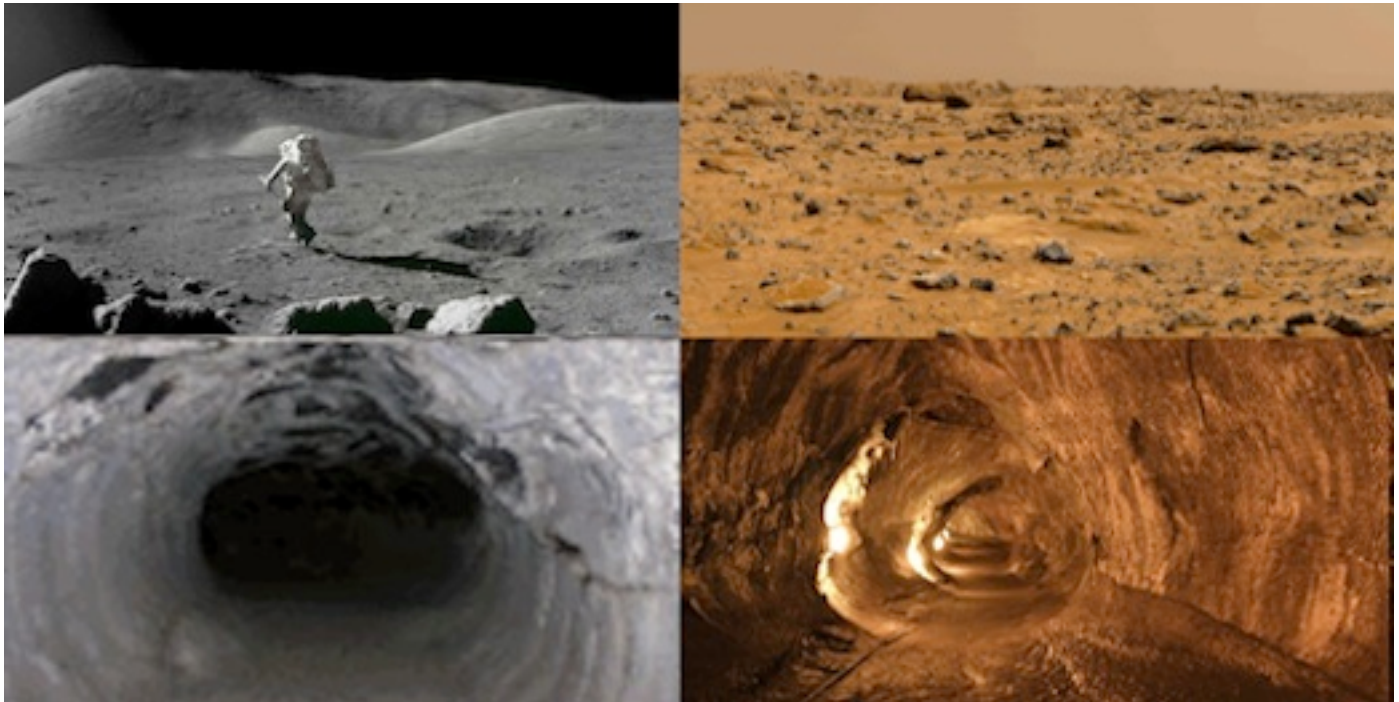


**"Towards an Earth-Moon Economy - Developing Off-Planet Resources"**

# Moon Miners' Manifesto

India Quarterly Edition [www.moonsociety.org/india/mmm-india/](http://www.moonsociety.org/india/mmm-india/)

**There is more to the Moon and Mars than just what we see "on the surface"**  
Lava Tubes on both worlds could someday provide radiation-free settlement space for millions of pioneers

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

**Our Vision says Who We Are** – We envision a future in, which the free enterprise human economy has expanded to include settlements on the Moon and elsewhere, contributing products and services that will foster a better life for all humanity on Earth and beyond, inspiring our youth, and fostering hope in an open-ended positive future for humankind.

**Moon Society Mission** – Our Mission is to inspire and involve people everywhere, and from all walks of life, in the effort to create an expanded Earth–Moon economy that will contribute solutions to the major problems that continue to challenge our home world.

**Moon Society Strategy** – We seek to address these goals through education, outreach to people of all ages, through contests & competitions, workshops, ground level research and technology experiments, private entrepreneurial ventures, analog research and other means. **We collaborate with Mars-focused and other space organizations.**

**About Moon Miners' Manifesto** <http://www.moonsociety.org/chapters/milwaukee/mmm/>

MMM is published 10 times a year The December 2011 issue began its 26<sup>th</sup> 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 available as pdf file downloads with a Moon Society username and password. International memberships are \$35 US; \$20 students, seniors

– join online at: <http://www.moonsociety.org/register/>

**MMM Classics:** All the “non-time-sensitive 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. These issues are freely accessible at: [www.moonsociety.org/publications/mmm\\_classics/](http://www.moonsociety.org/publications/mmm_classics/)

**MMM Theme Issues:** The same material has been reorganized in **14 Theme Issues**, also freely downloadable at: [http://www.moonsociety.org/publications/mmm\\_themes/](http://www.moonsociety.org/publications/mmm_themes/)

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**About MMM–India Quarterly** – <http://www.moonsociety.org/india/mmm-india/>

This publication was launched with the August 2008 issue. This issue begins our 5th year. The Moon Society was founded as an International organization, but has few members outside the US, mostly solitary and unorganized.

**Background** – The Moon Society and The Planetary Society of Youth (TPSY) in India, [www.youthplanetary.org/](http://www.youthplanetary.org/) in December 2003, put together a "Design a Mission to the Moon" category in TPSY's student design contest -- "A Mission to the Moon and Beyond." The contest was designed to help students learn about various objects in the solar system as they compete in the design of a mission. [www.youthplanetary.org/moon\\_mission\\_contest.html](http://www.youthplanetary.org/moon_mission_contest.html)

**Why an MMM – India Quarterly?** – India is a very populous country, and one in which, through the heritage of the British Raj, English is the almost universal medium of higher education. English-fluent Indians now outnumber English speakers in the United States. More books are published in English in India than in any other country. And – **India has now gone to the Moon and will soon be headed to Mars.**

We want to share with space-interested and space-enthused people in India, our vision of the possibilities for Exploration and Utilization of the Moon, development of lunar resources, not just to support a permanent population on the Moon, but to help better address chronic clean energy supply problems on Earth and to help slow and reverse our home planet's environmental degradation in the process. In short, we would like to share our glimpse of an emerging greater Earth–Moon Economy.

This vision was well-expressed by the former President of India, Dr. A. P. J. Abdul Kalam in a speech at The Symposium on “The Future of Space Exploration: Solutions to Earthly Problems” to mark the occasion of the 50th Anniversary of the dawn of Space Age, Boston University, Boston, MA, April 12, 2007. In this speech, Dr. Kalam made the point that to fully industrialize and become an equal partner in the future of our planet, India needs to access the unlimited clean undiluted solar energy available in space. We agree with this bold vision and want to share it with the forward-looking people of India.

**Free Access:** MMM–India Quarterly issues are available as a free access pdf file, downloadable from the address above. We encourage readers to share these files with others freely, and to use this publication to grow and cultivate wide-spread interest in the open-ended possibilities of space among the people of India, and to encourage the rise of additional citizen support space organizations within the country.



## TO THE EDGE OF SPACE

### Space-Diving Suit in Development

<http://www.space.com/21370-space-diving-suit.html>

<http://www.universetoday.com/102289/revolutionary-new-space-diving-suit-will-rival-anything-youve-ever-seen-in-the-movies/#ixzz2UnlBqyQ3>

[Editor's summary. For the full article see the link(s) above]



A futuristic space-suit being developed will take the high altitude adventurer of tomorrow from the total vacuum of outer space, through the searing heat of atmospheric reentry, then down to a pinpoint landing on Earth's surface that even Elon Musk would be envious of and one that Tony Stark, the "Iron Man" himself, would be totally familiar with.

Two start-ups, Juxtopia LLC and Solar System Express are combining their respective talents to assemble The RL MARK VI Space Diving Ensemble — hardware that, until now, only a bona fide superhero could truly appreciate. And, with this collaboration will come the ability for future space travelers — both in emergency situations and in recreational pursuits — to exit a spacecraft in low-earth orbit, reenter the earth's atmosphere and return safely back to the ground.

Juxtopia's augmented reality goggles will feed tomorrow's space diver with a visual display of all the vital information he will need to successfully navigate his way back to the surface of the planet. A pair of gyroscopic boots from Solar System Express will steady the jumper's descent through the upper atmosphere until the air becomes thick enough for aerodynamic control.

After several traditional parachute test jumps, a production model of the RL MARK VI **should be ready in 2016**. A hi-tech ensemble consisting of augmented reality goggles, power gloves, control moment gyros, and a low-cost commercial space suit, the RL Mark VI will allow future thrill seekers and space tourists an experience that up until now could only be imagined in the boldest science fiction.

Space diving would allow spaceflight participants a means of escape from a possibly disastrous on-orbit emergency, or perhaps just a new recreational activity for those no longer satisfied with merely jumping out of aircraft. The RL MARK VI would allow high-altitude jumps from near-space, suborbital space, and eventually low Earth orbit itself.

While the first few flight tests of the MARK VI hardware will follow a profile very reminiscent to that of the recent record-breaking Red Bull Stratos dive of Felix Baumgartner, who plunged through the stratosphere for a soft parachute touchdown back. But the ultimate goal of this futuristic project is far more radical than that. Eventually, through the use of modern "wing suit" skydiving technology and assisted by miniature aerospike engines attached to specially designed footwear, the space diver will end his spectacular glide with a propulsive, power-assisted landing on two feet. No parachute.

Juxtopia's AR Goggles will provide the space diver with a continuous stream of vital information that will keep him on course and within safe life-support parameters throughout the duration of his jump. Instruments will tell the jumper his heart rate, respiration, internal space suit temperature, and his external temperature as well. They will provide data on GPS location, elevation, and rates of acceleration and deceleration. ##

## New non-toxic "Energetic Ionic Liquid" Rocket Fuel to Help NASA 'Go Green'

<http://www.space.com/21185-new-rocket-fuel-helps-nasa-go-green.html>

[Editor's summary. For the full article see the link above]

May 16, 2013 – Since the beginning of the Space Age, rockets used hydrazine to propel them. In terms of raw power, hydrazine is highly flammable and throws off an enormous amount of heat.

But hydrazine is also highly toxic, both when inhaled and when it makes contact with human skin, and its flammability makes it very difficult to transport and handle. Burning it pollutes the atmosphere.

After years of research, scientists from the US Air Force Office of Scientific Research have found a replacement fuel that is not only safer than hydrazine, but also environmentally friendly and more efficient as well.

The new propellant is an energetic ionic liquid, or EIL. Ionic liquids are salt compounds in a liquid form whose molecules have either a positive or negative charge, which bonds them together more tightly and makes the liquid more stable and both safe and easy to handle.

Before now, known ionic liquids weren't very "energetic." They didn't produce a high amount of energy when combusted. But after a career of research into energetic ionic liquids by Tom Hawkins of the Air Force's Rocket Propulsion Division, this research has finally yielded concrete results.

The propellant, whose most recent iteration's technical name is AF-M315E, has all the desirable properties of an EIL: It's a liquid, and because it has a low vapor pressure (meaning it evaporates slowly) it's more stable and far less flammable than fuels like hydrazine. It's also easy to handle — "less toxic to humans than caffeine."

It's also "green" because when combusted, M315E only throws off nontoxic gasses like water vapor, hydrogen and carbon dioxide.

The main ingredient is **hydroxyl ammonium nitrate**. The latter part of that compound may sound familiar — ammonium nitrate is commonly used as a fertilizer in the United States. It's also potentially explosive. But ammonium nitrate is not the same substance as hydroxyl ammonium nitrate. By adding the hydroxyl group to the molecule, the compound's melting point drops by more than 100 degrees Celsius, which puts it in the realm of ionic liquids.

This green propellant is actually very difficult to ignite, but this makes it much safer to handle, and when it is ignited, the propellant burns far hotter than previous propellants — so hot, in fact, that it will damage the engines currently in use aboard NASA spacecraft.

"Now we need better materials [for engines] that can handle the temperatures generated," said Michael Berman, a program manager at the Arlington, Va., Air Force Office of Scientific Research where Hawkins conducts his research.

The task of designing an engine that can handle EILs has been awarded to **Ball Aerospace and Technologies Corp.** The first flight test for a rocket outfitted for the green propellant will be in 2015. If successful, energetic ionic liquids like M315E could be the fuel that ushers in a new age of manned spaceflight to the Moon, Mars and possibly beyond.

(And those of us space supporters who are dedicated environmentalists, can hold our heads higher!) PK

## NASA Commercial Partner Orbital Sciences Test Launches Antares Rocket

<http://www.orbital.com/SpaceLaunch/Antares/>

<http://www.space.com/20708-antares-rocket-5-surprising-facts.html>

<http://www.space.com/20526-antares-rocket-cygnus-spacecraft-explained.html> (images)

<http://www.space.com/15252-photos-antares-rocket-cygnus-spaceship-orbital-sciences.html>

[Editor's summary. For the full articles see the links above]



Antares is a two-stage launch vehicle designed to provide responsive, low-cost, and reliable access to space for medium-class payloads weighing up to 6120 kg. Initially developed to demonstrate commercial re-supply of the International Space Station under a NASA Commercial Orbital Transportation Services (COTS) contract, the Antares launch system will provide cost-effective access to a variety of orbits for civil, commercial and military Delta II-class payloads. The first launch of Antares took place on April 21, 2013.

### System Features:

- Both solid and liquid stages and flight-proven technologies for medium-class missions
- Substantial payload performance in a variety of low inclination low-Earth and sun synchronous orbits and interplanetary trajectories
- 3.9 meter faring accommodates large payloads
- Streamlined vehicle/payload integration via simplified interfaces reduce time to lift-off
- Capable of launching single and multiple payloads
- Will complement Space-X Dragon flights in servicing the International Space Station

### Antares Rocket Links

<http://www.space.com/20712-private-antares-rocket-launch-success.html> 4/21

video - <http://www.space.com/20753-antares-rocket-test-flight-launches-from-wallops-video.html>

video - <http://www.space.com/17877-pushing-freight-to-space-station-antares-rocket-animation.html>

edit: <http://www.thespacereview.com/article/2282/1>

## 7-person commercial mini-space shuttle "Dream Chaser" to begin drop tests

<http://www.space.com/21208-dream-chaser-space-plane-testing.html> (includes video)

design features: [www.space.com/15366-dream-chaser-private-space-plane-infographic.html](http://www.space.com/15366-dream-chaser-private-space-plane-infographic.html)

[Editor's summary. For the full articles see the links above]



Since the 7-person Space Shuttle fleet retired, only 3 astronauts could arrive/depart the Space Station at a time, aboard a Russian Soyuz. Dream Chaser will also carry a full crew of 7, but will not have a large payload bay for cargo. Like the shuttle, it will take off vertically, and land horizontally on an airfield. This was the dream of Jim Benson of Space Dev, now Sierra Nevada. Benson died of brain cancer in late 2008 but his dream is becoming real.

<http://www.space.com/21340-dream-chaser-more-than-just-a-mini-shuttle-video.html>

## Space-X Chief Says Reusable First Stage Will Slash Launch Costs

<http://www.space.com/21386-spacex-reusable-rockets-cost.html>

<http://www.space.com/20782-spacex-grasshopper-rocket-photos.html>

[Editor's summary. For the full articles see the links above]

PARIS — SpaceX chairman Elon Musk said the company's Dragon capsule, now used to ferry cargo to the international space station, should be ready to carry astronauts to and from space within two or three years, and that he is more optimistic than ever that a partially reusable rocket will accelerate the reduction in launch costs that SpaceX has already created with its Falcon 9. Musk said SpaceX's success in building and launching rockets less expensively than established launch service suppliers is "an incremental, not a revolutionary" breakthrough. "Our aspiration is to have a revolutionary breakthrough."

Musk reiterated the origin of the SpaceX production model, saying fuel is only 0.3 percent of the total cost of a rocket, with construction materials accounting for no more than 2 percent of the total cost, which for the Falcon 9 is about \$60 million. Given that the rocket's constituent materials are such a small part of the total vehicle cost, he said: "Clearly people were doing something silly in how they put those materials together. By eliminating those foolish things, we were able to make a rocket for much less."

A rocket's first stage accounts for three-quarters of its total price tag, so a vehicle with a reusable first stage can be produced at far less cost — assuming the hardware is fully and rapidly reusable. SpaceX is developing a reusable first stage for the Falcon 9 under a the Grasshopper program.

Meanwhile, SpaceX's upgraded, but still expendable, Falcon 9 rocket is scheduled to make its inaugural launch sometime this summer from Vandenberg Air Force Base, California, US, carrying Canada's Cassiope science satellite into low Earth orbit. A series of Falcon 9 commercial missions that the company has booked. The date of the inaugural flight of the new Falcon 9 remains uncertain. Following a successful Cassiope launch, the new Falcon 9 is scheduled to begin commercial operations from Cape Canaveral Air Force Station, Fla. The SES-8 commercial telecommunications satellite owned by SES of Luxembourg will be the payload on Falcon 9's first flight to geostationary transfer orbit. The SES launch will be followed by the launch of Thai satellite operator Thaicom's Thaicom 6 telecommunications satellite.

After Thaicom, SpaceX has scheduled the launch, this time into low Earth orbit, of the first batch of satellites for Rochelle Park, N.J.-based Orbcomm's machine-to-machine messaging satellite constellation.

## Solar Sail Deployment System tested on Cube-Sat on Zero-G flight

<http://www.space.com/20899-cubesat-sail-deployment-tested-on-zero-g-flight-video.html>

**Paper-Folding Trick May Help Tiny Satellites Use Sails in Space**

<http://www.space.com/20917-tiny-satellites-space-sails.html>

[Editor's summary. For the full articles see the links above]



**Left:** deployment on Zero-G Flight **Right:** special way solar sail is folded to fit inside 10x10x cm cube sat

A simple paper-folding technique could help tiny satellites unfurl big sails in space to detect micrometeoroid impacts, scientists say. The folding trick could be used to pack relatively large sails into 10cm x10 cm miniature "cubesat" satellites known as Cubesats. When the sails pop out, they could provide a bigger area to catch meteoroid impacts. "It's like putting a bigger windshield on your car to catch more bugs," said study co-author Nicolas Lee, an aerospace engineer at California Institute of Technology.

## ESA: Bed rest Simulation of Longterm Effects of Weightlessness

[http://www.esa.int/Our\\_Activities/Human\\_Spaceflight/Bedrest\\_studies/Bedsuit](http://www.esa.int/Our_Activities/Human_Spaceflight/Bedrest_studies/Bedsuit)

[http://www.esa.int/Our\\_Activities/Human\\_Spaceflight/Bedrest\\_studies](http://www.esa.int/Our_Activities/Human_Spaceflight/Bedrest_studies)

[Editor's summary. For the full articles see the links above]



This 'pillonaut' might not have his feet on firm ground, but he is simulating spaceflight by spending three weeks in bed. Thanks to the fact that our bodies adapt to long periods spent lying in bed **at 6° below the horizontal** as if they were flying in weightlessness, we can this process on bedrest volunteers a lot cheaper and easier than collecting information on astronauts. Muscles and bones waste away and when a mission or bedrest campaign ends, the body needs many days to return to form.

Finding ways to counteract negative effects to spaceflight is vital for astronauts on long-duration missions as well as for bedridden people on Earth.

The mask in this photo above is part of a system to estimate energy requirements by measuring how much oxygen is consumed and how much carbon dioxide is exhaled by the volunteer. The data allows scientists to get an idea of the relationship between food, the lungs and the energy consumption at rest.

