these ices might contain complex organic molecules.



- The New Horizons mission is poised to answer some of our myriad questions about Pluto. How did it form? What is the atmosphere made of? What is the surface like? Does Pluto have a magnetic field? What are the moons like? Does Pluto have a subsurface ocean? Is the surface of Pluto's moon Charon

Missions May Elevate Pluto, and Ceres, Dwarf Status

Another OP-ED Article on this topic

www.space.com/28760-**missions-may-elevate-pluto-and-ceres-dwarf-status**.html

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 – the "ISDC" – http://isdc.nss.org
The "ISDC" is usually held the weekend of the last Monday in May (Memorial Day weekend) in various locations. ISDC welcomes 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 also participate in this conference.

The Moon Society – TMS – http://www.moonsociety.org
The Moon Society has informal relationships with the Calgary Space Workers, Calgary, Alberta, Canada and with the Sociedad Espacial Mexicano, Mexico. The Society has individual members in many countries.

Moon Miners' Manifesto India Quarterly – the "older sister" to **To The Stars International Quarterly**, had been going to students and others in India and Elsewhere since August 2008. Older issues are available as free pdf downloads at www.moonsociety.org/india/mmm-india/
TTSIQ now replaces M3IQ, worldwide, and has much more material, especially in the Space News area.

Students for the Exploration and Development of Space – SEDS
http://www.seds.org
SEDS has had greater success in setting up chapters around the World than other Space organization.
- How to Stars a SEDS Chapter – http://wiki.seds.org/index.php?title=**Start_a_SEDS_Chapter**
  http://seds.org/chair/**ChapterExpansionKit**30.pdf

SEDS-Earth – http://earth.seds.org/index.php – This is the international chapter.
There are chapters of SEDS around the world: (USA), **Canada, India, Nigeria, United Kingdom, Philippines**, and more; SEDS-Earth is a central node for communication between worldwide chapters.

YURI's Night – https://yurisnight.net
This event celebrated annually on April 12th, the anniversary of the first human not only to reach "space" but to orbit Earth in 1961 – Yuri Gagarin. Yuri's Night Parties and observances are held world-wide.

EARTH Day – http://www.earthday.org
This event has been celebrated annually on April 22nd (or the nearest Saturday) since 1970. While its purpose is to support environmental efforts to preserve Earth's amazing and diversified biosphere against the many threats of deforestation. Extinction of species, etx. It is an opportunity for us to show the importance of space to Earth. After all, where would "Mother Earth" be without ":Father Sky", in particular without the Sun and the Moon! **That the Moon has no ecosphere, means that settlements ther must establish and preserve mini-biospheres in which they must live "downwind" and "downstream" of themselves**, learning lessons that we still on Earth could benefit from to preserve our own world: ample grounds for the "Space Exploration" and "Earth preservation" communities to work hand in hand, rather than to hold the other aloof.

Student Scientists Ready to Launch Experiments to Space Station

www.nasa.gov/press/2015/january/**student-scientists-persevere-ready-to-launch-experiments-to-space-station/**

JAN. 5, 2015 - Students will look to the skies this week when SpaceX's 5th commercial resupply services (CRS) mission to theSpace Station lifts off on January 6, from Cape Canaveral Air Force Station in Florida. SpaceX's Dragon spacecraft will carry scientific research conceived and designed by students who are learning first-hand what it takes to conduct research in space.

- Eighteen Student Spaceflight Experiments Program (SSEP) teams worked to prepare the investigations in time to fly to the space station.
- The teams previously had their research aboard Orbital Sciences' Antares rocket, which suffered a failure during launch in October.

"I try to teach students, when I speak to them, not to be afraid of failure.

An elementary school student once told me, when I asked for a definition of success, that

'Success is taking failure and turning it inside out.'

It is important that we rebound, learn from these events and try again
-- and that's a great lesson for students."

- SSEP managers and supporters worked to ensure the students' experiments were prepared and ready for the next available launch.
- Student experiments were rebuilt and shipped to Kennedy Space Center in Florida for stowage aboard SpaceX's Dragon spacecraft, destined for the space station.

"Failure happens in science, and what we do in the face of that failure defines who we are,"

- This unplanned lesson in real-world science fits with SSEP's goal of immersing and engaging students and their teachers in conducting authentic space science, just like professional investigators.

Student experiments will investigate a range of topics

- A crystal growth study that will enable students to learn more about how fluids act and form into crystals in the absence of gravity
- How microgravity affect milk spoilage.
- This set of student experiments collectively is known as Yankee Clipper and is the eighth flight opportunity associated with the SSEP.

The Center for the Advancement of Science in Space (CASIS), manager of the U.S. National Laboratory on the space station, is a national sponsor for SSEP and funds nine of the Yankee Clipper investigations. Additionally, CASIS is committed to re-flying six student experiments from its National Design Challenge program that were lost with Antares. ##

NASA Joins White House to Discuss STEM Education in America

www.nasa.gov/press/2015/january/**nasa-joins-white-house-from-ground-and-space-to-discuss-state-of-stem-education/** - unabridged

JAN. 21, 2015 - NASA joined the White House Office of Science & Technology Policy Wednesday, Jan. 21 for its third annual State of Science, Technology, Engineering and Mathematics (SoSTEM) event. The event was aired live on NASA Television, and also live-streamed online.

Approximately 130 middle and high school students from schools in Maryland, Virginia, and Washington joined OSTP Director John Holdren and NASA Administrator Charles Bolden for a rare opportunity to connect with two members of the International Space Station crew at 1:30 p.m. for a live ground-to-space question and answer session.

NASA astronauts Terry Virts and Barry E. "Butch" Wilmore took a brief break from their station research activities to answer questions and share with these students their perspectives on STEM education and professions.

Following this discussion, NASA Chief Scientist Ellen Stofan sat down with members of OSTP leadership for a panel discussion on women and girls in STEM, in a question and answer session.

NASA astronauts Barry E. "Butch" Wilmore and Terry Virts spoke to students from aboard the International Space Station ##

How to Get Students Interested in Space (& Science, Math, Engineering)

http://m.theatlantic.com/technology/archive/2012/08/**how-to-get-students-interested-in-space-and-science-and-math-and-engineering**/261219/

The learning platform "Alleyoop" is collaborating with NASA and other institutions to get kids to consider STEM careers. – text unabridged

How do you get young people excited about space? How do you get them interested not just in watching movies about space, or in playing video games set in space ... but in space itself? And how, while we're at it, do you inspire them to love math and science? How, in fact, do you get them to consider pursuing careers in engineering and tech?

Today, the gamified learning platform Alleyoop is offering one answer to those questions: It's announcing a collaboration with NASA. And with National Geographic. And with the National Science Foundation. And with Scientific Minds. And with a host of other outlets that produce content focused on science, technology, engineering, and math -- the STEM literacies.

The Pearson-owned Alleyoop, which uses a direct-to-student and direct-to-families education model, will offer videos and other interactive content from its new partners, integrating that content into its student-driven approach to learning.

With its new teaching tools, "I think there's a big opportunity for us to pique interest in younger kids," Gerard LaFond, Alleyoop's VP of marketing, told me. And that's significant, because the point of the new partnerships isn't (just) to extend Alleyoop's educational offerings; it's also, both more specifically and more broadly, to encourage students to consider pursuing careers in the STEM fields. Earlier this year, a report distributed by the President's Council of Advisors on Science and Technology made a dire assessment: If the U.S. wants to keep benefitting from its historical leadership in the STEM fields, it will have to produce one million more workers in those fields than it's currently on track to produce.

And it must generate those workers over the next decade alone.

If that's to happen, schools will likely need the help of external collaborators -- from extra-classroom platforms like Alleyoop, but also from outfits like NASA and the NSF. Institutions that are, in addition to everything, implicitly educational. By partnering with Alleyoop, those outfits get to do some additional outreach -- and to an audience that is of particular interest and value to them: young people.

With its new science and math content, LaFond notes, Alleyoop is hoping to put STEM subjects into a context that may have career implications for students. The new content is video-heavy; much of it is designed to entertain kids as much as it is education them. So "there's a little bit of an App Store aspect to our partner network," LaFond says: The most popular content rises to the top, informed by user selections. And that, in turn, helps inform Alleyoop about student preferences and tendencies -- both individually, and as a cohort. The collaborations with NASA -- specifically, its eClips arm, which produces educational videos -- and with its fellow institutions are trying to take STEM learning out of its traditional context (the classroom, the lecture, the lab) and redistribute it in a form that appeals to kids' habits of online exploration.

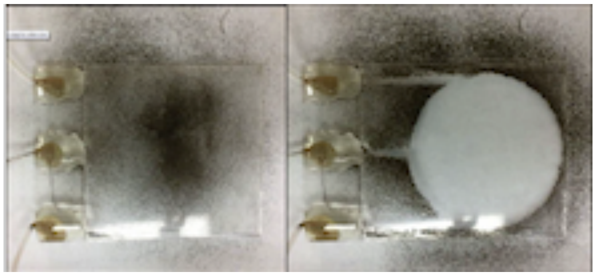
"Multimedia is a powerful way to engage students in STEM," says Rebecca Jaramillo, senior educator with the Center for Integrative STEM Education at the National Institute of Aerospace. In producing NASA's eClips, she says, "our goal is to help students see themselves as scientists and engineers." ##

Hawaii High School Students to Shoot for the Moon

http://pacificspacecenter.com/wp-content/uploads/2015/01/Jan-2015-Newsletter.pdf

The Pacific International Space Center for Exploration Systems (PISCES) has signed a non-reimbursable Space Act Agreement with NASA's Kennedy Space Center (KSC), formally establishing a partnership to jointly work on a Hawaii high school STEM (science, technology, engineering, and mathematics) project that will give students the opportunity to develop a space experiment and send it to the surface of the Moon.