This ESA bedrest study was held in Toulouse, France, in cooperation with the French space agency CNES. The University of Bonn is interested in seeing if a high-protein, high-salt diet combined with exercise could combat bone and muscle loss and insulin insensitivity. ##

## SpaceShipTwo Rises On A Tail Of Fire

<http://www.space.com/20873-spaceshiptwo-rises-on-a-tail-of-fire-video.html>

<http://www.space.com/20869-spaceshiptwo-first-rocket-test-photos.html>

<http://www.space.com/13296-photos-virgin-galactic-spaceshiptwo-test-flights.html>

[Editor's summary. For the full articles see the links above]



Photo at left taken from SpaceShipTwo Boom Camera during first rocket-powered flight, April 29, 2013, over the Mojave Desert, California



<http://www.space.com/20886-virgin-galactic-spaceshiptwo-ticket-prices.html> (\$200k>\$250k)

Designed to carry space tourists, SpaceShipTwo made its first rocket-powered test flight April 29th, reaching supersonic speeds. Virgin Galactic's space plane fired its rocket engines for the first time during flight this morning in a test from California's Mojave Air and Spaceport. The vehicle was carried aloft by the mothership WhiteKnightTwo, and then released in midair at an altitude of about 14,000 m (46,000 ft). Then it test fired its rocket engine, designed to propel the craft the rest of the way up to the accepted boundary of space at 100 km (60 mi) above Earth's surface.

After a short 16-second burn today, SpaceShipTwo reached a maximum altitude of 17,000 m (56,000 ft) before it flew back to Earth. The trip marked the 26th test flight of the vehicle, and the first "powered flight," which propelled the ship to Mach 1.2, fast enough to beat the speed of sound, which is 1224 km/h (761 m/h) at sea level.

With the expected burn duration, good engine performance and solid vehicle handling qualities throughout, Virgin Galactic president and CEO George Whitesides said that the company will now embark on a handful of similar powered flight tests, and then make our first test flight to space."

SpaceShipTwo is a suborbital vehicle, designed to carry space tourists on trips to the edge of space and back for \$200,000 a ride. These flights would provide passengers with a brief experience of weightlessness and a view of Earth from the blackness of space.

If test flights continue to go well, SpaceShipTwo may carry passengers as soon as later this year or in 2014, Virgin Galactic officials have said. Already, more than 500 people have signed up for the flights, which will be run out of Spaceport America in New Mexico once testing is complete. ##

## LOW EARTH ORBIT – SPACE STATIONS

### ESA's ATV Dubbed Albert Einstein off to the International Space Station

[http://www.esa.int/Our\\_Activities/Human\\_Spaceflight/ATV/Full\\_tank\\_please](http://www.esa.int/Our_Activities/Human_Spaceflight/ATV/Full_tank_please)

June 6 saw the launch of European Space Agency's (ESA) fourth Automated Transfer Vehicle (ATV), which lifted atop the Ariane 5 rocket from a spaceport in Kourou, French Guiana.



Dubbed Albert Einstein, the vehicle is the largest, most advanced and best among all the other vehicles servicing ISS. With a highly precise navigation systems, outstanding flight software and a self-monitoring and collision-avoidance system, no other vehicle servicing ISS has such a high level of autonomous control. It features independent power suppliers, control and thrusters. The ship will be managed by the ATV Control Center and operated by ESA and the French space agency CNES jointly.

As the Space Station circles Earth, it slowly loses altitude so ATVs reboost the orbit to keep it aloft. ATV's cargo includes propellants for the Station's own thrusters to keep the orbital outpost at the right height even when no spacecraft are there to offer a helping hand. ##



## 3D Printer Launching to Space Station in 2014

<http://www.space.com/20658-3d-printer-international-space-station-2014.html>

[http://www.nasa.gov/home/hqnews/2013/may/HQ\\_13-161\\_Made\\_in\\_Space.html](http://www.nasa.gov/home/hqnews/2013/may/HQ_13-161_Made_in_Space.html)

[Editor's summary. For the full articles see the links above]

A 3D printer is slated to arrive at the International Space Station next year, in August 2014, where it will crank out **the first parts ever manufactured off planet Earth**. The ability to 3D-print parts and tools on demand greatly increases the reliability and safety of space missions while also dropping the cost by orders of magnitude," **Made in Space** CEO Aaron Kemmer said in a statement.

The company is partnering with NASA's Marshall Space Flight Center on the #D Printing in Zero G Experiment (or 3D Print for short). The plan is to jump-start an off-planet manufacturing capability that could aid humanity's push out into the solar system. "The first printers will start by building test coupons, and will then build a broad range of parts, such as tools and science equipment,"

The 3D printer will tag along with a cargo mission SpaceX is launching to ISS for NASA. It will build objects layer by layer out of polymers and other materials, using a technique called "extrusion additive manufacturing." The blueprints for these objects will be pre-loaded onto a computer bound for the orbiting lab or uplinked from Earth.



3D printing should help make living in space easier and cheaper. More than 30 % of the spare parts currently aboard the International Space Station could be manufactured by Made in Space's machine. Niki Werkheiser, 3D Print project manager at NASA Marshall's Technology Development & Transfer Office, said "It will allow us to live and work in space with the same efficiency and productivity that we do on Earth, with the ultimate objective being to eliminate reliance on materials and parts launched from the ground."

The technology's potential goes beyond low-Earth orbit, and will be a critical enabler for NASA's exploration missions, beyond Earth orbit. NASA recently funded the development of a prototype 3D printer designed to make space food products out of cheap raw materials that have a long shelf life. This "3D pizza printer" could help feed astronauts on long space journeys, such as the 500-day trek to Mars.

California-based **Made in Space** was awarded a Phase 3 Small Business Innovation Research (SBIR) contract from Marshall for this mission, and the two organizations will work together to make it happen. The company tested out various 3D printing technologies in 2011 on parabolic airplane flights that produced short periods of weightlessness. While 3D Print is primarily a demonstration mission, Made in Space is also developing a more permanent space-printing capability called the Additive Manufacturing Facility that's expected to arrive at the orbiting lab in 2016. The Additive Manufacturing Facility will likely be used to build components for ongoing off-Earth experiments, Made in Space officials said.

## How 3D Printers Could Reinvent NASA Space Food

<http://www.space.com/21308-3d-printing-nasa-space-food.html>

[Editor's summary. For the full article see the link above]

Future astronauts may pull space pizzas from a 3D printer if a new NASA-funded project proves feasible. NASA officials confirmed this week that the space agency awarded \$125,000 to the Austin, Texas-based company Systems and Materials Research Consultancy (SMRC) to study how to make nutritious and efficient [space food](#) with a 3D-printer during long space missions. The project made headlines this week largely because of the first item on the menu: a 3D-printed space pizza.

See also: [http://denecs.usc.edu/hosted/ASTE/527\\_20111/Cosmic%20Synergy%20-%20Administration-Enterprise%20Alliance/ASTE%20527%202012%20Finals%20Section%2003%20-%20Space%20CAFE.pdf](http://denecs.usc.edu/hosted/ASTE/527_20111/Cosmic%20Synergy%20-%20Administration-Enterprise%20Alliance/ASTE%20527%202012%20Finals%20Section%2003%20-%20Space%20CAFE.pdf)



Because refrigeration and freezing require significant spacecraft resources, current NASA provisions consist solely of individually prepackaged shelf stable foods, processed with technologies that degrade the micronutrients in the foods. 3D printing will introduce more appealing, tastier foods.

Morale has not been a problem on the Station, but it is sure to get better with pizza!

**Links to “Space Food” as it has been up to now:**

[http://en.wikipedia.org/wiki/Space\\_food](http://en.wikipedia.org/wiki/Space_food)

[http://www.nasa.gov/audience/forstudents/postsecondary/features/F\\_Food\\_for\\_Space\\_Flight.html](http://www.nasa.gov/audience/forstudents/postsecondary/features/F_Food_for_Space_Flight.html)

[http://www.nasa.gov/pdf/190537main\\_Classifying\\_Space\\_Food.pdf](http://www.nasa.gov/pdf/190537main_Classifying_Space_Food.pdf)

<http://www.nasa.gov/audience/formedia/presskits/spacefood/factsheets.html>

[http://education.ssc.nasa.gov/fft\\_halloffame.asp](http://education.ssc.nasa.gov/fft_halloffame.asp)

**Videos:**

<http://science.discovery.com/tv-shows/how-do-they-do-it/videos/how-do-they-do-it-space-food.htm>

<http://video.pbs.org/video/1741712617/>

<http://www.youtube.com/watch?v=l14L1pcp9vY> (ESA)

<http://www.youtube.com/watch?v=49TkVLRWKoc> (Chris Hadfield and Chef David Chang)

## 5th Chinese Crew Soars into Space on board Shenzhou 5

<http://www.space.com/21509-china-shenzhou10-crew-launch.html>

<http://www.space.com/21547-china-astronauts-shenzhou10-docking.html>

<http://www.space.com/21506-china-shenzhou-10-mission-photos.html>

<http://www.space.com/21507-shenzhou-10-china-mission-infographic.html>

**Video** (narration in **English**) <https://www.youtube.com/watch?v=LndYEpr1UA>

[Editor's summary. For the full articles see the links above]

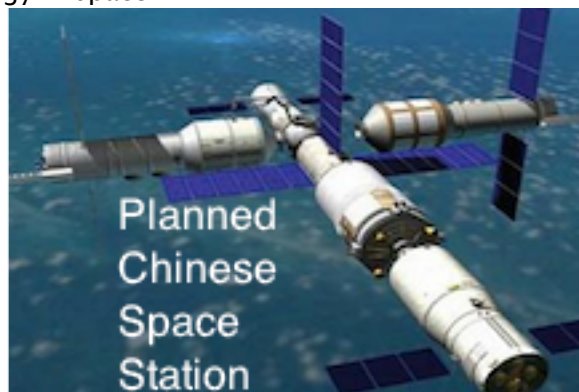
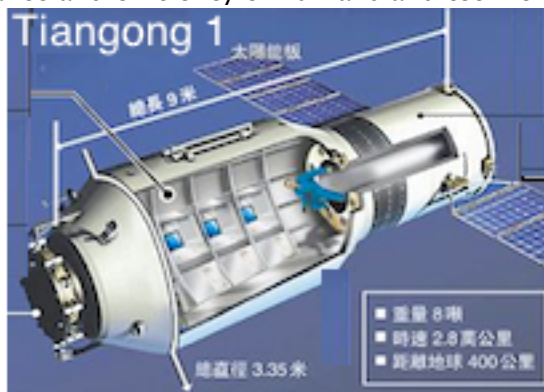
June 11, 2013 – A Chinese rocket roared into space Tuesday (June 11) carrying a crew of three is on its way to the nation's space module orbiting Earth. One woman and two men blasted off aboard the Shenzhou 10 spacecraft toward the Tiangong 1 station module from the Jiuquan Satellite Launch Center in the Gobi desert. [http://en.wikipedia.org/wiki/Jiuquan\\_Satellite\\_Launch\\_Center](http://en.wikipedia.org/wiki/Jiuquan_Satellite_Launch_Center)

Shenzhou 10's astronauts Nie Haisheng, a veteran from Shenzhou 5, and first timers Zhang Xiaoguang and Wang Yaping — the second female Chinese “spaceflyer” (Taikonaut) — are the fifth Chinese crew to launch into space. The Long March 2F rocket carrying them is the heaviest ever launched by China.



The Shenzhou 10 crew docked with the Tiangong 1 module (“Heavenly Palace 1”) June 13th, and will do so again during the course of its **15 day mission**. One docking was manual, the other automatic. To date, CSNA has conducted three automatic and one manual docking tests, with more are to follow, to prove that both taikonauts and the orbiting stations are ready for longer missions.

During their stay, the crew will beam a science lesson down to students on Earth, and test the performance and efficiency of humans and technology in space.



The Tiangong 1 module has been in Earth's orbit since September 2011. The 8.5-ton structure is about half of the mass of the Soviet Union's Salyut 1 — ISS is about 400 metric tons by comparison, The first Chinese 3-person crew docked to the Tiangong 1 module [<http://en.wikipedia.org/wiki/Tiangong-1>] in June 2012. Before the Shenzhou 10 mission, 8 Chinese astronauts had made the trip to space. The first Chinese astronaut flew into orbit in 2003.

This flight the last of three planned missions to master space rendezvous and docking to pave the way for the much larger 90 tonne 3-capsule space station (2 labs and a core unit) by around 2020, China is the third country to launch astronauts into space on its own vehicles.

[http://www.spacedaily.com/reports/Shenzhou\\_10\\_Returns\\_Safely\\_To\\_Earth\\_999.html](http://www.spacedaily.com/reports/Shenzhou_10_Returns_Safely_To_Earth_999.html) – June 26th.

<http://www.space.com/21506-china-shenzhou-10-mission-photos.html>

## MISSION TO PLANET EARTH

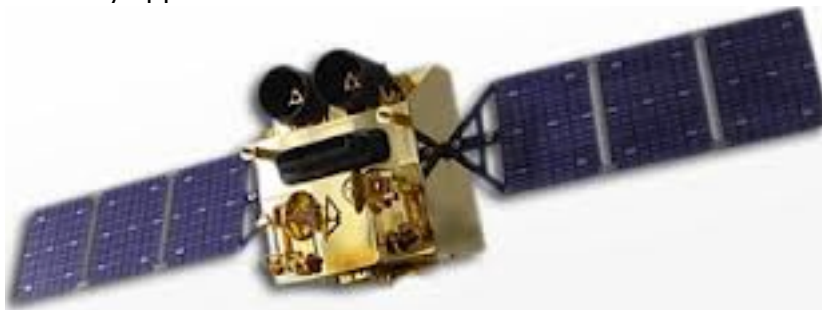
### Chinese Rocket Launches Remote Sensing Satellite and 3 others into Space

<http://www.space.com/20909-china-rocket-launch-four-satellites.html>

<http://digitaljournal.com/article/349007>

[Editor's summary. For the full articles see the links above]

The primary payload was China's **Gaofen** ["Hi Resolution"] 1 Earth-observation satellite, a civil remote-sensing satellite launched to help Chinese officials respond to disasters, survey natural resources, plot urban growth and support national security applications.

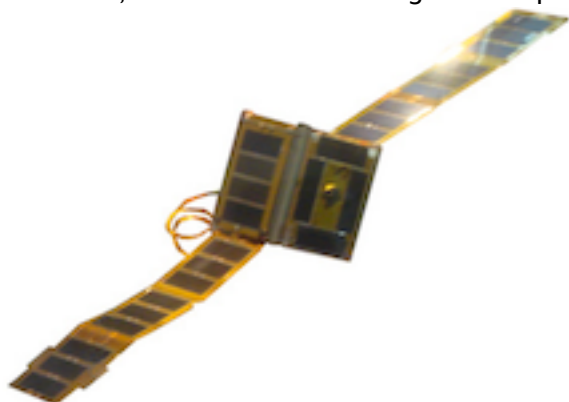


**Also on board for this launch were three CubeSats: Ecuador's first satellite, a spacecraft built by students in Turkey and a technology demonstration platform from Argentina.**

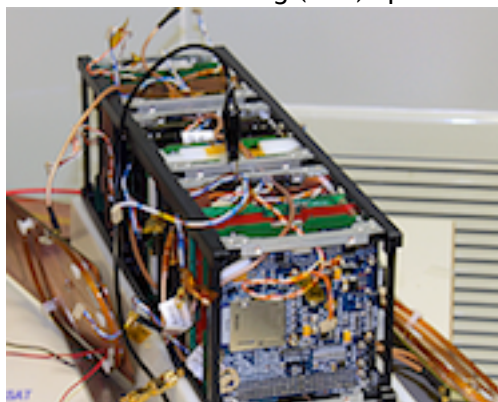
The **Ecuadorian** satellite — named **NEE-01 Pegasus** — is outfitted with a camera to stream live video from orbit in partnership with EarthCam, a company that broadcasts views from cameras worldwide on the Internet. The CubeSat will also transmit data and audio messages to the ground. Measuring 10 centimeters (4") on each side, it was developed by the Ecuadorian Civilian Space Agency, a non-profit, privately-funded organization set up in 2007. Ecuadorian President Rafael Correa watched the launch from a control center in Guayaquil, the country's largest city, and congratulated the space agency on the launch.

The toaster-sized **Turksat-3USAT** spacecraft was built in a joint effort between Turksat, Turkey's communications satellite operator, and the Istanbul Technical University. It carries a transponder to communicate with amateur radio hobbyists.

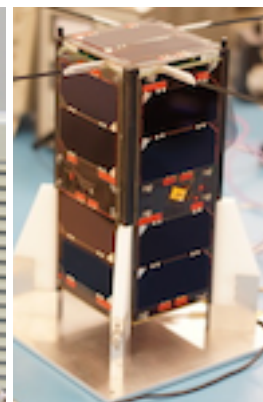
The **CubeBug 1** satellite, sponsored by **Argentina's** Ministry of Science, Technology and Productive Innovation, will test custom-designed components in a small 2.3 kg (5 lb) spacecraft



Cube sats: Left: Ecuadorian



Center: Turkish



Right: Argentinian

## Europe's Vega Launcher Succeeds on Second Launch

Launching Satellites for Europe, Vietnam, Estonia

<http://www.space.com/20998-europe-launches-vega-rocket-satellites.html>

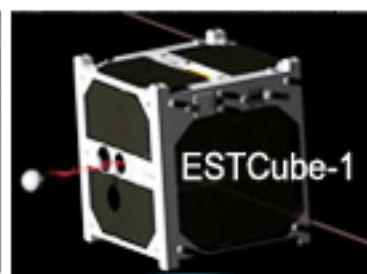
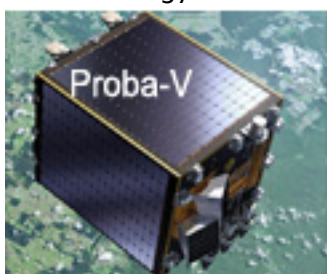
[Editor's summary. For the full article see the link above]

May-7-2013 Kourou, Guyana. Europe's 2nd Vega launch successfully deployed three satellites, owned by ESA, Vietnam and Estonia, on missions to map Earth's **vegetation** and peer down at **cities, oceans and forests**. The Vega rocket, incorporating a mix of heritage and new features, flies with advanced computers and solid-fueled motors derived from the workhorse Ariane 5 rocket's solid rocket boosters.



Vega Launch Vehicle

The second Vega Rocket, flight VV02, used the Vespa dual-payload adapter for the first time to hold ESA's **160-kg Proba-V** Earth observation satellite and **Vietnam's 1st Earth observation satellite VNREDSat-1A**, a 120-kg spacecraft built by EADS Astrium for the Vietnamese Academy of Science and Technology, and **Estonia's first CubeSat, ESTCube-1** built by University of Tartu students to test electric solar wind sail technology.



Links for individual satellites:

<http://en.wikipedia.org/wiki/Proba-V>

[http://en.wikipedia.org/wiki/VNREDSat\\_1A](http://en.wikipedia.org/wiki/VNREDSat_1A)

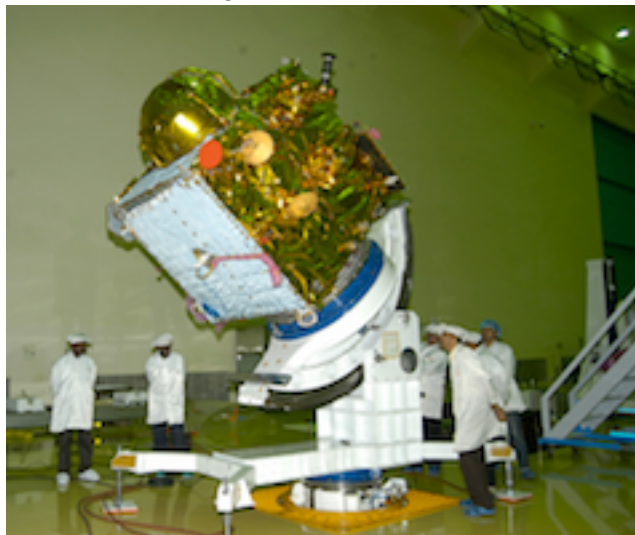
<http://en.wikipedia.org/wiki/ESTCube-1>

## India Launches Its First Navigation Satellite – IRNSS-1A

June 2, 2013 – <http://www.space.com/21822-india-launches-first-navigation-satellite.html>

[Editor's summary. For the full article see the link above]

BANGALORE, India — The Indian Space Research Organisation (ISRO) successfully launched the first of seven satellites that will constitute an independent, regional satellite navigation system.