The experiment involves electrodynamic dust shield (EDS) technology (pictured to the right, repelling dust). Under the Space Act Agreement, KSC will mentor the selected Hawaii students. This includes consulting with them on the physics of the EDS; the design, development, and construction of mounting and integration hardware; and testing and analysis of a flight experiment configuration.



Courtesy NASA. Above: A dusty surface shown before (left) and after (right) an electric current is applied using the electrodynamic dust shield.

In return, Hawaii high school students will provide their design and test data to KSC, which could benefit KSC research and design efforts in the area of dust mitigation.

PISCES will help the students construct a lunar lander mockup spacecraft, install and mount the EDS on it, and provide students the use of the Center's planetary analogue site on the Big Island of Hawaii so they can test their experiment before launching it to the Moon.

Dust is a major problem on the Moon because it interferes with and damages space equipment. KSC developed the EDS to remove the dust, but the technology has yet to be tested on the Moon. If this Hawaii high school experiment is successful, to our knowledge, it will be the first time in history that a student experiment has ever been conducted on the lunar surface.

The target date for the launch of this experiment is the end of 2016. ##

NYC Students Compete for Chance to Fly Experiments to Space Station

FEB.17, 2015 - www.space.com/28574-**student-space-station-experiment-contest**.html

The Intrepid International Space Station Challenge (I^2S^2C)

Testing the effects of microgravity on a system.

Inspired by the dream of seeing their work soar into space, 195 students in New York City are competing for the chance to put a science experiment aboard the International Space Station.

- The Intrepid Sea, Air and Space Museum in New York is hosting the new competition for middle school students in the public school system.
- Fifty groups of 3-5 students each will submit proposals for experiments to test the effects of micro-gravity.
- In May, one group will be selected to have their experiment delivered to the Space Station, there to be carried out by the Station crew.
- At a kick-off event for the contest at the Intrepid museum, the competing students had the opportunity to participate in microgravity workshops, and ask questions about an astronaut's time in space.
- The contest is being conducted in partnership with the **Student Spaceflight Experiments Program (SSEP)** and The Ramon Foundation.
- The 195 participating students come from five New York City schools.
- The Student Spaceflight Experiments Program was launched in 2010 to provide students with the opportunity to design and propose experiments to fly in low Earth orbit, on the final flights of the space shuttle, and on the International Space Station.
- Recently, SSEP has worked in conjunction with private spaceflight company SpaceX to send student experiments to the station aboard the company's latest robotic Dragon capsule.
- Competing students will have until the end of April to submit a proposal for an experiment "designed deisgned to assess the impact of microgravity on a physical, chemical, or biological system
- The experiment must take place inside a 6-inch test tube, and not contain any materials that could pose a hazard to the astronauts.
- After the proposals are submitted in April, a panel of judges will select three finalists.
- The winner will be selected by members of the Student Spaceflight Experiments Program, and will need to be approved by NASA before it can go into orbit.
- To learn more about the Student Spaceflight Experiments Program, visit: http://**ssep.ncesse.org**/.##

A Portable Analog Moon Base Design for School Gyms/Basketball Courts – Inexpensive, Easy to Duplicate, Easy to Relocate

By Peter Kokh, Milwaukee Lunar Reclamation Society (Wisconsin, USA)

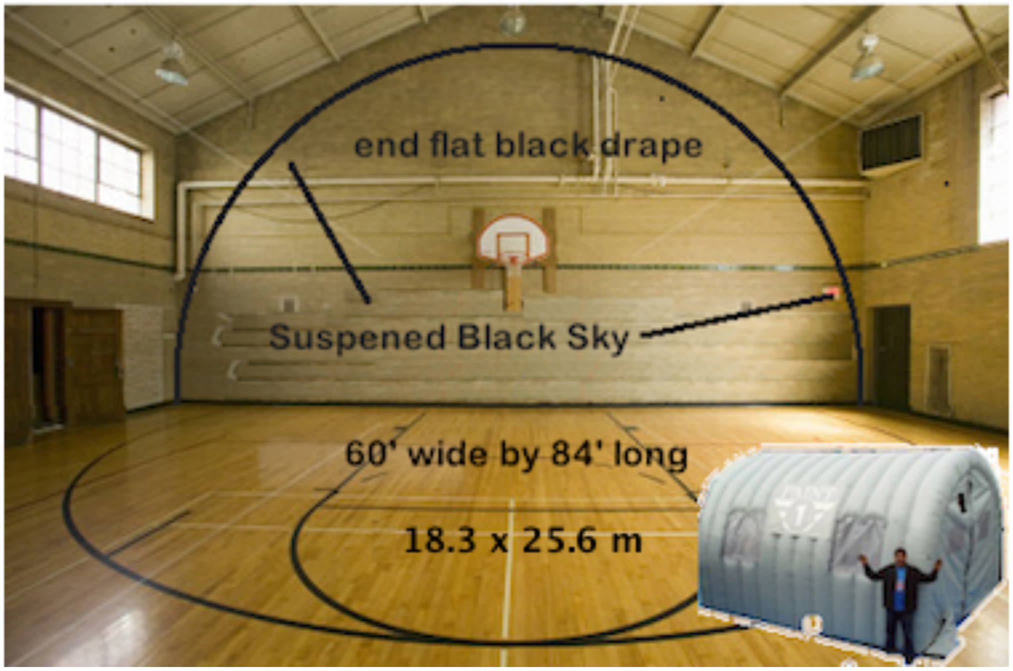


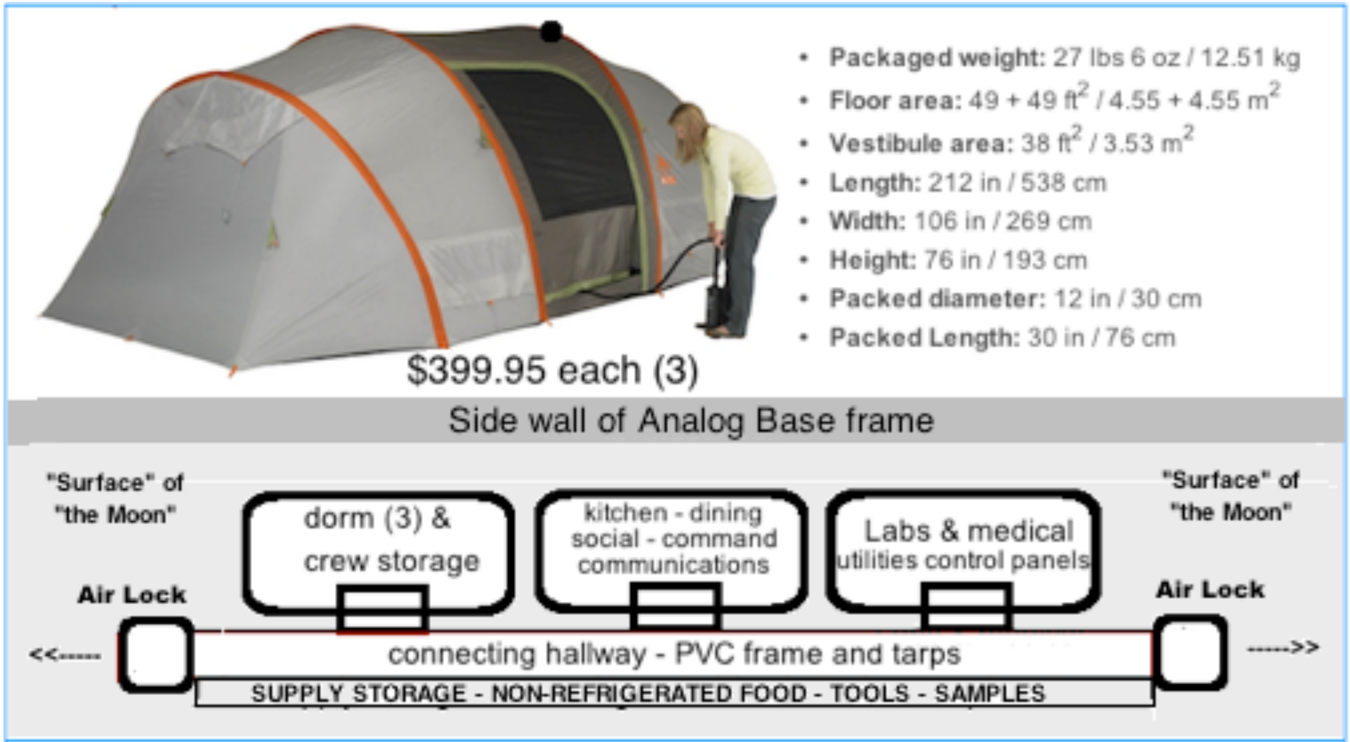
ILLUSTRATION of Quonset Shaped Hung Ceiling (Black Lunar Sky) with possible "stars" & "Earth" overhead