**LEFT:** An Indian Polar Satellite Launch Vehicle launched the IRNSS-1A satellite into an elliptical orbit.

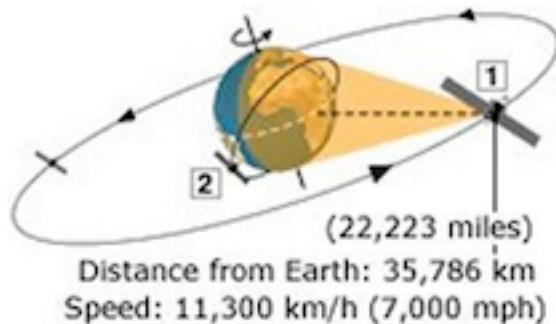
**RIGHT:** The Indian Regional Navigation Satellite System 1A satellite,

"With this we are entering into a new era of space applications after remote sensing and communications," said ISRO Chairman Koppili Radhakrishnan.

The constellation known as the **Indian Regional Navigation Satellite System (IRNSS)** is slated to become operational by 2015.

The launch of the 1,425-kg (3,142 lb) RNSS-1A satellite on board India's Polar Satellite Launch Vehicle rocket at 11:41 p.m. local time from Satish Dhawan Space Centre in southeastern Andhra Pradesh state, some 100 km north of Chennai, was televised. Originally scheduled for June 12, the launch was postponed due to a problem with the electro-hydraulic actuator in the rocket's second stage.

The satellite was put into its intended initial elliptical orbit with an apogee of 20,600 km (12,800 mi) and a perigee of 280 km (174 mi) with an inclination of 18° to the equator. The next step is to put it into a geosynchronous circular orbit of 36,000 km (22,370 mi) ] with 29° inclination.



The IRNSS constellation will include five operational satellites and two on-orbit spares. The system will cover the Indian subcontinent, remaining stationary above the subcontinent as the world turns. Coverage will extend up to c. 1,500 km (c. 950 mi) beyond India. This coverage could be extended even further beyond India's borders by adding four more satellites to the constellation.

The cost of building the seven satellites and of a ground network of 21 ranging stations across the sub-continent is expected to cost around 14.2 billion rupees (\$239 million), not including launch.

IRNSS will provide two types of services: standard positioning service using signals in the L5-band to an accuracy of 20 m (66 ft) for all users and an encrypted service in S-band provided for authorized users.

The hub for the IRNSS satellite communication links is hosted at the ISRO Navigation Centre that was inaugurated in June at the Deep Space Network complex at Byalalu, about 40 km (25 mi. from Bangalore, ISRO's principle center. ##

## Russian Space Ark Returns Animal Astronauts to Earth, Some Die

<http://www.space.com/21252-russian-animal-space-mission-bion-m1.html>

[Editor's summary. For the full article see the link(s) above]

A Russian space capsule carrying lizards, mice, gerbils, fish and other creatures has safely returned to Earth, but not all of its animal passengers survived the month-long spaceflight, according to news reports.



<http://www.space.com/20716-animals-in-space-bion-m1-photos.html>

The **Bion M1 space capsule** launched into space on April 19 atop a Russian-built Soyuz 2 rocket from Baikonur Cosmodrome in Kazakhstan. It spent 30 days orbiting 575 km (357 mi) above Earth.

On Sunday, May 19th, a month later, the capsule came back to Earth, guided with the help of a parachute system to the ground, landing in Russia's Orenburg region, just across the border from NW Kazakhstan where Baikonur is located. It is the longest animal astronaut mission of its kind.

More than half of the 45 mice aboard the spacecraft died during the flight, as did all eight Mongolian gerbils and many of the other creatures. On the other hand, all 15 geckos did survive.

Some losses were to be expected during the flight, and the mission still promises to yield valuable data from experiments on how space travel affects living things. Scientists planned to humanely euthanize the animals after their return to Earth in order to complete the experiments.

Animals have been launched into orbit in the past. In the early days of spaceflight, both the United States and the Soviet Union launched animals into space to test the safety of launching humans into orbit. But the Bion-M1 mission marks longest experiment of its kind.

**Previous animal launches** by the Soviet Union, the United States, France, China, Japan, and Iran.

[http://en.wikipedia.org/wiki/Animals\\_in\\_space](http://en.wikipedia.org/wiki/Animals_in_space) – a very thorough treatment beginning with the early days of ballooning: “Animals had been used in aeronautic exploration since 1783 when the Montgolfier Brothers sent a sheep, a duck and a rooster aloft in a hot air balloon.”

Among the most famous are the Monkey Baker (United States 1964) and the dog Laika (Soviet Union), the first creature to orbit the Earth.



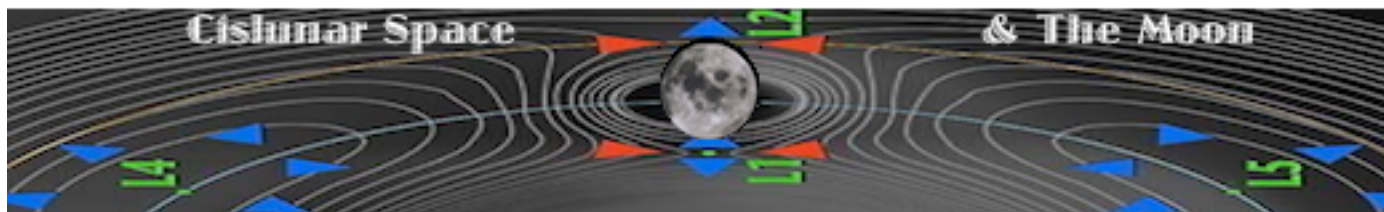
[http://en.wikipedia.org/wiki/Miss\\_Baker](http://en.wikipedia.org/wiki/Miss_Baker)



<http://en.wikipedia.org/wiki/Laika> ##

## New Photos of the Extent of Vegetation on Earth

<http://www.space.com/21661-earth-plant-life-space-photos-npp-satellite.html>

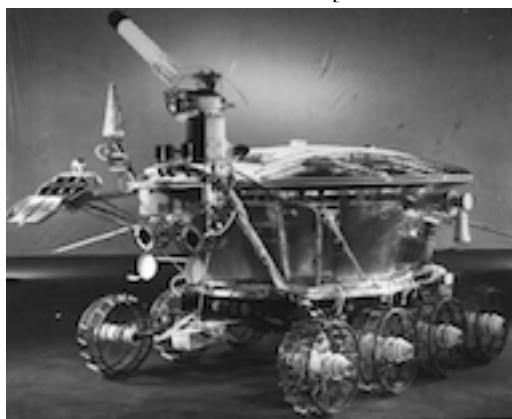


## French scientists bounce Laser Beams off old Soviet Lunakhod 1 Moon rover

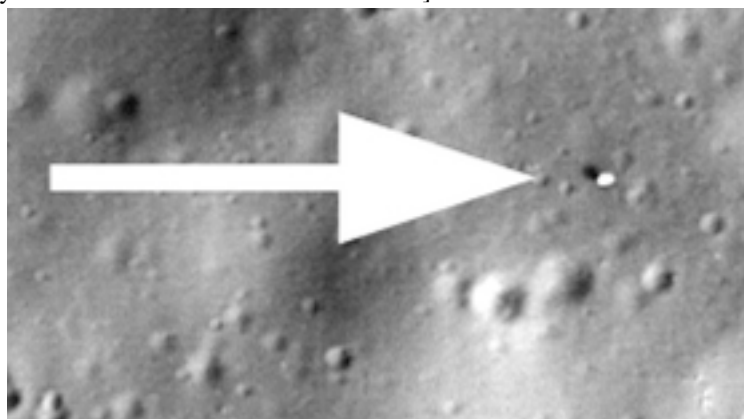
From the Côte d'Azur Observatory in Calern, France

<http://www.space.com/20865-soviet-moon-rover-lunokhod-laser.html>

[Editor's summary. For the full article see the link above]



Lunakhod 1



Present position. Note the shadow is in a direction opposite that of craters

**Left:** On November 17, 1970 the Soviet Luna 17 spacecraft landed the first roving remote-controlled robot on the Moon. Known as **Lunokhod 1**, the first remote-controlled rover ever to land on another celestial body, it weighed about 900 kg and was designed to operate for 90 days while guided by a 5-person team at the Deep Space Center near Moscow. The rover **toured Mare Imbrium** (Sea of Rains) for **11 months** – a great successes for the Soviet lunar exploration program. Among its instruments, the rover carried a French-built laser retroreflector consisting of 14 corner cubes that can reflect laser light beamed from Earth, and this is what made the recent reestablishment of “contact” possible.

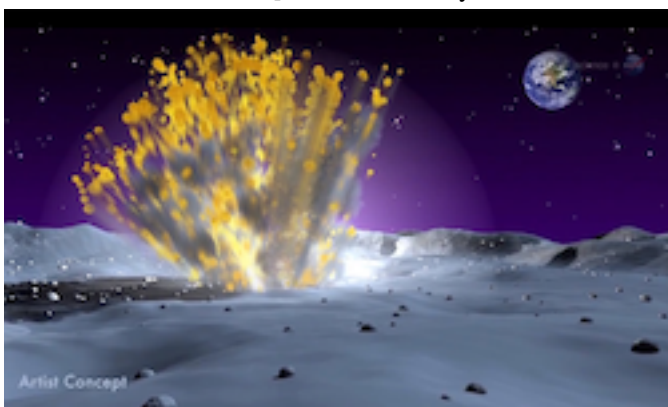
**Right:** NASA's LRO (Lunar Reconnaissance Orbiter) recently discovered the rover, which had vanished from detection in September 1971. Note that crater depressions show sunlight on the left, while this feature reflects sunlight on the right indicating that it rises above the surrounding surface. The shadow reversal stands out. CREDIT: NASA

## 30 cm 40 kg Rock hits the Moon at 90,000 kph creates new crater 20 m wide

<http://www.space.com/21197-moon-crash-meteor-impact-explosion.html>

<http://www.space.com/21195-56-000-mpg-space-rock-hits-moon-explosion-seen-video.html>

[Editor's summary. For the full article see the link(s) above]



Right: Artist conception



Left: NASA photo of event

The Moon has a new crater on its surface thanks to a boulder that slammed into it on March 17th, creating the biggest explosion scientists have seen on the Moon since they started monitoring it.

The meteorite slammed into the surface in Mare Imbrium at high speed, some 90,000 kph (56,000 mph) and creating a new crater 20 m (65 ft) wide. The crash sparked a bright flash of light that would have been visible to anyone looking at the Moon at the time with the naked eye, NASA scientists say.

NASA estimates the impacting object to be about the size of a small boulder. It exploded in a flash nearly 10 times as bright as anything we've ever seen before.

NASA astronomers have been monitoring the Moon's Earth-facing side for lunar meteor impacts for the past eight years, and haven't seen anything this powerful before.

Scientists did not see the impact in real time. It was only when Ron Suggs, an analyst at NASA's Marshall Space Flight Center in Huntsville, Ala., reviewed a video of the bright crash recorded by one of the Moon monitoring program's 35 cm (14") telescopes, that the event was discovered.

Will we be able to identify this crater when and if we return on an exploratory mission? We have a pretty good fix on the co-ordinates. Unlike craters much older, it will be fresh, almost certainly without any small impact pits within its splashout area. ##

## Surprise! Moon Craters May Hold Ancient Asteroid Pieces

<http://www.space.com/21306-moon-craters-asteroid-impacts.html>

[Editor's summary. For the full article see the link above]

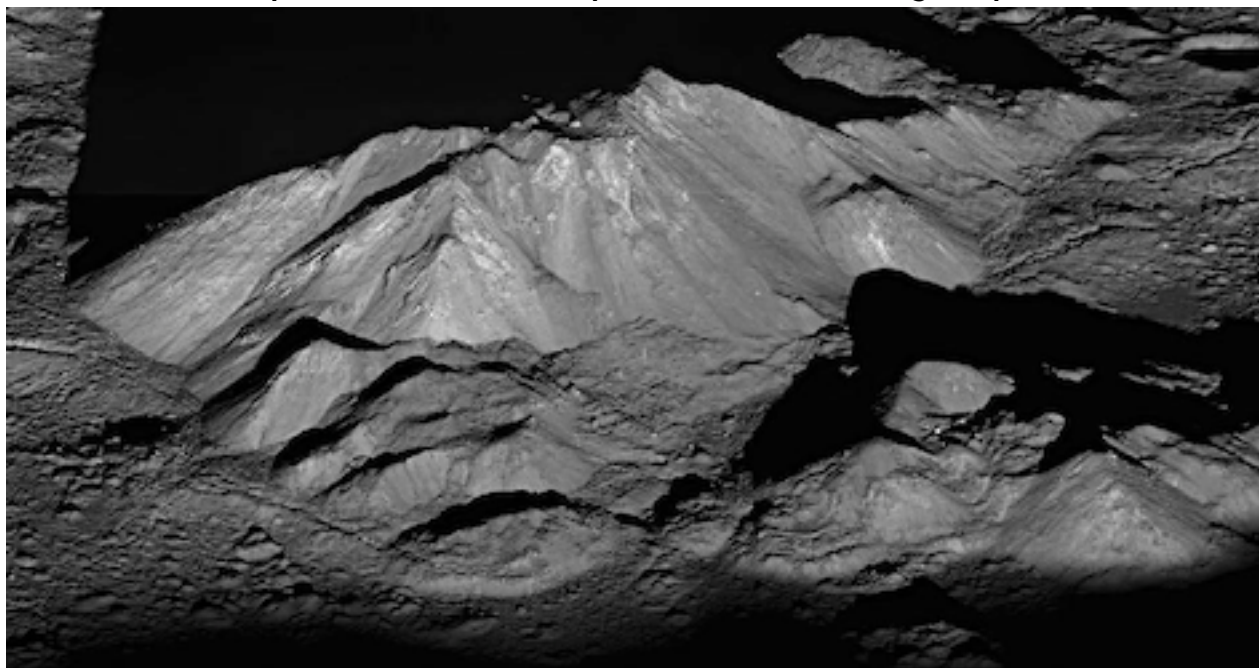
"25% of the moon's impact craters may retain substantial remnants of the asteroids that created them," a new study finds. Scientists will have to do more research to figure out what the Moon is made of. Co-authors Jay Melosh of Purdue University, and Zhong Yue of Purdue and the Chinese Academy of Sciences' Institute of Remote Sensing Applications in Beijing, used computer models to simulate formation of lunar craters by asteroid impacts.

They determined that a quarter of space rock strikes on the Moon likely occur at a velocity of 26,800 mph (43,130 km/h) or less — not fast enough to obliterate the asteroid.

Simulations performed by the team show that, at such impact speeds,

- little asteroid material is vaporized and
- lots of it is hurled against the walls of the newly formed crater.

**"If the crater is at least 12 miles (20 kilometers) or so wide, impactor remnants tend to accumulate in a central peak as the crater collapses under the Moon's gravity."**



**Above:** a spectacular up close photo of the central peak of the prominent lunar crater **Tycho**

The findings of the new study, published online May 26 in the journal *Nature Geoscience*, could "explain the occurrence of minerals called **spinel**s and **olivine**s in the central peaks of large lunar craters such as the 58-mile-wide (93 km) Copernicus." These minerals are common in many asteroids, so "it is possible that these and other minerals that scientists had until now assumed were indigenous to the Moon



were actually delivered via space rock strikes. We cannot infer the deep composition of the Moon from rocks in the centers of large craters without more care than used to date," Melosh told SPACE.com.

#### Editor's note:

We have frequently noted that the Moon may be the best place to sample and study asteroids. Most recently, in MMM #239, October 2010, we asked the question "Could the Moon be the Best Place to Mine the Asteroids?" This article is reprinted in full in the **Articles & Essays** section below.

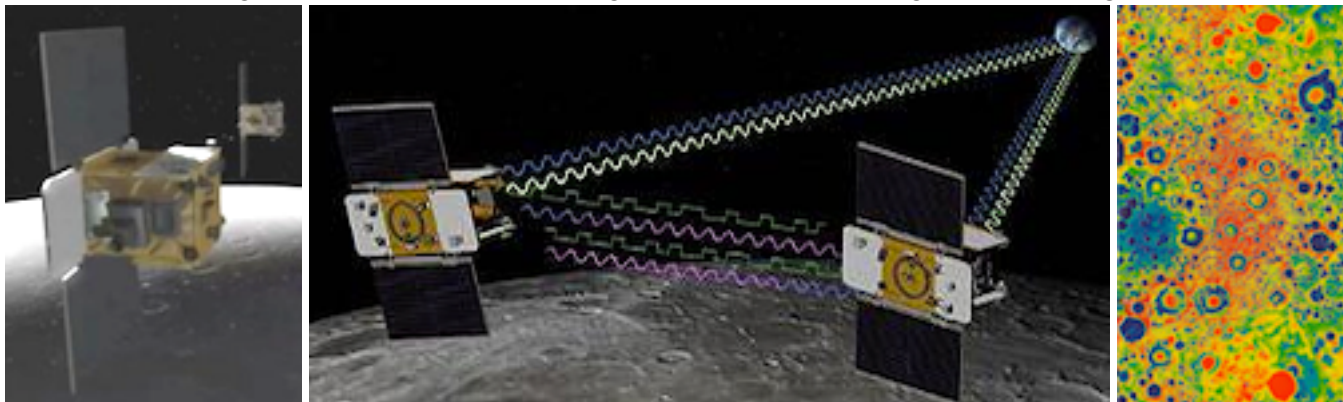
## NASA's GRAIL Mission Solves Mystery of Moon's Surface Gravity

[http://www.nasa.gov/home/hqnews/2013/may/HQ\\_13-164\\_Grail.html](http://www.nasa.gov/home/hqnews/2013/may/HQ_13-164_Grail.html)

[www.space-travel.com/reports/NASAs\\_GRAIL\\_Mission\\_Solves\\_Mystery\\_of\\_Moons\\_Surface\\_Gravity\\_999.html](http://www.space-travel.com/reports/NASAs_GRAIL_Mission_Solves_Mystery_of_Moons_Surface_Gravity_999.html)

[Editor's summary. For the full articles see the links above]

May 31, 2013 NASA's Gravity Recovery and Interior Laboratory (GRAIL) mission has uncovered the origin of massive invisible regions that make the moon's gravity uneven, affecting lunar-orbiting spacecraft.



[http://www.nasa.gov/mission\\_pages/grail/main/index.html](http://www.nasa.gov/mission_pages/grail/main/index.html)

Using a precision formation-flying technique, the twin GRAIL spacecraft mapped the Moon's gravity field: NASA/JPL-Caltech

Because of GRAIL's findings, spacecraft on missions to other celestial bodies can navigate with greater precision in the future. GRAIL's twin spacecraft studied the internal structure and composition of the Moon in unprecedented detail for nine months. They pinpointed the locations of large, dense regions called mass concentrations, or mascons, which are characterized by strong gravitational pull. Mascons lurk beneath the lunar surface and cannot be seen by normal optical cameras.