- U.S. School Gyms / Basketball Courts provide **a standard size 60 'x 84' (18.3 x 25.6 m)**
- A **suspended curved flat black canvas inside a high school gym** to create the black sky and cut off views of terrestrial horizons, with black end caps – it could be attached to a topside colapsable pipe framework.
- **Designing an inexpensive, easy to assemble and disassemble framework kit could be the goal of a student design competition with qualified architects as jusges**
- With **a smaller inflatable quonset for the hab on the "surface" or a modular tent complex**

  >> see next page for another, less expensive, and more adaptable idea
- **Earth and stars moving across the "sky'** projected by device in {a) "hill(s)" on the "surface" floor
- Since high school gyms are pretty much the same basketball court size, **such a setup could be put up almost anywhere and move around from school to school, district to district.**
- We'd need **corporate money**, but that might be doable, as could be **a Kickstarter fundraising effort**.
- A movable "lunar surface" (rocks, small hills, etc.) for gym floors and this itself could be the object of a student design contest as could be the interior outfitting of the "hab" and surface vehicles
- With windows blocked, It would be **easy to simulate the two week long lunar dayspans and nightspans**
- **Outfitting the "hab"** with inexpensive, movable fixtures should be easy too.
- A google image search for inflatable hangars, inflatable quonsets, etc.

  http://forum.monolithic.org/viewtopic.php?f=4&t=350&start=45

  http://www.ffti.com.au/wp-content/gallery/3-1-6-acd-air-shelter/acd-air-shelter-inflatable-hangar.jpg
- **This setup could be easily copied and/or modified by others.**
- This is a crude design, and we'd need help designing a real one that could work in many standard gyms
- Junior High Schools and Middle Schools would be best (**most receptive students – ready to be enthused, and not yet distracted as they will be in senior high schools)**
- An electric vehicle that took student astronauts from the "entrance" to the hab and to other "surface" points.
- Could be **a "summer school} project, so as not to interfere with scheduled gym use**.
- Two schools each summer, one urban, one suburban or rural
- Afrer a few years, start the cycle tour over, from school to school
- **Could this work in your city?**
- **An Inexpensive "<u>Modular</u> Hab Complex" design suggestion below:**



Tent information: http://www.kelty.com/p-759-sonic-8.aspx?category=tents-shelters

This “modular” setup would not only be cheaper than an “all-in-one” manufactured “caravan/camper” as well as easier to modify to suit special uses, as well as to teach the benefits of modularity.

Further, the complex above is “growable” when and if planned activities demand. P.S. Need Port-a-potty

The Goals:

- Design the “sky” frame and suspended fabric so that it is easy to erect, take down, package, ship, and setup at another location, in the same area or elsewhere
- Design a lunar or Martian “surface” – with lightweight movable “rock outcrops” for sense of reality
- Reach as many “still impressionable” younger students as possible and get them interested in the exploration of the Moon and Mars

The Target:

- Middle School, Junior High School, or equivalent students, still impressionable -- not yet adrift in the current “Smart Phone” addicted sub culture with ADHD – “Attention Deficit Hyperactivity Disorder!”

Financing Sources:

- State or Province School Systems
- Major Aerospace Contractors
- Other industries with relevant operations
- Individual supplier companies of parts and items needed kokhmmm@aol.com
- **Kickstarter campaign** to purchase the bulk of needed equipment

Advertising

- Student newspapers
- Cell Phone Apps for the program
- Video presentations
- Design competitions for the facilities and for equipment needed

Your Input wanted:

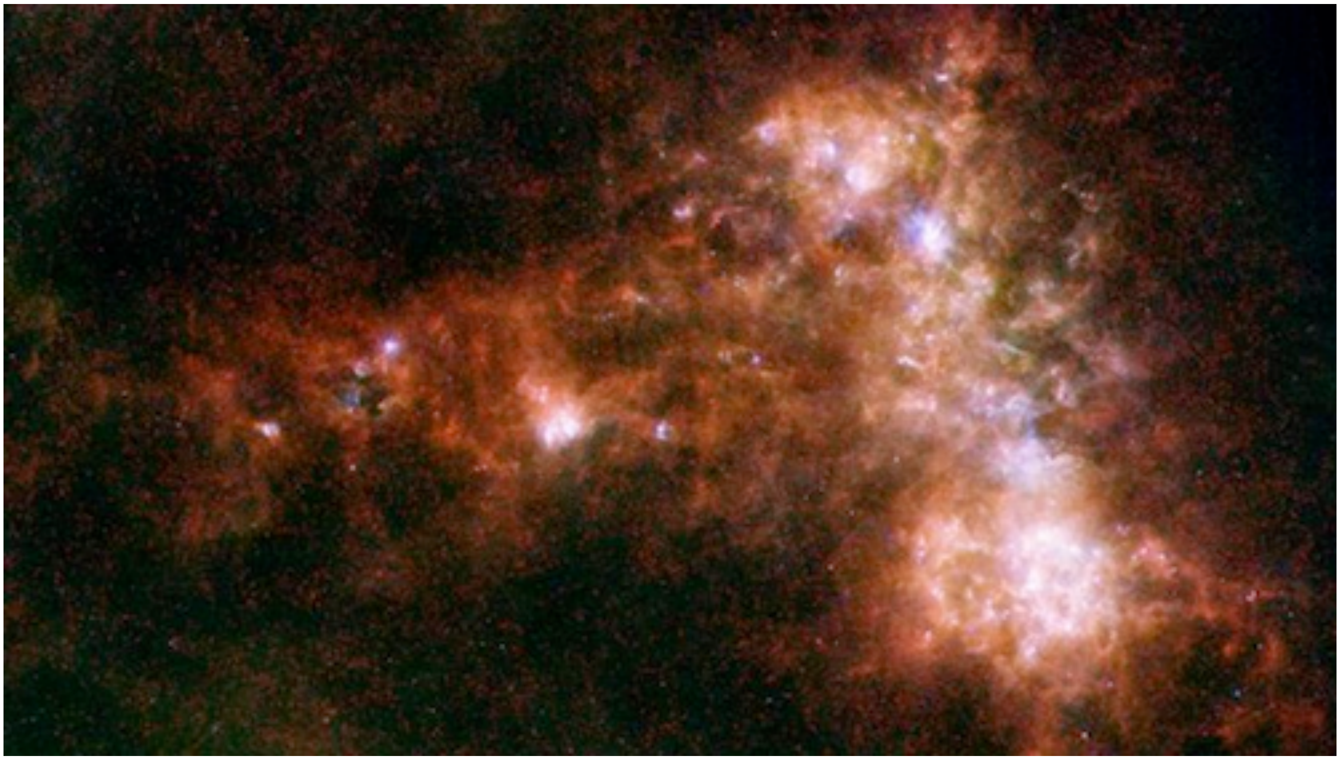
- The brainstorming of this concept is still fluid, open to improvements. Do send us your suggestions.
- If you have constructive additions, alternatives, etc., we would like to see them. We could create a website for this purpose – sharing ideas.
- If you think this idea is impractical, we’d like to have your feedback.

Write kokhmmm@aol.com subject line: “**Movable Gym Analog Outpost**”

What Would our Milky Way Galaxy Look Like from Nearby?

A Challenge to Student Teams to "compose" a Milky Way "Selfie"

By Peter Kokh



Above: Herschel and Spitzer telescopes team up to view the **Small Magellanic Cloud ("SMC")**, an irregular dwarf satellite galaxy of the Milky Way visible from southern latitudes. http://en.wikipedia.org/wiki/**Small_Magellanic_Cloud**

The Challenge - a chance to take a Milky Way "Selfie": Given that the SMC location in the Constellation Tucana at Right Ascension 00^h 52^m 44.8^s and Declanation $-72°$ 49′ 43″, **how would our parent Milky Way Galaxy appear from the SMC?**

This won't be easy, but it should be possible.

Helpful Hints

If you have access to a celestial globe, turn it so that the south pole is facing you. Look for the constellation Tucana and find the Small Magallenic Cloud. Take a string or shoestring, hold one end over the SMC, and then, after you have located the constellation Sagitarius, the direction in which the "hub" of our Milku Way galaxy lies, move the string so it passes through that point, and mark that on the string. Then lay the marked string along the globe's equator to determine how many degrees the Milky Way galaxy is "open" as seen from the SMC. We got approximately 47° - roughly half of the 90° of a view from directly overhead. To someone in the SMC, the Milky Way will present a more open appearance than the Andromeda galaxy does for us, half the apparebt height as its apparent width

Right: Celestial Globe - **Center:** Andromeda Galaxy - **Right:** a galaxy (NGC 2903) (reshaped to a 45° angle by the editor) - as our galaxy might look from the Small Magallenic Cloud

Keep in mind, that the distance of the SMC is not great, only about 200,000 light years from our location, about twice the width of the Milky Way, so that our home galaxy seen from the SMC should span half the distance from horizon to horizon, about 90°, and its height about half that. In comparison, the Andromeda Galxy spans only about 3 degrees in northern skies.

Now for our "more open galaxy" shown above right, we just grabbed a photo, not having a way to determine exactly how one at a 47° angle would look. In which direction will the arms (we can expect two) extend outward from the hub? Use the track of the Milky Way on the celestial globe as a cue.

The Challenge does not end there. How big will the Milky Way "hub" look compared to its arms? At what angles will the two arms appear to diverge from the hub? In which direction? (right? Left?) In the sky of the SMC, our galaxy should span 90° – half the distance from horizon to horizon, awesome!