GRAIL scientists found the mascons by combining the gravity data from GRAIL with sophisticated computer models of large asteroid impacts and known detail about the geologic evolution of the impact craters. The findings were published in the May 30 edition of the journal *Science*.

"GRAIL data confirm that lunar mascons were generated when large asteroids or comets impacted the ancient Moon, when its interior was much hotter than it is now," said Jay Melosh, GRAIL co-investigator at Purdue University in West Lafayette, Indiana, US, and lead author of the paper.

GRAIL data show how the Moon's light crust and dense mantle combined with the shock of a large impact to create the distinctive pattern of density anomalies we recognize as mascons. The origin of mascons has been a mystery since their discovery in 1968. Researchers generally agree mascons resulted from ancient impacts billions of years ago. It was not clear until now how much of the unseen excess mass resulted from (a) lava filling the crater or (b) iron-rich mantle upwelling to the crust.

On a map of the Moon's gravity field, a mascon appears in a target pattern. The bulls-eye has a gravity surplus. It is surrounded by a ring with a gravity deficit. A ring with a gravity surplus surrounds the bulls-eye and the inner ring.

This pattern is a natural consequence of crater excavation, collapse and cooling following an impact. The increase in density and gravitational pull at a mascon's bulls-eye is caused by lunar material melted from the heat of a long-ago asteroid impact.

"Knowing about mascons means we finally are beginning to understand the geologic consequences of large impacts. Our planet suffered similar impacts in its distant past, and understanding mascons may teach us more about the ancient Earth, perhaps about how plate tectonics got started and what created the first ore deposits," says Melosh.

This new understanding is expected to influence knowledge of planetary geology well beyond that of Earth and our nearest celestial neighbor. Mascons also have been identified in association with impact basins on Mars and Mercury.

Launched as GRAIL A and GRAIL B in September 2011, the probes, later renamed Ebb and Flow [names submitted by a contest winner] operated in a nearly circular polar orbit at an altitude of about 55 km (34 mi) until the mission ended in December 2012. The distance between the twin probes changed slightly as they flew over areas of greater and lesser gravity caused in part by visible features, such as mountains and craters, but also by masses hidden beneath the lunar surface. ##

## NASA Builds Mock Moon 'Roverscape' for Robot Driving Tests

<http://www.space.com/21356-nasa-mock-moon-rover-driving.html>

[Editor's summary. For the full article see the link above]



NASA Ames has created a unique "roverscape" to help assess the blending of human and robotic skills in deploying a low-radio frequency array on the Moon's farside. The series of tests will tap the talents of Space Station astronauts to command an Earth-based robot to conduct simulated lunar tasks.

The football field-size roverscape and adjacent control center is located at the NASA Ames Research Center, near Silicon Valley in California, US. Tests are focused on the feasibility of telerobotic deployment of science gear on the Moon, Mars, or on asteroids. Operational readiness tests will be followed by tentative sessions involving space station crew members in June, July and August.

The K10 robot is ready for action, as is software to be used by ISS astronauts to interface with a wheeled rover. End-to-end testing and communications checks to and from the space station are finished. But live simulations with an astronaut, haven't been done. As yet there is no "designated driver" of the K10 among the ISS astronauts. Tests may involve multiple crew members. The outdoor robot test area has craters, a hill, a variety of boulders and is covered in crushed rock, step up from a being indoors in the lab.

One early exercise is to mimic teleoperating a rover on the Moon's farside from NASA's Orion Multi-Purpose Crew Vehicle parked at the lunar L2 Lagrange Point, where the combined gravity of the Earth and moon allows a spacecraft to be synchronized with the Moon in its orbit around the Earth, so that the spacecraft is relatively stationary over the Moon's farside.

A proposed L2 lunar farside piloted mission that uses astronauts to remotely unfurl a low-radio frequency antenna comprised of polyimide film on the Moon's surface. That array could track down the "cosmic dawn" of the universe shortly after the Big Bang. A university vacuum chamber is in use to imitate the day/night thermal cycles on the Moon. A mini-rover has been built that will be controlled from inside the chamber to help scope out deployment issues.

Each stage of the tests — at the Ames roverscape or at the university — build toward more realism, enabling team members to uncover, ahead of time, some of the glitches.

"Humans and machines working together, is really the way exploration is going to be done in the future...be it on the surface of the Moon or on Mars." ##

## LRO Radiation Data Finds Way to Reduce Risks for Astronauts – Plastics!

[www.spacedaily.com/reports/Moon\\_Radiation\\_Findings\\_May\\_Reduce\\_Health\\_Risks\\_to\\_Astronauts\\_999.html](http://www.spacedaily.com/reports/Moon_Radiation_Findings_May_Reduce_Health_Risks_to_Astronauts_999.html)

[Editor's summary. For the full article see the link above]

Readings by the CRaTER Instrument aboard Lunar Reconnaissance Orbiter indicate that space ship hulls made of "tissue equivalent plastic" are "pound for pound" superior to those made of aluminum in terms of radiation protection from high energy cosmic rays. ##  
18

## Australian team maps Moon's hidden craters

<http://www.space-travel.com/reports/>

[Scientists use gravity topographic data to find unmapped moon craters 999.html](http://www.space-travel.com/reports/Australian_team_maps_Moons_hidden_craters_999.html)

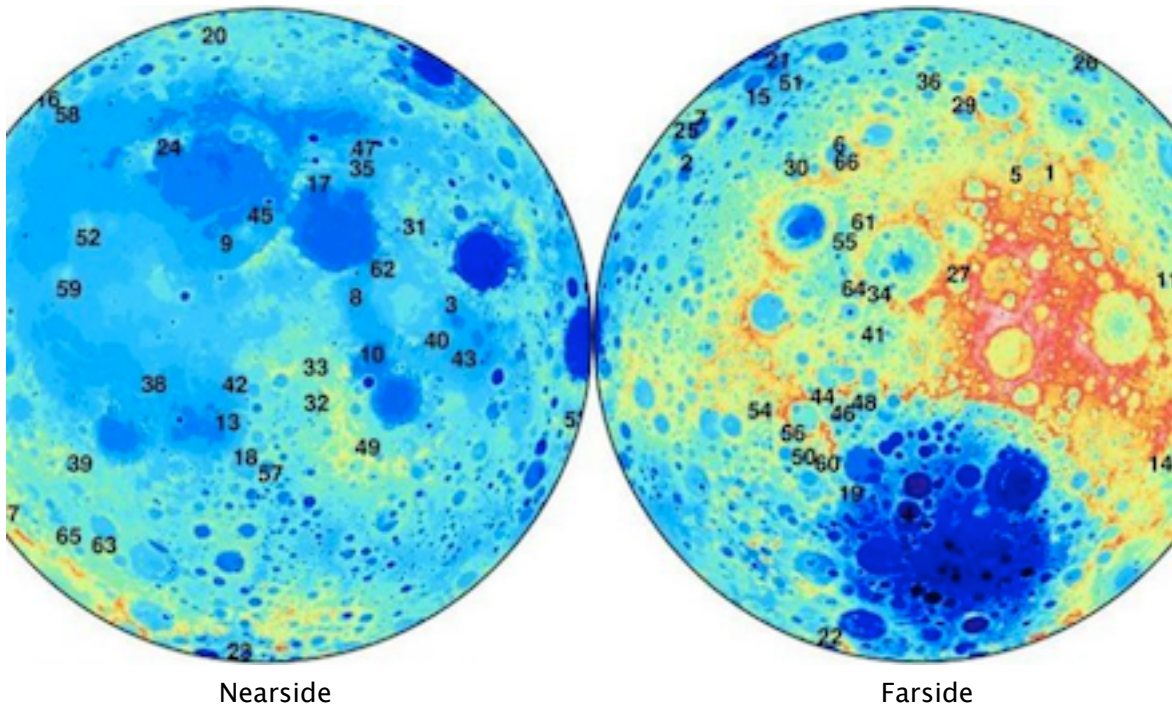
[http://www.space-travel.com/reports/Australian\\_team\\_maps\\_Moons\\_hidden\\_craters\\_999.html](http://www.space-travel.com/reports/Australian_team_maps_Moons_hidden_craters_999.html)

<http://www.foxnews.com/world/2013/06/18/australian-team-maps-moon-hidden-craters/#ixzz2YGbWoHve>

[Editor's summary. For the full articles see the links above]

June 19/21, 2013 Australian scientists have used ultra-high resolution mapping techniques to identify 280 craters on the Moon that had never been mapped before, a finding that could shed light on the Moon's history. Researchers at Curtin University in Perth, Western Australia used computer modeling of lunar gravity and topographic data to explore basins in detail that would be obscured using other methods.

By combining gravity and topography data collected by satellites, they were able to use computer modeling to at first identify two basins on the far side of the Moon. After an original identification of these two basins, they extended their search effort to the entire surface of the Moon.



**Full size image:** [http://a57.foxnews.com/global.fncstatic.com/static/managed/img/fn2/feeds/AFP/660/371/photo\\_1371549518254-1-HD.jpg?ve=1](http://a57.foxnews.com/global.fncstatic.com/static/managed/img/fn2/feeds/AFP/660/371/photo_1371549518254-1-HD.jpg?ve=1)

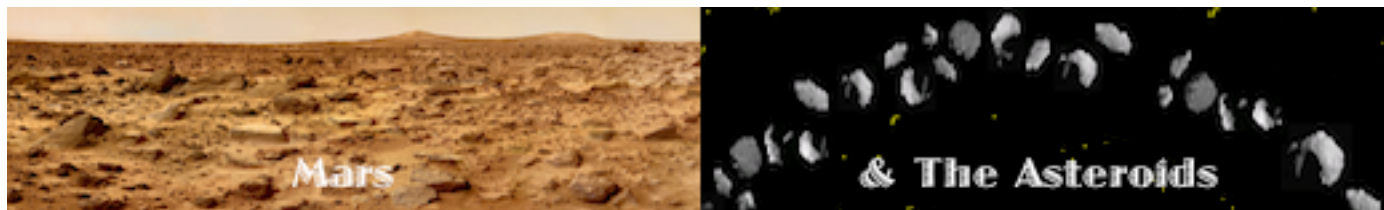
Some 66 of the possible 280 additional craters on the Moon, in a photo from Western Australia's Curtin University in Perth released on June 18, 2013. Australian scientists Tuesday said they had identified a possible 280 additional craters on the Moon, a finding that could shed light on the history of the Earth's natural satellite. (Curtin University/AFP)

**Read more:** <http://www.foxnews.com/world/2013/06/18/australian-team-maps-moon-hidden-craters/#ixzz2YGbWoHve>

Because Moon-orbiting satellites cannot be tracked from Earth when they are over the far side, this search was quite challenging. Their technique was fine-tuned in an initial development of an ultra-high resolution gravity map of Earth.

The new maps include many craters already known, but they were able to apply this technique, combining topography and gravity data together, to enhance the ones that aren't so easy to see.

The team has also done some work on the gravity of Mars and other data sets are also available for Venus and other planets. Scientists are optimistic about further discoveries from applying their techniques to new gravity data from NASA's GRAIL mission, whose extended mission at lower altitudes ended in late 2012 when the two satellites – named Ebb and Flow – crashed on the Moon's surface. ##



## MARS – UNMANNED MISSIONS

### New found Comet most unlikely to impact Mars next year

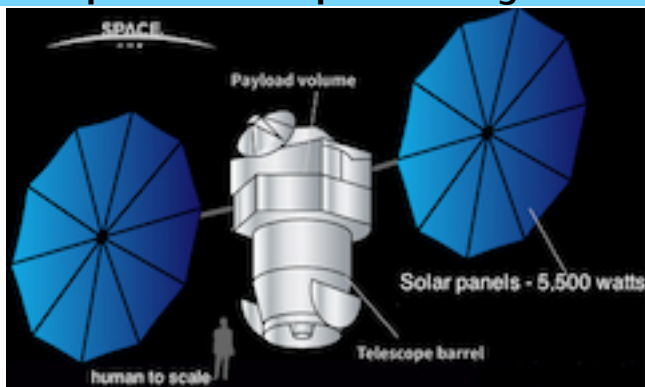
<http://www.space.com/20512-mars-comet-crash-2014-odds.html>

[http://en.wikipedia.org/wiki/C/2013\\_A1](http://en.wikipedia.org/wiki/C/2013_A1)

[Editor's summary. For the full articles see the links above]

A comet that had been given a slim chance of impacting Mars in 2014 will almost certainly fly past. NASA researchers had given Comet C/2013 A1 ("Siding Spring") a 1-in-8,000 chance of striking Mars on October 14, 2014. Revised calculations now put the possibility of an impact at just 1-in-120,000. But the new data also suggests that it will fly by closer to the planet than originally expected. ##

### A Space Telescope Orbiting Mars?



<http://www.space.com/21064-nasa-donated-spy-telescope-mars.html>

<http://www.space.com/21034-mars-space-telescope-spy-satellite-infographic.html>

<http://www.space.com/20955-nasa-spy-satellite-telescopes-missions.html>

[Editor's summary. For the full articles see the links above]

**MOST**, or the "**Mars-Orbiting Space Telescope**," is a concept that would send a Hubble-class telescope to the vicinity of Mars. The instrument would point down to study the Martian surface in high detail, or point outward to study astronomical targets. The project would use one of two National Reconnaissance Office spy satellites donated to NASA in 2012.

MOST has three main science instruments:

- The Imaging Spectral Mapper (ISM) would have higher spatial resolution than the HiRISE instrument aboard the Mars Reconnaissance Orbiter now in orbit.
- The High-Resolution Imager (HRI) could image the surface of Mars at a resolution of 8 cm/pixel (3 "/pixel) from an orbit 400 km (250 mi)
- The Ultraviolet Spectrometer (UVS) would continue the work of a similar instrument on the Hubble ST

MOST's instruments would enable observation of astrophysical and planetary targets as well as Mars' surface, upper atmosphere and aurora phenomena. The mission would continue work done by NASA with the Hubble Space Telescope and would complement the capabilities of other planned space telescopes including the James Webb Space.

Those interested in Mars can expect to see even more spectacular and more detailed images of Mars surface from the HRI instrument. And Mars scientists can expect to learn much more about Mars mineral resources from the ISM instrument. ##

## Cold-Loving Bacteria Offer Clues for Life on Mars

<http://www.space.com/21295-coldest-temperature-bacteria-found-in-permafrost.html>

[Editor's summary. For the full article see the link(s) above]

A microbe discovered on Ellesmere Island in the Canadian high Arctic, *Planococcus halocryophilus* OR<sub>1</sub>, thrives in permafrost — permanently frozen ground — at the coldest temperature known for bacterial growth, at  $-15^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ). Researchers believe this microbe may hold clues to adaptations that might be necessary for life on Mars or on Saturn's moon Enceladus, where temperatures are well below freezing.

This primitive life form lives inside veins of salty water, the salt preventing the water in the veins from freezing. The bacterium can remain active and breathing in permafrost at temperatures down to at least  $-25^{\circ}$  ( $-13^{\circ}\text{F}$ ).

The bacterium withstands the cold and salt thanks to modifications in its cell structure, cell function and an abundance of cold-adapted proteins, as well as changes in the cell membrane that protect the bacterium. It also appears to contain high levels of a compound that works as molecular antifreeze, as well as protecting the cell from the salty fluid in its environment.

"What we can learn from this microbe may tell us a lot about how similar microbial life may exist elsewhere in the solar system", says investigator Lyle Whyte of McGill University in Montreal.

Cold-loving extremophiles, called psychrophiles, are most often bacteria, fungi or algae. These hardy microbes have been found living beneath sheets of ice in Siberia and Antarctica, where temperatures range from  $-5^{\circ}$  to  $+20^{\circ}\text{C}$  ( $23$ – $68^{\circ}\text{F}$ ).

A 2006 review article in the journal *EMBO Reports* describes some of the adaptations organisms have developed for surviving the challenges of life at these frigid temperatures. These challenges include slowed rates of biochemical reactions and more viscous fluid environments. ##

## Rounded Stones on Mars Evidence of Flowing Water

[http://www.marsdaily.com/reports/Rounded\\_Stones\\_on\\_Mars\\_Evidence\\_of\\_Flowing\\_Water\\_999.html](http://www.marsdaily.com/reports/Rounded_Stones_on_Mars_Evidence_of_Flowing_Water_999.html)

[Editor's summary. For the full article see the link above]

The Mars rover Curiosity has found areas with gravel and pebbles characteristic of a former riverbed. Researchers have analyzed their shapes and sizes and believe that the rounded pebbles clearly show that there has been flowing water on Mars. The results are published in the scientific journal *Science*.

The rover's stereo camera took pictures of a few areas with densely packed pebbles, cemented together like concrete. The image field named Hottah is a mosaic of about  $140 \times 80$  cm ( $55 \times 31$ ").



Curiosity found evidence for an ancient, flowing stream on Mars at a few sites, including the rock outcrop pictured above right, named "Hottah" after Hottah Lake in Canada's Northwest Territories. This geological feature is actually exposed bedrock made up of smaller fragments cemented together, a sedimentary conglomerate. The bedrock may have been disrupted in the past, giving it the titled angle. This view of Hottah is a mosaic of images taken by Curiosity's telephoto-lens camera Sept. 14, 2012.

### Smooth, Rounded Stones

Rocks worn by the wind become angular and rough. Rocks moving in flowing water are worn down in a completely different way. They tumble around in a mixture of water and sand bumping into each other, smoothing and rounding the corners and edges/

Almost all of the 515 pebbles analyzed were worn flat, smooth and round. There are both light and dark rocks in various shades and colors – much like the original rocks on Earth and Mars. Densely packed deposits were formed locally, when fine sand and mud flow along with the gravel and pebbles. This all clumps together into something that can harden into a concrete-like substance, a conglomerate. The solid sediments have subsequently been worn flat on the top by wind-borne sands.

The new results are interesting because they tell us about the climate history of Mars. "In order to have moved and formed these rounded pebbles, there must have been flowing water with a depth of between 10–100 cm (4–40") and a flow rate of about 1 m/s = 3.6 km/h – slightly faster than a typical natural stream here on Earth.

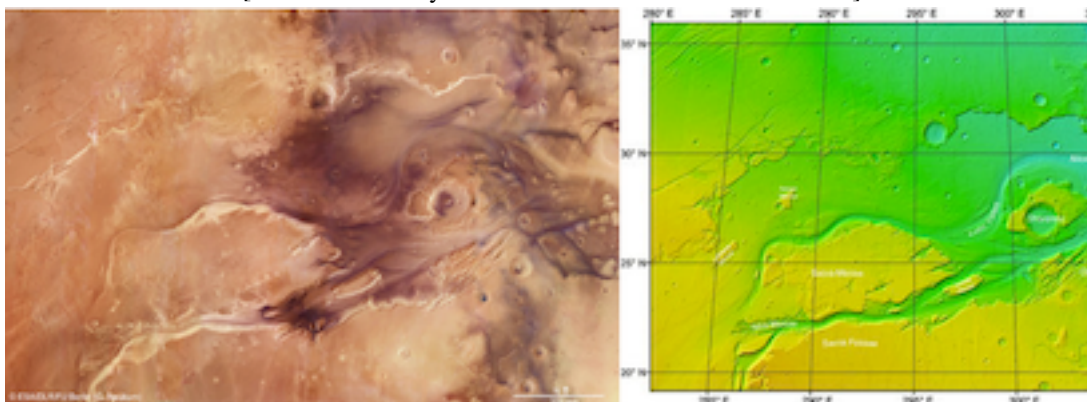
So Mars must have enjoyed prolonged warmer periods when the streams were active. Mars must have had a denser atmosphere than today. Previously scientists believed that the warm period on Mars was as far back as 3.5–3.7 billion years ago, but with the new studies it is now clear that this period may have extended to as recently as 2 to 3 billion years ago.