Size comparisons (Actually, "mass" comparisons)

> http://en.wikipedia.org/wiki/Andromeda_Galaxy "Andromeda Galaxy is estimated to be 1.5×10^{12} solar masses, while the mass of the Milky Way is estimated to be 8.5×10^{11} solar masses." "The 2006 observations by the Spitzer Space Telescope revealed that M31 contains one trillion stars: at least twice the number of stars in the Milky Way, which is estimated to be 200–400 billion."

This means that we cannot expect the Milky Way to look as grand from the SMC as Andromeda does to us. On the other hand, the distance to the SMC is only a small fraction of the distance of M31 Andromeda is from us, so we can expect much more detail.

A follow-up challenge?

If we get good results from this challenge, TTSIQ may issue a follow-up challenge:
"**What would our Milky Way look like from the vantage point of M31**, the great Andromeda Galaxy?" (Surely, there are any number of civilizations in that galaxy looking at the galaxy (ours) that is going to collide with them someday. What do they see? This collision will be slow enough that there should be few dire consequences for civilizations thriving in both galaxies during this collision/merger period.)

Galaxies will collide at every imaginable angle. even at millions of kilometers per hour, the process will take a long time. Inhabited planets of both will likely survive.

Prizes?

While we are not in a position to offer monetary prizes, we will spread the word – and the artwork – far and wide! That you will know that many young people will see the results and be inspired, should be reward enough.

If you have an idea for a prize, monetary, memberships, sculptures, whatever – lets hear it.

P.S. Is it likely that many civilizations – in whatever galaxy – will name the thick band of stars circling their heavens "the Milky Way" – assuming that they are mammals, of course? "Milky Way" might be a generic name, when you come down to it.

Homework: What is the name for our galaxy in other languages? "Milky Way" in translation? But what about languages of peoples not exposed to Europen culture until long after they had settled on their own name for this great band of stars around our heavens?

In the Navaho language the common word is **Yikáísídáhí** (It Waits For Dawn) It represents tádídíín (corn pollen) that is sprinked when traditional Navajos pray in the morningd .

Find some other cases where the name does not translate to "Milky Way?" Let us know!

- Of possible interest: www.space.com/28643-**giant-star-eta-carinae-3d-printing**.html

List of Recent Feature Articles and Essays in Our Sister Publications

Ad Astra [Latin (ancient Roman): “To The Stars”]
Sent to all National Space Society Members as a primary membership benefit
(with choice of print hardcopy or downloadable pdf file)

SPRING 2014 issue

- **12 The Other Suborbital Market: Commercial and Research Payloads** – Clifford R. McMurray
- **16 Chasing the Dream** – Mark Williamson
- **22 Reducing the Risk of Long Duration Spaceflight** – Marianne Dyson
- **28 Equilibrium: Astronauts Relearn How to Plant Feet on the Ground after Long Duration Spaceflight** – – Travis K. Kircher
- **32 EFT-1: a Perfect Flight but What Comes Next?** – Bart D. Leahy
- **36 A Chance Encounter: What a Passing Comet can Teach us about Mars** – Roxanne Elliott
- **40 One Grain in a Field of Millet** – Lance Fraxer
- **42 Enterprise in Space is Changing Science Fiction into Science Fact** – Bryan Jones
- **45 Constructing Space Habitats: The National Space Society’s Roadmap to Space** – Lynne F. Zielinski
- **46 A Tale of Two Space Settlement Bills** – Steve Wolfe
- **47 The Implications of 3D Printing for Space Settlements** – Mark M. Hopkins
- **48 2001: The Heritge and the Legacy of the Space Odyssey** – Ted Spitzmiller

www.MMM-MoonMinersManifesto.com

FEBRUARY 2015 – MMM #282

3-8. **Making it on the Moon: Bootstrapping Lunar Industry** – Dave Dietzler
Site Preparation; Early Development; Excavating
Materials Production: Cast Basalt, Sintered Basalt, Spun Basalt (fibers),
Manufacturing, Solar Panels, hypothetical materials, loads of __

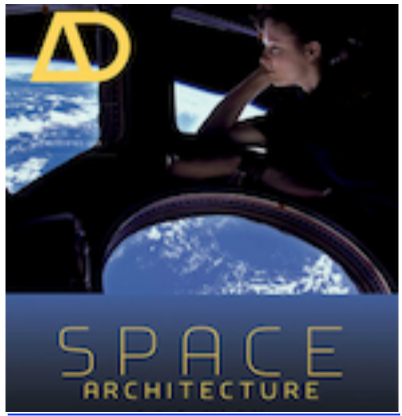
MARCH 2015 – MMM #283

2. **In Focus: We’ve put off learning to fly on Mars long enough** – Peter Kokh
4. **Why the Hellas Basin should take priority** as site for the first lunar outpost
5. **What we need to do to gain Worldwide Support for the Opening of Mars**
6. **What the “Mars One Project” must do if it is to succeed**