Apart from running water, recent investigations with Curiosity have shown that there were a pH-neutral environment and minerals that microbial life could use for nourishment. One of Curiosity's objectives has been to investigate whether there are areas on Mars that could have been habitable for microbial life. We now have the grounds to believe that this may indeed have been the case. ##

## The Floodwaters of Mars

[http://www.esa.int/Our\\_Activities/Space\\_Science/Mars\\_Express/The\\_floodwaters\\_of\\_Mars](http://www.esa.int/Our_Activities/Space_Science/Mars_Express/The_floodwaters_of_Mars)

[Editor's summary. For the full article see the link above]



This mosaic, which features the spectacular Kasei Valles, comprises 67 images taken with the High Resolution Stereo Camera on ESA's Mars Express. The mosaic spans 987 km (613 mi) north-south (19–36°N) and 1550 km (963 mi) east-west (280–310°E).

June 6, 2013: Shown above in a stunning new mosaic from ESA's Mars Express. Dramatic flood events carved this impressive channel system on Mars covering 1.55 million square km (600,000 sq. mi.)

The mosaic features the spectacular Kasei Valles, one of the largest outflow channel systems on Mars. From "source to sink," it extends some 3000 km (1,850 mi) and descends by 3 km (9,850') in altitude. The scene covered in the mosaic spans 987 km (613 mi) NS and 1550 km (963 mi) EW (280–310°E). The channel originates beyond the southern edge of this image near Valles Marineris, and empties into the vast plains of Chryse Planitia to the east (right).

A broad island of fractured terrain, Sacra Mensa, rises 2 km (6,600') above the channels that crumpled the southern rim of the 100 km (60 mi) wide Sharonov crater. Many small streamlined islands form teardrop shapes rising from the riverbed, carved as water swept around these natural obstacles.

On the valley floor we see small craters with bright dust 'tails' seemingly flowing in the opposite direction to the movement of water. These craters were formed by impacts that took place after the catastrophic flooding, their delicate tails created by winds blowing in a westwards direction 'up' valley.

Kasei Valles has likely seen floods of many different sizes, brought about by the changing tectonic and volcanic activity in the nearby Tharsis region over 3 billion years ago. Snow and ice melted by volcanic eruptions also likely contributed to torrential, muddy outpourings, while glacial activity may have further shaped the channel system.

One can only imagine from examples on Earth the roar of gushing water that once cascaded through Kasei Valles, undermining cliff faces and engulfing craters, and eventually flooding onto the plains of Chryse Planitia. ##

**23 Videos from "Humans to Mars" Summit, May 6–8, 2013, George Washington Univ., Washington DC**

<http://www.livestream.com/exploremars/folder?dirId=1cd480d3-c6a0-4043-92fe-21c56ba0b92f>

**Billion Pixel 360° Mars Panorama taken by Curiosity**

<http://mars.nasa.gov/multimedia/interactives/billionpixel/index.cfm?image=PIA16919&view=cyl>

## MARS – HUMAN MISSIONS

### Mars One Colony News



#### Astronaut Selection & China's charge that Mars One recruitment is a scam

<http://www.space.com/20680-mars-one-colony-astronaut-selection.html>

<http://www.space.com/20758-private-mars-one-colony-astronauts.html>

<http://www.space.com/20757-private-mars-mission-night-vision.html> (includes video)

<http://mars-one.com/en/faq-en/21-faq-selection/204-how-will-the-astronauts-be-chosen>

<http://www.space.com/21270-private-mars-colony-scam-china.html>

[Editor's summary. For the full articles see the links above]

**Background:** NEW YORK — If a one-way trip to Mars appeals to you, now's the time to apply to be part of the first crew of a Red Planet colony. The Netherlands-based nonprofit Mars One is planning to fly teams of four astronauts to the Red Planet, with the first landing slated to occur in 2023, 10 years from today. The purpose is to establish a permanent human settlement on our planetary neighbor. That means that applicants have to be prepared to stay, forsaking Earth for a brave new rugged frontier with few perks.

The \$6 billion cost for the first landing would be covered through reality-TV deals and merchandising, a tall order.

On April 22, 2013, the organization opened up its four-round astronaut selection process which it hopes will raise some of the funding for the project. Those over age 18 interested in spending the rest of their lives in space can apply by submitting applications and short videos to the Mars One site. There is no maximum age for applicants, nor a required technical background or even nationality or language — astronaut candidates will have a few years to learn English if they don't speak it already.

Round 3 of the selection process (see link 4 above), a televised "challenge-based reality show" broadcasted on TV and Internet worldwide, is expected to bring in much of the needed money. In each country, 20–40 applicants will participate in challenges that demonstrate their suitability to become one of the first humans on Mars. The audience will select one winner per country and Mars One experts will select additional participants to continue to round four.

#### Early mixed response

While early response in the form of applications has been high, several state-run media outlets in China are targeting the project with even harsher terms like "hoax" and "hype." Some 10,000 people from China had applied to become Mars One astronauts since the organization opened its selection process last month. (Mars One charges a non-refundable application fee that varies from nation to nation; it's \$11 for Chinese applicants and \$38 for United States citizens.) Apparently, to some MarsOne is taking its time confirming their applications, leading to the charge that the whole idea is to "raise money and run."

Mars One's registered address is the home of the organization's co-founder and CEO Bas Lansdorp, in the Dutch city of Amersfoort, And its headquarters are based at a rented office. When reporters went to the office of the company, they did not see any sign or logo of Mars One. Lansdorp and his colleagues only occupied a few tables in a large open office area.

A humble start of an ambitious well-thought out project, with early response too large to handle? – or a half-baked idea to grab the money and run hoax? Stay tuned. ##

#### LEGO to roll out Mars Rover Curiosity as toy model

<http://www.space.com/21596-mars-rover-curiosity-lego-model.html>

## Life on Mars? Finding It May Require Humans on Red Planet

<http://www.space.com/20775-mars-life-search-manned-missions.html>

[Editor's summary. For the full article see the link above]

Life still lies hidden beneath the Martian surface today, it will be tough to detect until robots are able to drill deep enough to find it, or explore Martian caves and other promising spots. "If humanity wants to satisfy its curiosity about potential life on Mars anytime soon, it should work to get boots in the red dirt, advocates say." Actually, this is quite true. The rovers on Mars to date operate very slowly. The 6–40 minute time delay in communications between Earth and Mars is unworkable for "teleoperation" and rovers have to be reprogrammed ahead of time for each day's work. More advanced, self-reprogramming robotic rovers could do much more. But in the end, there is no substitute for feet on the ground: humans. And as the human population grows, far more of Mars will be explored **sooner and in greater detail**. Science and Exploration are permanent activities of human settlements. ##

## NASA: Astronauts could face "dangerous" radiation levels on trek to Mars

[http://www.theregister.co.uk/2013/05/30/nasa\\_says\\_mars\\_trip\\_would\\_exceed\\_radiation\\_guidelines/](http://www.theregister.co.uk/2013/05/30/nasa_says_mars_trip_would_exceed_radiation_guidelines/)

[Editor's summary. For the full article see the link above]

NASA has released the results of radiation measurements taken during the Mars rover Curiosity's trip to the Red Planet, and the data show **doses received during a such a trip would exceed the space agency's current career limit for astronauts**. "Given this data and our models that confirm it, **we currently would exceed our acceptable limits of 3 per cent excess fatal cancer**." That "excess" risk is 3% added to the average fatal-cancer risk, which – depending on a whole host of factors – is around 20–25%.

Findings obtained from Curiosity's Radiation Assessment Detector (RAD), which measured radiation during its trip to Mars raise questions. **Radiation that RAD measured came both from the relatively low-level, steady bath of energetic galactic cosmic rays from outside our solar system, and from periodic bursts of intense solar radiation from our Sun's as-yet-unpredictable coronal mass ejections.**

There are two basic ways to limit an astronaut's exposure to radiation levels that exceed NASA's guidelines: (1) reduce the time spent in interplanetary space by speeding up the trip, or (2) improve the shielding protecting the astronauts in their craft.

[Editor's opinion: It appears that NASA feels it has to follow public opinion, instead of taking the lead to change that opinion. To people who are disinterested in Mars in the first place, it makes no sense to to take such a risk. But to those with a deep interest in extending the human diaspora to include Mars, such a risk is quite acceptable. Would Columbus have set out across the Atlantic into unknown territory if he were risk averse? Does NASA need to play the cautious coward, in the hopes that public response will be to "go ahead?" Surely, there will be no shortage of volunteers. Soldiers enlist and go to war facing far far greater risks. Coal miners do so just to make a living and feed their families. It is a shame that the subject even comes up. For many of us, the rewards of personal achievement in such missions would smash any risks like a bugs on an auto windshield.]

**Reducing flight times to Mars and Back:** Work is underway on improved propulsion systems beyond today's rocketry, but they're unlikely to be ready in time for NASA's planned mid-2030s Mars mission.

Two basic types of advanced propulsion are in the early development stage: **Solar Electric** propulsion systems and **Nuclear Thermal** rockets. Of these, development of low-thrust, essentially always-on solar electric systems is "more mature." But to cut trip time down significantly, nuclear thermal propulsion would be needed. The problem, of course, is money. Congress is not interested.

Nuclear rockets would help for trips to/from Mars, but not be fast enough to take humans out to the Main Belt Asteroids, or further – out to the Moons of Jupiter. **So shielding, not speed, is the answer. Better Shielding:** One way we can protect the crew is to surround them with water in the walls of the habitat. That is the tactic that the Mars Inspiration project will use. Fresh and waste water, food and other hydrogen-rich commodities will surround the crew cabin to protect the couple on their non-stop 501 day swing out to Mars and back. Polyethylene "stuffing" could be added. The chosen couple will be married, without dependents to worry about. That should work. ##

## LRO Radiation Data Finds Way to Reduce Risks for Astronauts – Plastics!

<http://www.space.com/21561-space-exploration-radiation-protection-plastic.html>

[Editor's summary. For the full article see the link above]

Readings by the CRaTER Instrument aboard Lunar Reconnaissance Orbiter indicate that space ship hulls made of "tissue equivalent plastic" are "pound for pound" superior to those made of aluminum in terms of radiation protection from high energy cosmic rays. ##<sup>24</sup>



## Toxic Mars: Astronauts Must Deal with Perchlorate on the Red Planet

<http://www.space.com/21554-mars-toxic-perchlorate-chemicals.html>

By Leonard David – June 13, 2013

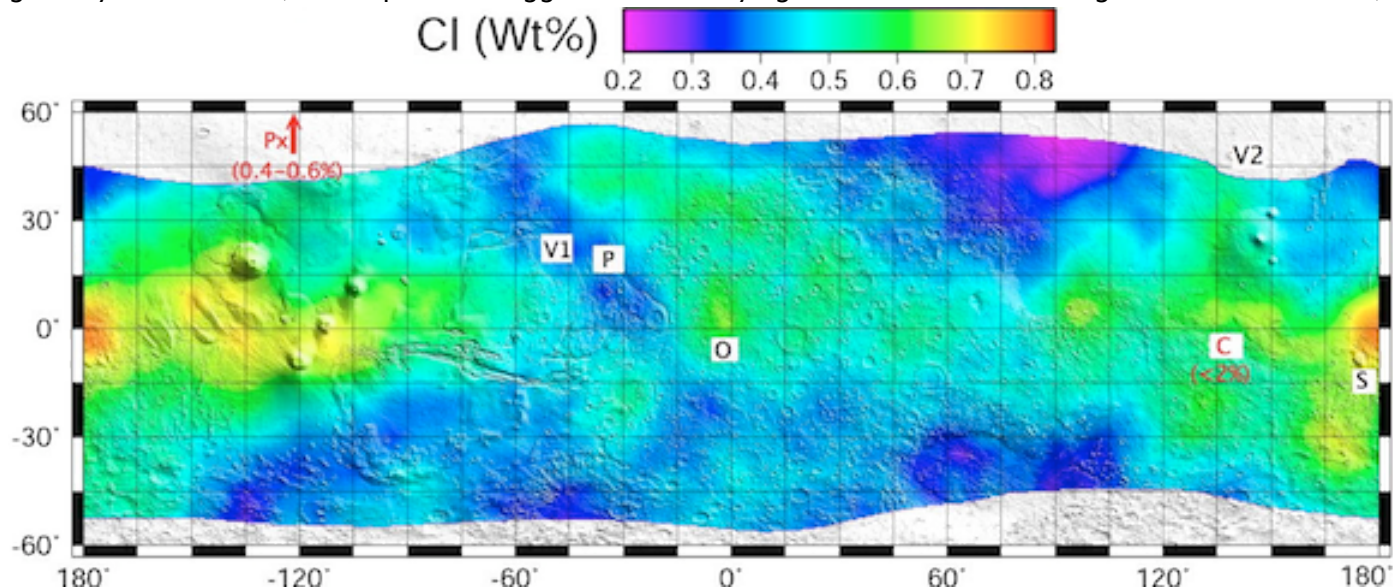
[Editor's summary. For the full article see the link above]

### Good News, Bad News

On the one hand, the pervading carpet of perchlorate chemicals found on Mars may boost the chances that microbial life exists on the Red Planet — On the other hand, perchlorates could also be perilous to the health of future crews destined to explore that world, if we go unprepared.

Perchlorates are reactive chemicals first detected in arctic Martian soil by NASA's Phoenix lander that plopped down on Mars over five years ago in May 2008.

NASA's Viking Mars landers in 1976 measured signatures of perchlorates, in the form of chlorinated hydrocarbons. Other US Mars robots – Sojourner, Spirit, and Opportunity — detected elemental chlorine. Moreover, orbital measurements taken by the Mars Odyssey spacecraft show that chlorine is globally distributed. (The map below suggests that low lying areas have less than high altitude areas.– PK)



Finding calcium perchlorate was quite unexpected. Microbes on Earth use perchlorate for an energy source. They actually live off highly oxidized chlorine, and in reducing the chlorine down to chloride, they use the energy in that transaction to power themselves.

Now that we know perchlorates are there, at concentrations of between 0.5 to 1 percent, we might reinterpret seasonal flow features on Mars as caused by high concentrations of their brines which can drastically lower the freezing point of water.

The threat is that high levels of perchlorate found on Mars would be toxic to humans, interfering with the thyroid. Very small amounts are considered toxic. Explorers will find it hard to avoid the finest of dust particles. "It'll get into everything...certainly into your habitat." So we need a plan to deal with perchlorates on the surface." Martian dust devils laden with perchlorates are sure to be a problem.

On the good side, perchlorate is used within the pyrotechnics industry, and ammonium perchlorate is also a component of solid rocket fuel. Thus this threatening nuisance is also an industrial and economic asset, and humans are used to "Jekyll and Hyde" type situations. Uranium, lead, and other heavy metal miners have faced similar situations – a wash-down spray cleans suits and equipment of dust.

NASA's latest space suit allows an option: Mars suits could be kept on the outside of extravehicular activity rovers or habitation modules. Astronauts would climb into them through a bulkhead opening, and then the suits would be sealed from within. Thus, crews avoid coming into contact with outside materials.

Perchlorate could also be an important source of oxygen. In the forthcoming paper, the researchers propose a biochemical approach for the removal of perchlorate from Martian soil that would not only be energetically cheap and friendly environmentally, but could also be used to obtain oxygen both for human consumption and to fuel surface operations.

The most important thing is that "now that we know it is there, we have time to figure out how to deal with it. And as always, we must keep in mind, that "any challenge is also an opportunity." Knowing that is part of having "the Right Stuff." ##

[For NASA's new suits, see TTSIQ#2 p.5]

Video: [http://www.dailymotion.com/video/xw8h0c\\_nasa-reveals-new-spacesuits\\_travel#.UN9VjaV5nzK](http://www.dailymotion.com/video/xw8h0c_nasa-reveals-new-spacesuits_travel#.UN9VjaV5nzK)

## NASA to Partner with ISRO on India's Mars "Mangalyaan" Orbiter Mission

<http://timesofindia.indiatimes.com/home/science/Nasa-to-partner-isro-in-Indias-Mars-mission/articleshow/20769793.cms> By Srinivas Laxman

<http://www.space.com/21766-indian-mars-mission-nasa-support.html>

<http://en.wikipedia.org/wiki/Mangalyaan>



Click on link below

for full-size illustration

<http://www.americaspace.com/wp-content/uploads/2013/05/mangalyaan-mars-mission2.jpg>

[Editor's summary. For the full articles see the links above]

MUMBAI: By Srinivas Laxman: The US would support India in its much-awaited Rs 450 crore Mars Orbiter Mission (MOM) slated for lift off from Sriharikota launch site in October–November 2013, later this year.

"NASA is providing the deep space navigation and tracking support to this mission during the non-visible period of the Indian Deep Space Network," said a US State Department announcement.

The decision to cooperate was taken at the 4th meeting of the US–India joint working group on civil space co-operation held in Washington on March 21. The details of the meeting were made public on Monday through the US–India joint fact sheet. Its release coincided with the Indo–US Strategic dialogu, and the talks between ISRO chairman K Radhakrishnan and NASA Administrator Chalres Bolden in New Delhi.

NASA will provide support from its facilities at The **Goldstone** Deep Space Communications Complex in California's Mojave desert and from NASA facilities in **Madrid**, Spain and **Canberra**, Australia.

The teaming up for the Mars mission assumes significance in the context of Bolden calling for strengthened co-operation in this programme, when he addressed ISRO staffers nationwide on Tuesday afternoon from the Ahmedabad-based Space Applications Centre.

Both countries have "agreed to co-operate in potential future missions to the Moon and Mars".

ISRO has not ruled out a second mission to Mars, which they said will have more scientific content. Nasa also wished to partner with ISRO in the analysis of data from the Methane Sensor For Mars, one of the five instruments on board the Mars orbiter. But ISRO has not given any firm response so far. ##

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"NASA is providing deep space navigation and tracking support services to this mission during the non-visible period of the Indian Deep Space Network," the governments said in a joint statement released during the three-day visit to India by of U.S. Secretary of State John Kerry.

NASA and ISRO have also agreed to "explore further cooperation in such fields as planetary science and heliophysics, as well as potential future missions to the Moon and Mars," the joint statement said.

According to the release, the expanded cooperative plan, endorsed by the U.S.–India Civil Space Joint Working Group, includes "measures that will improve the use of Earth observation data to promote sustainable development and the compatibility–interoperability between the U.S. Global Positioning System and the Indian Regional Navigation Satellite System."

ISRO and NASA are also exploring the possibility of collaborating on a dual-frequency radar satellite, with the US supplying the L-band portion and India supplying the S-band portion, for Earth observation studies. ISRO would supply the spacecraft. ##

## ASTERIODS & COMETS

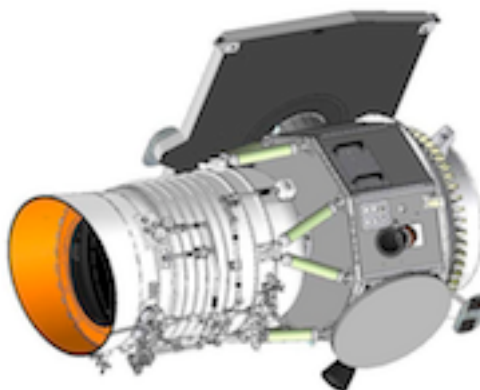
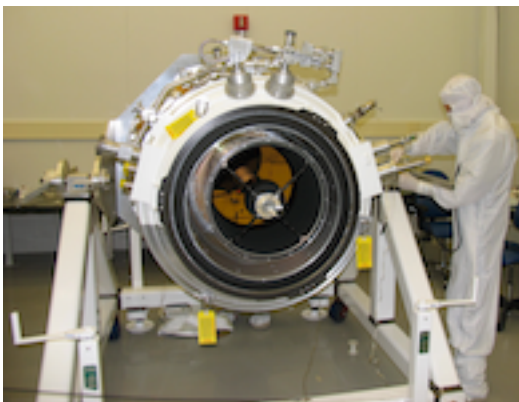
### NASA's WISE Mission Finds Lost Asteroid Family Members

[http://www.nasa.gov/home/hqnews/2013/may/HQ\\_13-157\\_WISE\\_Asteroid\\_Families.html](http://www.nasa.gov/home/hqnews/2013/may/HQ_13-157_WISE_Asteroid_Families.html)

[http://www.nasa.gov/mission\\_pages/WISE/main/index.html](http://www.nasa.gov/mission_pages/WISE/main/index.html)

[Editor's summary. For the full articles see the links above]

May 29, 2013 WASHINGTON -- Data from NASA's Wide-field Infrared Survey Explorer (WISE) have led to a **new and improved family tree for asteroids in the main belt between Mars and Jupiter**. Using millions of infrared snapshots from the asteroid-hunting portion of the WISE all-sky survey, called NEOWISE, 28 new asteroid families have been identified, helping place thousands of previously hidden and/or uncategorized asteroids into families for the first time. This is vital to understanding the origins of asteroid families, and the collisions that created this "families."



Importantly, this information may allow us to trace Near Earth Objects, NEOs, to their sources and help us understand how some of them have migrated from the main belt into orbits that could lead to a catastrophic impact with Earth.

The NEOWISE team looked at about 120,000 main belt asteroids out of the approximately 600,000 known. They found that about 38,000 of these objects, roughly one third of the observed population, could be assigned to 48 previously known families, and 28 new ones. Some previously known asteroids were found to belong to a family other than the one in which they had been associated.

**Asteroid families are formed by a collision that breaks apart a large "parent" body into fragments of various sizes.** Some collisions leave giant craters. For example, the asteroid Vesta's southern hemisphere was excavated by two large impacts. Other smash-ups are catastrophic, shattering an object into numerous fragments, as was the case with the Eos asteroid family. **The cast-off pieces move together in packs, traveling on the same path around the sun, but over time the pieces become more and more spread out.**

Previous knowledge of asteroid family lineages comes from observations of their orbits. NEOWISE also looked at the asteroids' reflectivity to identify family members with more accuracy, as Asteroids in the same family generally have similar mineral composition and reflect similar amounts of light. Some families consist of darker-colored, or duller, asteroids, while others are made up of lighter-colored, or shinier, rocks.

It is difficult to distinguish between dark and light asteroids in visible light. A large, dull asteroid can appear the same as a small, shiny one. The dark asteroid reflects less light but has more total surface area, so it appears brighter.

NEOWISE can distinguish between the dark and light asteroids by infrared light, which reveals the heat of an object. The larger the object, the more heat it gives off. When the size of an asteroid can be measured, its true reflective properties can be determined. A group of asteroids once thought to belong to a single family circling the sun in a similar orbit can be sorted into distinct families.

The next step for the team is to learn more about the original parent bodies that spawned the families. "It's as if you have shards from a broken vase, and you want to put it back together to find out what happened," said Amy Mainzer, the NEOWISE principal investigator at JPL. "Why did the asteroid belt form in the first place and fail to become a planet? We are piecing together our asteroids' history."

WISE went into hibernation mode in 2011, after scanning the entire sky twice. ##

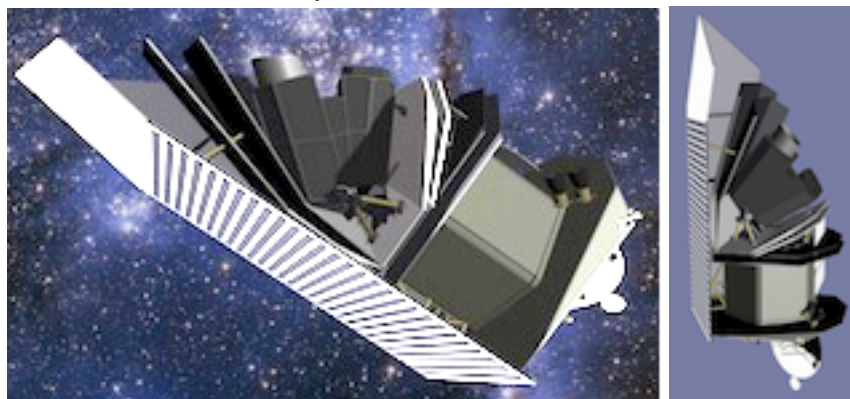
## Non-Profit's Private Space Telescope to Hunt Dangerous Asteroids in 2017

<http://www.space.com/20636-private-asteroid-space-telescope-b612.html>

<http://www.space.com/16341-sentinel-space-telescope-asteroid-mission-pictures.html>

<http://www.space.com/16336-private-asteroid-sentinel-space-telescope-infographic.html>

[Editor's summary. For the full article see the link above]



With the dangers of rogue asteroids brought home to many by the surprise explosion of a 17 m (55') wide meteor over Chelyabinsk, Russia in February, the B12 Foundation is ramping up its effort to search for potentially hazardous space rocks near Earth.

B12 was started in 2002 by former NASA astronauts Ed Lu and Rusty Schweickart with colleagues. Their plan is to launch a space telescope called Sentinel in 2017 to catalog near-Earth asteroids, including those that may pose a danger to Earth. To date, about 90 % of near-Earth asteroids large enough to cause a catastrophe (about 1 km, 0.6 mi wide) have been discovered, but far fewer of the smaller, city-killing size (roughly 140 m, or 460' wide) have been found. "We are essentially flying blind in a cosmic shooting gallery," remarks Scott Hubbard, B612 program architect.

Sentinel's goal is to detect about 90 % of this city-killing class of asteroids within 6.5 years. The \$450 million mission is to be privately funded. The foundation has partnered with NASA to share its data and use the agency's Deep Space Network of satellites to facilitate communications between Sentinel and the ground. NASA and lawmakers have expressed support. ##

>> [http://www.spacedaily.com/reports/Huge\\_Chunk\\_of\\_Meteorite\\_Located\\_in\\_Urals\\_Lake\\_999.html](http://www.spacedaily.com/reports/Huge_Chunk_of_Meteorite_Located_in_Urals_Lake_999.html)

## Bringing in Asteroid Samples to Earth: OSIRIS REX 2023 – watch video

<http://www.space.com/21181-bring-some-asteroid-to-earth-osiris-rex-2023-video.html>

## NASA Announces Plan for Capturing Asteroid and Bringing it "Home"

<http://news.nationalgeographic.com/news/2013/04/130410-asteroid-recovery-nasa-space-budget-science/>

### Watch the Video

[Editor's summary. For the full article see the link above]

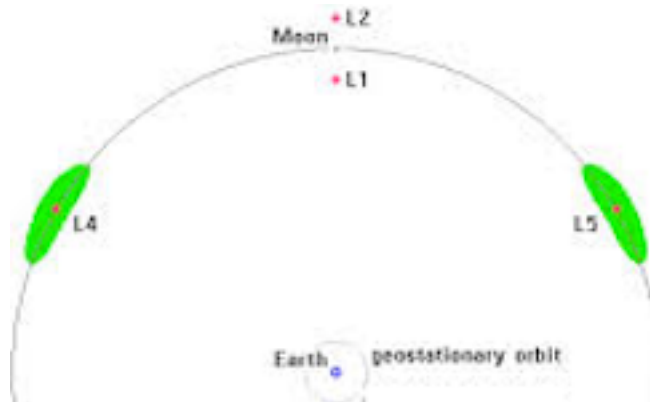
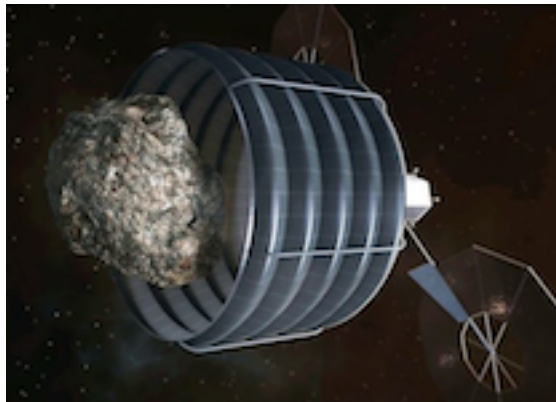
**NASA wants to identify an asteroid in deep space, figure out a way to capture the spinning and hard-to-grab orb, nudge it into our planetary region, and then set it into orbit around the Moon.**

April 10 2013: The capture would be performed robotically, and the relocated asteroid would become a destination for astronauts to explore—and, possibly, for space entrepreneurs to mine. The idea fits in with key goals of the Obama administration and the space community that include learning how to identify asteroids heading toward us and to change their course, finding destinations where astronauts can go as they try to learn how to make the longer trip to Mars, and providing opportunities for space investors.

"This would be an unprecedented technological feat, leading to new scientific discoveries and technological capabilities and help protect our home planet," NASA administrator Charles Bolden said in a statement before the plan was announced. "This asteroid initiative brings together the best of NASA's science, technology, and human exploration efforts to achieve the president's goal of sending humans to an asteroid by 2025. Planning for the effort has just begun, and teams will meet over the summer to work out how to select the right asteroid, how to get a spacecraft to it, and how to tow it many millions of miles back to the Earth-Moon system.

As envisioned in a new NASA video (link above), the asteroid would be caught and then surrounded by a large, flexible covering that will be towed by a spacecraft with two large solar arrays.

A robotic spacecraft could drag a 7m (23'), 450 metric ton (500 US ton) using currently available technology, the Keck scientists concluded, though that technology would have to be modified somewhat. That Keck team which first looked at the idea last year estimated that the project would cost \$2.6 billion. NASA officials say its effort would cost much less because NASA will look much closer to Earth for their target asteroid, and because it will already be spending millions on related rocketry and technology.



The asteroid proposal was part of the NASA budget for 2014, part of the broader federal budget that President Barack Obama had unveiled, which included an initial \$104 million for the project.

**Target selection 2016, asteroid capture 2019, first astronaut visits to the relocated rock in 2021.**

The physics of the endeavor requires a relatively small asteroid of 500 to 1,000 tons.

Another consideration is the type of the target asteroid. Asteroids come in many forms, from rubble piles barely held together by their own gravity to dense balls of iron and nickel. The asteroid to capture needs to be the **consistency of dried mud**. Finding the right asteroid to capture will not be easy. The limited size and nudging or towing power of the capsule that will be sent to the asteroid, limits the rock itself to more than 1,000 tons. And it needs to be on a trajectory that would take it close to the Earth and Moon even without a tow. The capture spacecraft would not have enough power and fuel to dramatically change the direction of an asteroid of that mass. NASA will be looking for one in Earth's extended neighborhood, not in the Main Asteroid Belt.

### Three principle reasons for undertaking the asteroid capture project

1. Asteroids are among the oldest objects in the solar system. Bringing one to a place where it could be studied intensely would give us better understanding of what that early solar system was like. And having an asteroid nearby that could be constantly visited could likely lead to scientific breakthroughs.
2. If the long-term goal of American space exploration is to send astronauts to Mars, then space program managers need achievable milestones to prepare for that mission.
3. An asteroid orbiting the Moon, or at the unique LaGrange point 2 above the Moon's farside, where the gravitational pull of Earth and the Moon are about equal, would provide such a destination. It would also provide a use for the Orion capsule and Space Launch System now being developed by the agency.

Additionally, the issue of asteroid hazards has taken on a greater urgency of late. ##

## Asteroid Capture Doesn't Impress Everyone

[Original Story in Science Magazine is unavailable to non-subscribers]

<http://nasawatch.com/archives/2013/05/asteroid-captur.html>

[Editor's summary. For the full article see the link above]

"Asteroid scientists are also a bit miffed that NASA left them out of its planning. They had heard presentations on the concept, but "we just couldn't take it seriously," [Mark] Sykes says. By early February, after realizing that NASA was indeed taking it seriously, he offered headquarters the services of its Small Bodies Assessment Group to help evaluate the idea. He got no response. NASA's Green says that "this is just the start. We will get them more involved." Although it falls outside their expertise, asteroid scientists have one more complaint about NASA's latest plan. The whole point of astronauts going to an asteroid has been to gain experience for long-duration missions far from home, such as a trip to Mars. But "if you bring the asteroid to the astronauts instead of the other way around, you really aren't sending humans into deep space, or for that matter cutting any new ground over ... circling the Earth in the ISS."

[Editor: in our opinion, this assertion, true or not, is beside the point, and sour grapes. For gaining experience in deep space, Mars is a much more fascinating target to scientists and the public alike.]

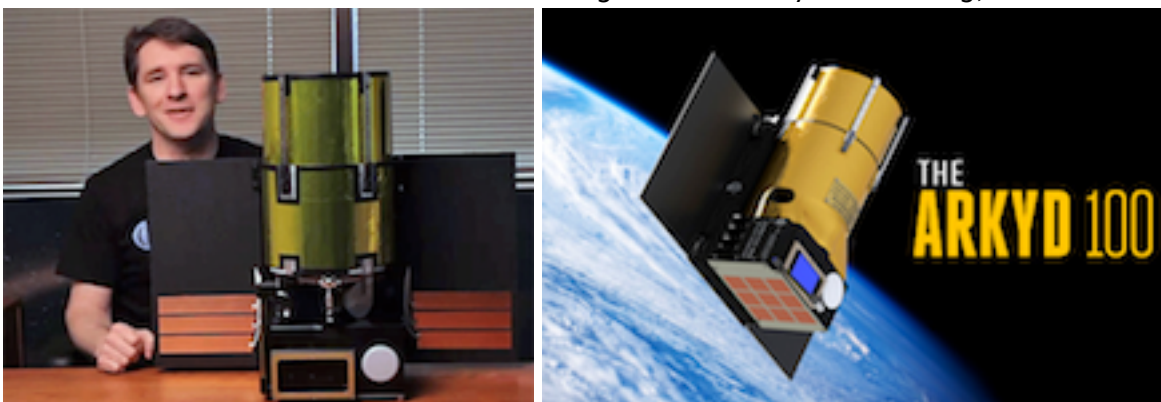
## Asteroid-Mining Project Launching Tiny Satellites in 2014

<http://www.space.com/20817-asteroid-mining-satellite-test-flight.html>

[Editor's summary. For the full articles see the links above]

Planetary Resources, a billionaire-backed asteroid-mining company, plans to loft a set of tiny "cubesats" to Earth orbit in early 2014, to test out gear for its first line of asteroid-prospecting spacecraft. While they peg themselves as a deep-space company, they are going to use Earth orbit as much as possible, as a valuable learning experience.

The cubesats slated for launch in 2014 will measure 30x10x10 cm (10"x 4"x4"). These "Arkyd-3" satellites will test technologies for Planetary Resources' Arkyd-100 scouts [images below], which the firm hopes to launch to low-Earth orbit on asteroid-hunting missions the year following, in 2015.



A series of other robotic probes beyond the 15 kg (33 lb) Arkyd-100 will investigate near-Earth asteroids up close, eventually mining suitable ones for resources such as water and precious metals. Planetary Resources sees water as the key focus at first, because it is the key enabler of off-Earth living. Water can keep astronauts hydrated, and can also serve as a shield against dangerous radiation. Split into its constituent hydrogen and oxygen, it can also provide breathable air and rocket fuel, allowing voyaging spaceships to fill up on the go. Sourcing water in space will make space travel much cheaper and more efficient. It currently costs about \$10,000 to launch 1 liter (0.26 gallons) of water to low-Earth orbit. ##

## Nuking Dangerous Asteroids Might Be the Best Protection, Expert Says

<http://www.space.com/21333-asteroid-nuke-spacecraft-mission.html> – Video & illustrations

[Editor's summary. For the full article see the link above]

If a dangerous asteroid appears to be on a collision course for Earth, one option is to send a spacecraft to destroy it with a nuclear warhead. Such a mission, which would cost about \$1 billion, could be developed from work NASA is already funding, suggests an asteroid defense expert. An anti-asteroid spacecraft would deliver a nuclear warhead to destroy an incoming threat before it could reach Earth.

**2 stages:** The two-section spacecraft would consist of (1) a kinetic energy impactor that would separate before arrival and blast a crater in the asteroid. The other half of the spacecraft would carry (2) the nuclear weapon, which would then explode inside the crater after the vehicle impacted.

**The goal is to fragment the asteroid into many pieces, which would then disperse along separate trajectories. Up to 99 % or more of the asteroid pieces could end up missing the Earth, greatly limiting the impacts on Earth. Of those pieces that do reach our world, many would burn up in the atmosphere.**

The focus of the study has been to provide **the capability to respond to a threatening asteroid on short notices of a year or so.** The plan would be to have two spacecraft on standby — one primary, the other backup — that could be launched on Delta 4 rockets. If the first spacecraft failed on launch or didn't fragment the asteroid, the second would be sent aloft to finish the job.

Sending nuclear weapons into space would be politically controversial. But safety features could be built into the craft to prevent the nuclear warhead from detonating in the event of a launch failure.

**Other systems designed to divert an asteroid such as tugboats, gravity tractors, solar sails and mass drivers would require 10 or 20 years of advance notice.**

Much of the technology for the mission has already been successfully demonstrated in flight. NASA's Deep Impact spacecraft sent a kinetic impactor to collide with Comet Tempel 1 on July 4, 2005. The point would be to demonstrate the capability to accurately target an asteroid that small, something that neither Deep Impact nor LCROSS accomplished. Accurately hitting a larger, more threatening asteroid would be easier. ##

## Indian Scientist to Plan Collision Course to Catch an Asteroid

<http://timesofindia.indiatimes.com/home/science/An-Indian-to-plan-collision-course-to-catch-asteroid/articleshow/19607189.cms> – April 18, 2013 by Srinivas Laxman

[Editor's summary. For the full article see the link(s) above]

MUMBAI: With Nasa's asteroid-capture mission gathering steady momentum, the critical task of planning how to collide with one has fallen on Mumbai-born Shyam Bhaskaran of the space agency's Jet Propulsion Laboratory ("JPL") in Pasadena, California. A NASA statement on Wednesday quotes Bhaskaran as saying: "If you want to see below the surface of an asteroid, there's no better way than smacking it hard."

But it's not that easy. Hitting an asteroid with a spacecraft traveling at hypervelocity is like "shooting an arrow at a target on a speeding race car." The term hypervelocity usually refers to something travelling at very high speed — two miles per second (11,000 km per hour) or above.

Bhaskaran is a deep space navigator who had his early schooling in Mumbai. He was a navigator on the Deep Impact mission, which collided with Comet Tempel 1 on July 4, 2005. He says that not all hypervelocity impacts are created equal.

"Impacting an asteroid presents slightly different challenges than impacting a comet. Comets can have jets firing material into space, which can upset your imaging and guidance systems, while potential asteroid targets can be as small as 50 meters and have their own mini-moons orbiting them. Since they're small and dim, they can be harder to spot," he said.

Along with the size of the celestial body being targeted, Bhaskaran also has to take into account its orbit, targeting errors, how hard an impact the scientists want, and even the shape. "Asteroids hardly ever resemble perfect spheroids," he notes.