APRIL 2015 – MMM #284

2 **In Focus**: **Radical Moon-Mars Differences affect Analog Research Directions** – Peter Kokh
3 **An Analog Moon Outpost inside a modified Airliner Hangar** – Peter Kokh
6 **Proposed Moon/Mars Outpost Analog Projects & Earth Day** – Peter Kokh
7 **Yuri’s Night – The courage “to go where no man has gone before”** – Peter Kokh
8 **3D Printing may not be the instant Boost to Settlement that many hope** – Dave Dietzler

THE book WORM



Space Architecture: The New Frontier for Design Research

www.wiley.com/WileyCDA/WileyTitle/productCd-1118663306.html

Neil Leach (Editor)   ISBN: 978-1-118-66330-1   136 pages   January 2015

Description: Forty years on from the first Moon landing, architecture in Space is entering a new era. Over the last decade, there has been a fundamental shift in the Space industry from short-term pioneering expeditions to long-term planning for colonisation, and new ventures such as Space tourism.

Architects are now involved in designing the interiors of long-term habitable structures in Space, such as the International Space Station, researching advanced robotic fabrication technologies for building structures on the Moon and Mars, envisioning new 'space yachts' for the super-rich, and building new facilities, such as the Virgin Galactic 'Spaceport America' in New Mexico designed by Foster + Partners.

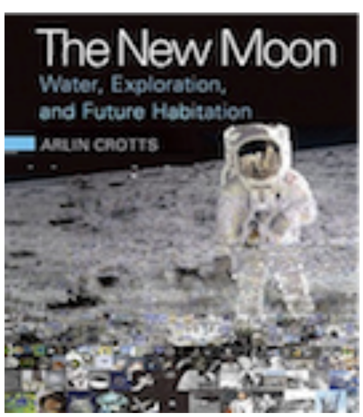
Meanwhile the mystique of Space remains as alluring as ever, as high-profile designers and educators - such as Greg Lynn - are running designs studios drawing upon ever more inventive computational design techniques.

This issue of AD features the most significant current projects underway and highlights key areas of research in Space, such as energy, materials, manufacture and robotics. It also looks at how this research and investment in new technologies might transfer to terrestrial design and construction.

Contributors inc: Anders Carlson, Anita Genupta, Behrokh Khoshnevis, Sandra Häuplik-Meusburger.

Space architects: Constance Adams, Marc Cohen, Ondrej Doule, Scott Howe, Brent Sherwood, John Spencer, **Madhu Thangavelu**, Andreas Vogler.

Architects: Bevk Perovic Arhitekti, Dekleva Gregoric Arhitekti, Foster + Partners, Neil Leach, Greg Lynn, OFIS architects, SADAR + VUGA. ##



Review: The New Moon By Arlin Crotts

The New Moon: Water, Exploration, and Future Habitation (Amazon.com listing)

Cambridge Univ. Press, 2014 - hardcover, 522 pp., illus.   ISBN 978-0-521-76224-3 - US$39.99

Space Review Reviewer, Jeff Foust - www.thespacereview.com/article/2660/1

Moon Miners' Manifesto Resources

http://www.moonsociety.org/chapters/milwaukee/mmm/

MMM is published 10 times a year (except January and July. The December 2011 issue began its 26th year of continuous publication.

Most issues deal with the **opening of the Lunar frontier**, suggesting how pioneers can make best use of **local resources** and learn to **make themselves at home.** This will involve psychological, social, and physiological adjustment**.**

Some of the points made will relate specifically to **pioneer life** in the lunar environment. But much of what will hold for the Moon, will also hold true for **Mars and for space in general.** We have one Mars theme issue each year, and occasionally **other space destinations** are discussed: the asteroids, Europa (Jupiter), Titan (Saturn), even the cloud tops of Venus.

Issues #145 (May 2001) forward through current are as pdf file downloads with a Moon Society username and password. Moon Society International memberships are $35 US; $20 students, seniors – join online at:

http://www.moonsociety.org/register/

MMM Classics: All the "non-time-sensitive editorials and articles from past issues of MMM have been re-edited and republished in pdf files, one per publication year. A 3-year plus lag is kept between the MMM Classic volumes and the current issue. **As of December 2011, the first twenty-two years of MMM, 200 issues, will be preserved in this directory,** These issues are freely accessible to all, no username or password needed, at:

www.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 to join our team.

If you think that you can add to the usefulness and vitality of this publication, in any of the ways listed above, or in fields we had not thought of, write us at: ttsiq@moonsociety.org [goes to the whole editorial team]

Tell us about yourself; your interest in space, and how you think you can make this publication of real service in the education of the public, and in the education of young people on whom the future of the world rests.

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