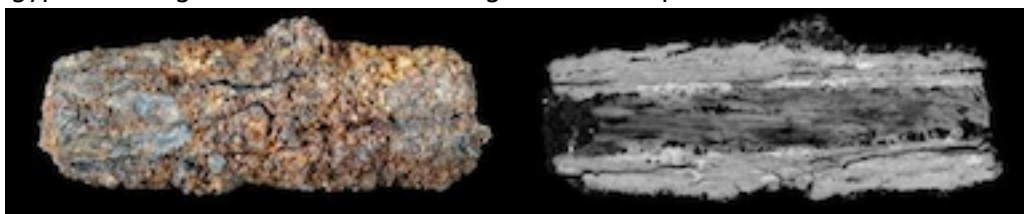
Shyam Bhaskaran is a part of NASA's Outer Planets Navigation Group at the JPL. He is also leading a team which is navigating a spacecraft to Comet Hartley-2. ##

## Ancient Egyptians Crafted Jewelry From Meteorites

<http://news.yahoo.com/ancient-egyptians-crafted-jewelry-meteorites-155809920.html>

[Editor's summary. For the full article see the link(s) above]

An ancient Egyptian iron bead found inside a 5,000-year-old tomb was crafted from a meteorite, new research shows. The tube-shaped piece of jewelry was first discovered in 1911 at the Gerzeh cemetery, roughly 40 miles (70 kilometers) south of Cairo. Dating between 3350 B.C. and 3600 B.C., beads found at the burial site represent the first known examples of iron use in ancient Egypt, thousands of years before Egypt's Iron Age. And their cosmic origins were suspected from the start.

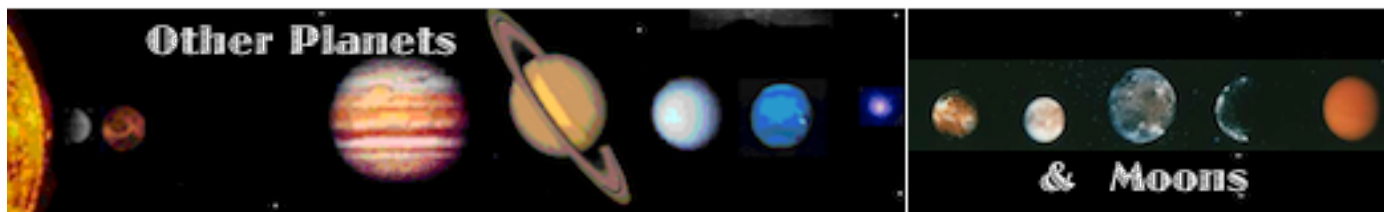


Soon after the beads were discovered, researchers showed that the metal jewelry was rich in nickel, a signature of iron meteorites. But in the 1980s, academics cast doubt on the beads' celestial source, arguing that the high nickel content could have been the result of smelting.

Scientists from the Open University and the University of Manchester recently analyzed one of the beads with an electron microscope and an X-ray CT scanner. They say the nickel-rich chemical composition of the bead's original metal confirms its meteorite origins.

What's more, the bead had a Widmanstätten pattern, a distinctive crystal structure found only in meteorites that cooled at an extremely slow rate inside asteroids when the solar system was forming. Further investigation also showed that the bead was not molded under heat, but rather hammered into shape by cold-working. The first record of iron smelting in ancient Egypt comes from the sixth century B.C., and iron artifacts from before that time are quite rare. ##

[Editor: Perhaps one day, settlers of the Moon, intact meteorite debris found on the Moon's surface, might also be cold-worked it into distinctive jewelry items.]



## VENUS

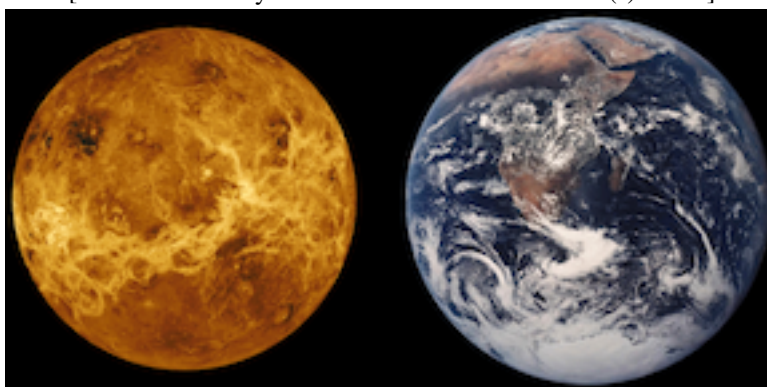
### Hellish Venus Dried Out Because It's Closer to Sun

<http://www.space.com/21346-venus-water-earth-sun-explained.html>

<http://www.space.com/12437-venus-photos-planets-venusian-solar-system.html>

#### How the twin planets – Earth and Venus – evolved so differently

[Editor's summary. For the full article see the link(s) above]



Venus is slightly smaller than Earth

The more varied and diverse planets we study, the better astronomers will understand the various ways alien worlds can evolve. Taking a closer look at the history of Venus, and how our “sister” planet transformed into a hellish hot house, is essential.

A Japanese team has concluded that ultraviolet rays from the sun sapped Venus' atmosphere of water during the planet's evolution, keeping it in a "prolonged molten state" for longer than Earth's molten state. Having formed closer to the Sun than Earth did, Venus' vastly different environment is the result. In turn, what we learn about Venus , gives us clues as to what to look for in the surfaces of exoplanets proportionately close to their stars.

"In a situation such [that] a magma ocean sustains very long, the planets are covered with a thick atmosphere. Therefore, unfortunately, it would be difficult to observe their surface temperatures directly," said Keiko Hamano, a planetary scientist with Tokyo University. "According to previous studies, however, hot atmospheres could contain unique species, such as alkali- and halogen-bearing gases. We hope to recognize hot surfaces indirectly by detecting such signatures on future missions."

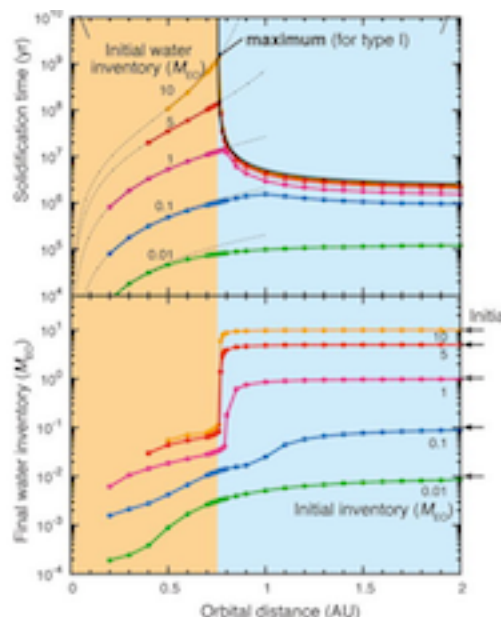
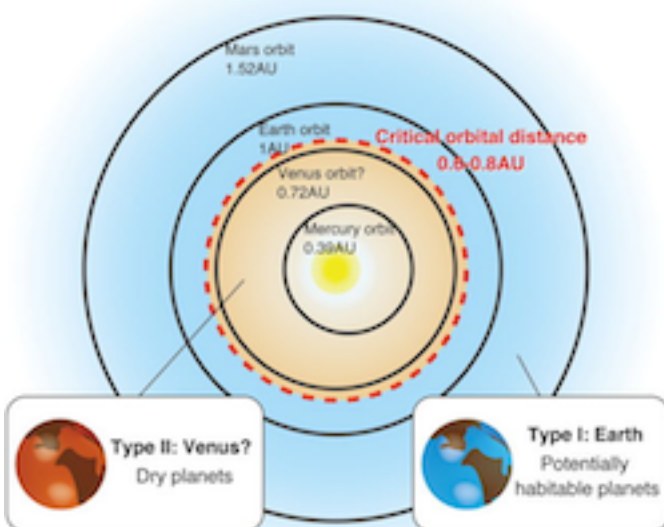
#### Planet of love to planet of lava

Venus and Earth were once considered twin planets because they are close in size. Venus was named after the ancient Roman goddess of love, and early-20th-century science-fiction writers portrayed Venus as a jungle-and life-filled planet suitable for humans to visit. But when radio telescopes and spacecraft showed the planet's surface temperatures actually reached an ovenlike 427°C (800 °F), that optimistic vision of Venus was “fried.” Our cloud-shrouded sister world is a runaway greenhouse more akin to images of “hell” than anything else we know.

All terrestrial planets look like this in the early stages of evolution, the Japanese scientists wrote. The planets begin evolving when the magma ocean solidifies, providing the initial conditions for the mantle to differentiate from the planet's crust. Volatiles, such as water, are distributed inside the planet, allowing the mantle to turn solid because water affects its thickness.

"The timing of the end of this phase also determines the starting point for subsequent events, such as water ocean formation, and possibly the onset of plate tectonics and the development of life," scientists wrote in the Venus study, which was published in Nature, May 29th, 2013.





<http://i.space.com/images/i/000/029/459/original/terrestrial-planets-classification.jpg?1369843694>

### Classifying the planets

- Type I is a planet similar to Earth. The magma ocean solidifies within a few million years, allowing them to keep any water they received during their formation and, eventually, create oceans. On Earth, this probably took about 4 million years, the model indicates.
- Type II planets are closer to their host star, receiving more solar radiation, and their magma oceans stay put for longer — perhaps for as long as 100 million years, the researchers said. These planets also dry out due to hydrodynamic escape, in which lighter molecules (driven by heat) leave the planet for space.

At an average distance of 108 million km (67 million mi) from the sun, Venus is straddling the line between where Type I and Type II planets are predicted to form. However, its dry surface and mantle are consistent with Type II planets. We do not yet know if Venus and other terrestrial planets received any water from comets or other sources early in their history. It would take more observations of alien-planet systems to determine how water arises, Hamano wrote in an email to SPACE.com.

"If we can measure [the] frequency of molten terrestrial planets with respect to orbital distance and age, [we] might be able to put some constraints on what initial amount of water is common to terrestrial planets, especially in the inner zone, and possibly what processes mainly contribute to water endowment of planets." ##

For speculations about what we could do to make Venus a human destination, read

**“Rehabilitating” Venus as a Human Destination**

[http://www.moonsociety.org/publications/mmm\\_papers/venus\\_rehabpaper.htm](http://www.moonsociety.org/publications/mmm_papers/venus_rehabpaper.htm)

## JUPITER

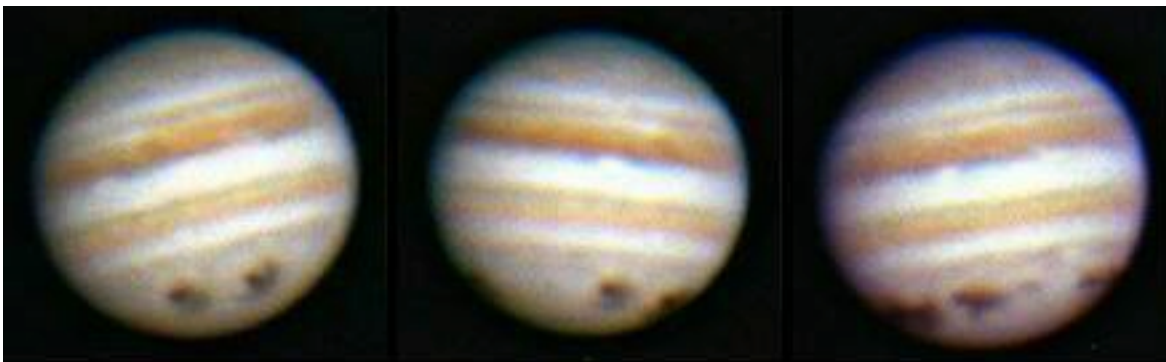
### Comet Shoemaker–Levy Impact Deposited Water in Jupiter’s Atmosphere

[www.esa.int/Our\\_Activities/Space\\_Science/Herschel/Herschel\\_links\\_Jupiter\\_s\\_water\\_to\\_comet\\_impact](http://www.esa.int/Our_Activities/Space_Science/Herschel/Herschel_links_Jupiter_s_water_to_comet_impact)

<http://phys.org/news/2013-04-herschel-links-jupiter-comet-impact.html>

[Editor’s summary. For the full article see the link(s) above]

April 23, 2013 – ESA’s Herschel space observatory has solved a long-standing mystery as to the origin of water in the upper atmosphere of Jupiter, finding conclusive evidence that it was delivered by the dramatic impact of comet Shoemaker–Levy 9 in July 1994. Followed by many amateur observers as well as by the Hubble Space Telescope, the world watched a spectacular week-long collision by a string of 21 comet fragments into the southern hemisphere of Jupiter. The tell-tale dark scars in the Jupiter’s atmosphere lasted for several weeks. We had never seen anything like this before. Launched the following year, ESA’s Infrared Space Observatory was the first to detect and study water in Jupiter’s upper atmosphere. It was widely speculated that comet Shoemaker–Levy 9 may have been the origin of this water, but direct proof was missing.



We knew that it is not possible for water vapour to pass through the 'cold trap' that separates Jupiter's stratosphere from the visible cloud deck in the troposphere below. So we knew that any water in Jupiter's stratosphere must have been delivered from outside. But confirming that Shoemaker-Levy 9 was the delivery truck train had to wait more than 15 years, until Herschel used its sensitive infrared eyes to map the vertical and horizontal distribution of water's chemical signature, and that there was 2-3 times more water in Jupiter's southern hemisphere than in the northern hemisphere, with most of it concentrated around the sites of the 1994 comet impact, and it is only found at high altitudes. ##

## JUPITER'S MOONS

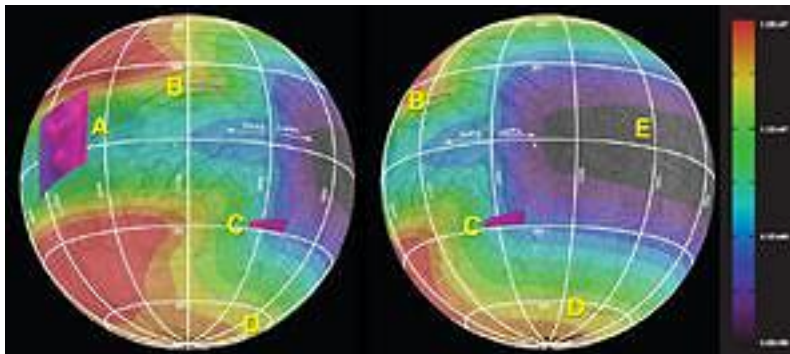
### Where are the Best Windows Into Europa's Interior?

April 4, 2013 <http://www.spacedaily.com/reports/>

[Where are the Best Windows Into Europas Interior\\_999.html](http://www.spacedaily.com/reports/Where_are_the_Best_Windows_Into_Europas_Interior_999.html)

<http://www.space.com/20785-jupiter-moon-europa-interior.html>

[Editor's summary of the two articles. For the full articles see the link(s) above]



This Europa graphic maps a relationship between the amount of energy deposited on the moon from charged-particle bombardment and the chemical contents of ice deposits on the surface in five areas of the moon (labeled A through E). Credit: NASA/JPL-Caltech/Univ. of Ariz./JHUAPL/Univ. of Colo.

A larger version of this image: <http://www.nasa.gov/topics/solarsystem/features/pia16921.html>

The surface of Europa exposes material churned up from inside the moon and also material coming from above. If you want to learn about the deep saltwater ocean beneath this unusual world's icy shell -- as do many who are interested in the possibility extraterrestrial life -- you might target your investigation of the surface somewhere that has "more of the **up-from-below stuff** and less of the **down-from-above stuff**." New analysis of old observations made by the Galileo mission is helping identify those places.

Jupiter has the most powerful magnetic field of all the planets in our solar system at nearly 20,000 times the strength of Earth's. This field traps electrons and other charged particles including ions of sulfur and oxygen spewed from volcanic eruptions on Io, a neighboring Jovian moon.

"We have found the regions where charged electrons and ions striking the surface would have done the most, and the least, chemical processing of materials emplaced at the surface from the interior ocean. That tells us where to look for materials representing the most pristine ocean composition, which would be the best places to target with a lander or study with an orbiter." -- J. Brad Dalton of JPLPropulsion.

Europa is a bit smaller than the Moon, 3122 km (1940 mi) vs. 3476 km (2160 mi) in diameter. And, like our Moon, keeps the same side toward the planet it orbits. The area in which it orbits is filled with

charged, energetic particles tied to Jupiter's powerful magnetic field. These particles include ions of sulfur and oxygen originating from volcanic eruptions on Io, a neighboring moon, a bit larger than ours.

The magnetic field carrying these energetic particles sweeps around Jupiter faster than Europa orbits Jupiter, in the same direction: about 10 hours per circuit for the magnetic field versus about 3.6 days for Europa's orbit. So, instead of "getting bugs on the front windshield, the bugs are plastered on the back of the car by a "wind" from behind, traveling nearly nine times faster than Europa travels.

Earlier studies found more sulfuric acid being produced near the center of the trailing hemisphere than elsewhere, interpreted as resulting from chemistry driven by sulfur ions bombarding the icy surface.

### **Salts on Europa's surface**

Dalton and his co-authors at JPL and at Johns Hopkins University Applied Physics Laboratory, Laurel, Md., examined data from observations by Galileo's near infrared mapping spectrometer of five widely distributed areas of Europa's surface. The spectra of reflected light from frozen material on the surface enabled them to distinguish between relatively pristine water and sulfate hydrates.

Included are magnesium and sodium sulfate salt hydrates, and hydrated sulfuric acid. The concentration of frozen sulfuric acid on the surface varies greatly, from undetectable levels near the center of the leading hemisphere, to more than half of the surface materials near the center of the heavily bombarded trailing hemisphere. The concentration was closely related to the amount of electrons and sulfur ions striking the surface. "The close correlation of electron and ion fluxes with the sulfuric acid hydrate concentrations indicates that the surface chemistry is affected by these charged particles," says Dalton.

### **Composition and habitability of the interior ocean**

The best window into the interior ocean would be the parts of the leading hemisphere identified as receiving the fewest electrons and having the lowest sulfuric acid concentrations." Surface deposits in these leading hemisphere areas are most likely to preserve the original chemical compounds that erupted from the interior. Dalton said, "The darkest material, on the trailing hemisphere, is probably the result of externally-driven chemical processing, with little of the original oceanic material intact.

Characterizing the contents of the ocean and determine whether it could support life seems to be the top priority of those fascinated by Europa.N

The study was funded by NASA's Outer Planets Research Program.

The new research was detailed recently in the journal Planetary and Space Science. ##

**NOTE: a new science-fiction film, "Europa Report", will be in US Theaters August 2nd, 2013**

<http://www.space.com/21224-europa-report-dramatizes-human-mission-to-jupiter-s-moon-video-trailer.html>

## **Tiny Submersible Could Search for Life in Europa's Ocean**

<http://www.space.com/21565-small-submarine-europa-mission.html>

Tiny "2 beer can" probe strikes "right balance between cost and capability" – Article in TTSIQ#5, Sept 2013

## **SATURN'S RINGS & MOONS**

### **Saturn's Rings Rain Charged Particles on Saturn**

4/12 [http://www.spacedaily.com/reports/Blame\\_it\\_on\\_the\\_Rain\\_from\\_Saturns\\_Rings\\_999.html](http://www.spacedaily.com/reports/Blame_it_on_the_Rain_from_Saturns_Rings_999.html)

<http://www.space.com/20727-iapetus-moon.html>

[Editor's summary. For the full article see the link(s) above]

A new study tracks the "rain" of charged water particles into the atmosphere of Saturn. There is more of it and it falls across larger areas of the planet than previously thought. Saturn is the first planet to show significant interaction between its atmosphere and ring system

The study, whose observations were funded by NASA and whose analysis was led by the University of Leicester, England, reveals that the rain influences the composition and temperature structure of parts of Saturn's upper atmosphere.

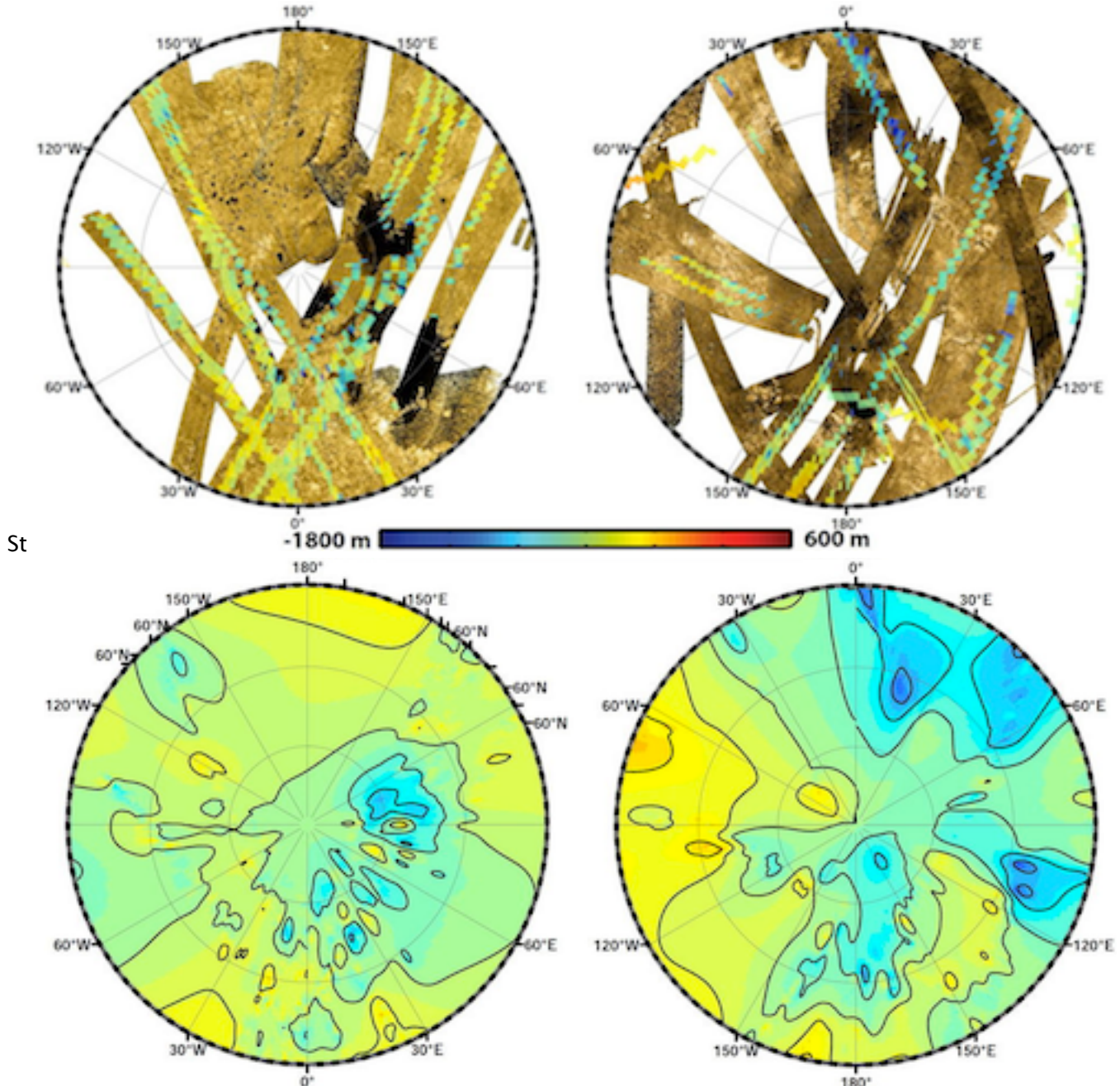
The "ring rain" acts to 'quench' the ionosphere of Saturn, severely reducing the electron densities in regions in which it falls." This explains why, for many decades, observations have shown those densities to be unusually low at certain latitudes on Saturn. The study also helps scientists better understand the origin and evolution of Saturn's ring system and changes in the planet's atmosphere.

"A major driver of Saturn's ionospheric environment and climate across vast reaches of the planet are ring particles located some 36,000 miles [60,000 kilometers] overhead. The ring particles affect both what species of particles are in this part of the atmosphere and where it is warm or cool." ##

## Titan Unmasked: 1st Map of Saturn Moon's Topography Revealed

[http://www.spacedaily.com/reports/NASA\\_Team\\_Investigates\\_Complex\\_Chemistry\\_At\\_Titan\\_999.html](http://www.spacedaily.com/reports/NASA_Team_Investigates_Complex_Chemistry_At_Titan_999.html)  
<http://www.space.com/20706-saturn-moon-titan-methane-lakes.html> <http://www.space.com/19183-titan-saturn-largest-moon-infographic.html>  
<http://www.space.com/21291-titan-topographic-map.html> <<<  
<http://timesofindia.indiatimes.com/home/science/Saturns-moon-Titan-to-be-mapped-in-3D/articleshow/20302485.cms>

[Editor's summary. For the full article see the link(s) above]



To create the maps above, scientists used a mathematical process called **splining**, which uses smooth curved surfaces to "join" the areas between grids of existing topography profiles obtained by Cassini's radar instrument. The result is the first global topographic map of Titan, using radar observations from veteran NASA " , stitching together data from Cassini radar observations of the moon to give us an unprecedented look at Titan's surface. The map should help scientists learn even more about one of the most intriguing world.

"Titan has a lot of interesting activity — like flowing liquids and moving sand dunes — but to understand these processes it's useful to know how the terrain slopes," Ralph Lorenz, a member of the Cassini spacecraft's radar team at the Johns Hopkins University Applied Physics Laboratory, said in a

statement. "It's especially helpful to those studying hydrology and modeling Titan's climate and weather, who need to know whether there is high ground or low ground driving their models."

Titan is the second largest moon in the solar system, after Jupiter's Ganymede, and the only one known to have clouds and a dense atmosphere. Titan's atmosphere, like Earth, is primarily composed of nitrogen, but instead of water, Titan's rain, clouds and lakes are made of cold liquid methane. Titan's atmosphere also contains organic chemicals that are derived from methane, which may hold clues to the building blocks of life as we know it, the researchers said.

Titan's thick atmosphere and clouds make conventional surface mapping impossible. The Cassini probe has flown by Titan nearly 100 times since it arrived at Saturn in 2004. As the spacecraft swings past the hazy moon, it uses a radar imager to pierce through the clouds. These radar measurements can then be used to estimate the heights of topographical features on the moon. But, since Cassini is only able to observe Titan on flybys, putting together a complete map of its surface is challenging.

"We have only imaged about half of Titan's surface, and multiple 'looks' or special observations are needed to estimate the surface heights," Lorenz said. "If you divided Titan into 1-degree by 1-degree [latitude and longitude] squares, **only 11 percent** of those squares have topography data in them." To create a global map, Lorenz and his colleagues used a mathematical process called "**splining**," which **uses smooth, curved surfaces to stitch together grids of existing data**.

"You can take a spot where there is no data, look how close it is to the nearest data, and use various approaches of averaging and estimating to calculate your best guess," Lorenz said. "If you pick a point, and all the nearby points are high altitude, you'd need a special reason for thinking that point would be lower. We're mathematically papering over the gaps in our coverage." ##

## Saturn's moon Dione may join list of moons harboring subsurface oceans

<http://www.space.com/21482-saturn-moon-dione-subsurface-ocean.html>

[Editor's summary. For the full article see the link above]

Saturn's moon Dione, may have once had a geologically active subsurface ocean. Dione's 800 km (500 mi) long mountain **Janiculum Dorsa** is a clue. Dione is 1,123 km (700 mi) in diameter.

Subsurface oceans are thought to exist on several bodies in the solar system, including Saturn's moons **Enceladus** and **Titan** and Jupiter's moon **Europa**. Jupiter's largest moons, **Ganymede** and **Callisto**, and dwarf planet **Ceres** may be others. These worlds have caught the interest of scientists searching for life beyond Earth. If Dione has or had an ocean under its crust, it would rank higher on the radar screen.

Cassini, which has been exploring Saturn since 2004, detected a weak particle stream coming from Dione with its magnetometer. Images suggest a slushy liquid layer beneath its icy crust, as well as ancient, inactive fractures that spew water ice and carbon-containing particles, much like ones seen on Enceladus.

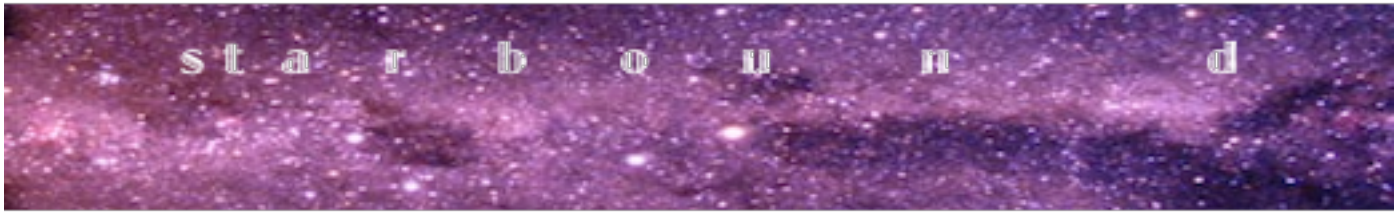


Dione's Janiculum Dorsa ranges from about 1–2 km (3,300–6,600 ft) in height. The mountain seems to have deformed the icy crust underneath by as much as 0.5 km, (0.3 mi). The deformation suggests that the crust was warm, most likely from a subsurface ocean when the mountain formed.

That ocean may or may not still be liquid, but if it had frozen, it should have expanded in the process and Dione's surface should show many fractures which it doesn't. [Editor's Comment]

As Dione swings around Saturn (at about the same distance as the Moon from Earth) every 2.7 days, it gets squished and stretched, causing it to heat up. If there is a subsurface ocean that lets the icy crust float around on top, Saturn's gravitational pull becomes amplified and generates 10 times more heat, the researchers said. Other less likely explanations are that the heating could also be caused by a local hotspot or a crazy orbit, but these explanations are less likely.

Scientists don't know why Dione hasn't been as active as Enceladus. The latter may have experienced stronger gravitational forces or more radioactive heating in its core, they suggest. Subsurface oceans appear to be common on icy satellites, and could exist on dwarf planets like Ceres and Pluto. Cassini's recent findings were reported in March in the journal *Icarus*. ##



## NIGHT SKY LIGHT POLLUTION

### 'Darkened Cities' by Thierry Cohen: Amazing Night Skies Imagined

<http://www.space.com/20542-darkened-cities-night-sky-photos.html>



825x550 pixel photo: <http://i.space.com/images/i/000/027/798/original/rio-de-janeiro-skyline.jpg>

[Editor's summary. For the full article see the link(s) above]

If you live in Los Angeles, San Francisco, New York, **Rio de Janeiro** (above), Sao Paulo, Paris, London, Hong Kong, Shanghai, Tokyo, or any other city of size, and have never been far from a city on a cloudless and moonless night, here is what you could be missing.

This sorry condition is a **great opportunity to organize others in your community** to agitate for replacing inefficient city street lighting that sheds light upwards, with more efficient, money-saving hooded lights. Then young people will grow up aware of much more than the Moon, in nighttime skies.

**Hint:** If you have a series of cycling "wallpapers" on your computer screen rather than a "screen saver, you might want to download one of these amazing images to that cycling image folder.

Read "**Leveraging the Sky**" in Moon Miners' Manifesto India Quarterly "12, OCT, 2011, pp. 14-15.

[http://www.moonsociety.org/india/mmm-india/m3india12\\_Oct-Dec.pdf](http://www.moonsociety.org/india/mmm-india/m3india12_Oct-Dec.pdf)

## STARBOUND TELESCOPES

### ESA's Herschel Space Observatory no longer functional

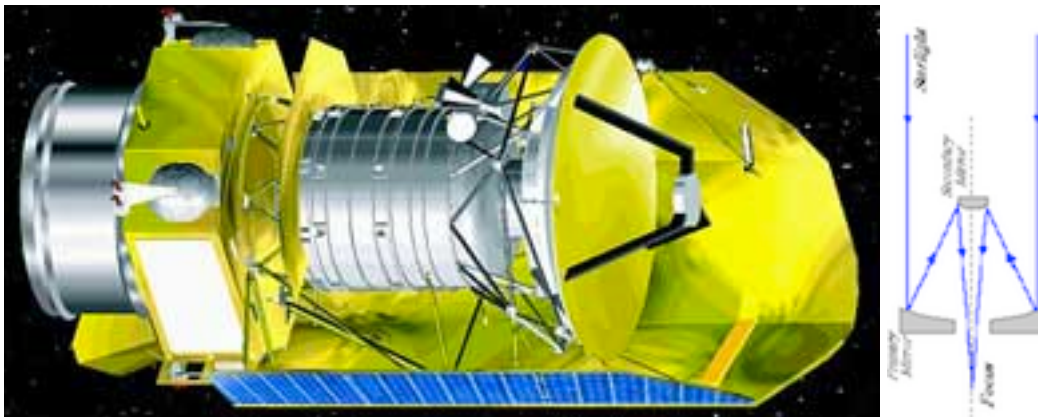
<http://www.space.com/20883-largest-infrared-space-telescope-ends.html>

<http://www.space.com/21598-herschel-space-telescope-turned-off.html>

[Editor's summary. For the full article see the link(s) above]

The \$1.4 billion Herschel Space Observatory has exhausted the vital supply of liquid helium coolant that allowed it make the most sensitive and detailed observations of the cosmos in infrared light,

[http://en.wikipedia.org/wiki/Herschel\\_Space\\_Observatory](http://en.wikipedia.org/wiki/Herschel_Space_Observatory) - <http://herschel.esac.esa.int>



**Mass:** 3,300kg, **Type:** Richey-Chretien, **Diameter Primary Mirror:** 3,500mm 140 in  
**Instruments:** HIFI – Heterodyne instrument for the far infrared  
 PACS – Photodetector Array Camera and Spectrometer  
 SPIRE – Spectral and Photometric imaging receiver  
 The Telescope was turned off on June 17th. “Rest in peace!”

### SEARCH FOR EXO-PLANETS & LIFE – links

<http://www.space.com/20441-giant-alien-planets-atmosphere.html>  
<http://www.space.com/20231-giant-exoplanets-hr-8799-atmosphere-infographic.html>  
<http://www.space.com/20733-alien-life-search-next-phase.html>  
<http://www.space.com/20728-new-alien-planets-oceans-life.html>  
<http://www.space.com/20400-the-search-for-another-earth.html> – “Outstanding!” Do watch!

### Planet-Hunting Kepler Telescope Will Have Long Legacy, Despite Big Glitch

<http://www.space.com/21210-nasa-kepler-exoplanet-telescope-legacy.html>  
<http://www.thespacereview.com/article/2298/1>  
<http://www.space.com/21570-nasa-kepler-alien-planet-candidates.html> 503 more!

[Editor’s summary. For the full articles see the links above]

“Kepler has spotted more than 2,700 potential [exoplanets](#) to date, with many more waiting to be plucked from the mission's huge dataset. Its discoveries have opened the eyes of scientists and the public alike, revealing that the Milky Way galaxy abounds with an incredible diversity of alien worlds.” “Before we flew Kepler, we didn't know that Earth-sized planets in habitable zones were common throughout our galaxy,” Hertz added. “We didn't know that virtually every star in the sky had planets around them. Now we know that.”

A reaction wheel on NASA's Kepler spacecraft has failed, putting the future of the extrasolar planet hunting spacecraft into jeopardy. Jeff Foust reports on efforts to rescue or repurpose Kepler, and why, even with the failure, the spacecraft's exoplanet discoveries will continue. ##

### You Can Help Search for Planets around Other Stars

<http://www.planethunters.org>

[Editor’s summary. For the full article see the link above]

There was some sad news for Planet Hunters everywhere recently. NASA’s Kepler spacecraft is no longer collecting data. Don’t worry though: there is still plenty of data left unexplored in the Kepler database and that is where Planet Hunters (which could include you) are already involve!

Kepler’s finds are but the tip of the proverbial iceberg. The telescope has been searching a very small patch of the sky, in the constellation Lyra (brightest star Vega.) So to get a better idea of how many exo-planets are out there, we would have to multiply Kepler’s finds many many times over.

By participating in the Planet Hunters project, you can help explore that great backlog of data already captured. Go to the website above to learn how to help search the data. ##

## New Technique Could Probe Rocky Alien Planet Surfaces

<http://www.space.com/21293-rocky-alien-planets-surface-composition.html>

[Editor's summary. For the full article see the link(s) above]

Numerous rocky, Earth-like worlds have been discovered by transit surveys such as NASA's Kepler mission. A transit occurs when an exoplanet crosses the face of its parent star as seen from Earth, or from an Earth launched satellite telescope. The amount of starlight the transiting planet blocks lets astronomers calculate the radius of a transiting planet.

Recent surveys have hinted at the existence of exoplanets with rocky surfaces, as do our own "terrestrial" planets Mercury, Venus, Earth and Mars. However, a number of the exoplanets thought to have rocky surfaces appear to lack significant atmospheres. 55 Cancri, twice as wide and eight times as massive as Earth, may be a rocky planet, perhaps made of diamond. The first rocky exoplanet discovered, Kepler-10b, is roughly 4 1/2 times as massive as Earth. Planet more massive than Earth but less massive than Neptune are dubbed "super-Earth." Some may have rocky surfaces, some gaseous like Neptune

MIT and Caltech researchers have propose to identify unique chemical surface by studying exoplanets in the infrared part of the spectrum. As we learn more about the range and percentages of exo-planet surface composition we will have a better idea of how prevalent Earth-like planets are in our galaxy. Current methods currently single out airless or thin-air rocky worlds like the Moon, Mars and Mercury. The team proposes to analyze exoplanets in the infrared portion of the spectrum to determine the surface composition. Ideal exoplanets to study using the team's method are those that transit their host star. With current technology, the team is concentrating on the most prominent mineral signatures detected from exoplanets with surface temperatures under 3,140 degrees Fahrenheit (1,727 degrees Celsius), to find the signatures of different materials. A large number of exoplanets detected by Kepler are the right distance from their host star to have silicate rocky surfaces.

- Minerals such as pyroxene, olivine and hematite provide strong chemical signatures.
- Minerals such as hematite have prominent signals in the visible and ultraviolet wavelengths.
- Materials formed with water offer signals in the near-infrared. o

One reason to concentrate on worlds with little or no atmosphere is, that is is difficult to sort out what's present. We can expect more research on just how to separate atmospheric and surface signals.

Once deployed, the James Webb Space may be able to detect rocky surfaces on planets around sun-like stars. In time, the detailed composition of rocky surfaces on an exoplanet can be investigated by observing the stellar light reflected by the planetary surfaces," Hu said. "To do this, the rocky exoplanet needs to be directly imaged, which requires space-based telescopes with great power." ##

## Spitzer Telescope to look for Mars-size Planets around Brown Dwarfs

<http://www.space.com/21318-mars-size-exoplanets-brown-dwarfs.html> Paper on [www.Arxiv.org](http://www.Arxiv.org)

[http://en.wikipedia.org/wiki/Brown\\_dwarf](http://en.wikipedia.org/wiki/Brown_dwarf)

[Editor's summary. For the full articles see the links above]

NASA's Spitzer Space Telescope could be used to find Mars-size alien planets orbiting strange "failed stars" known as brown dwarfs, according to a new proposal by a multinational astronomy team led by a postdoctoral researcher at MIT who proposes to use the observatory to find small, rocky planets around brown dwarfs. Brown dwarfs are gaseous bodies larger than gas giant planets but without enough mass to support nuclear fusion reactions that make stars shine. Spitzer, launched in 2003, ran out of coolant four years ago, and is observing new targets (e.g. near-Earth objects) in an extended mission.

The plan is to look for planets crossing the face of brown dwarfs, in the hopes that some of them will end up being capable of supporting life as we know it, such as planets orbiting the brown dwarf close enough warm them up. They wish to explore "the concept of habitability beyond Earth-like conditions, "aiming for Mars-size . Solar systems cross a threshold when any proto-planets reach the size of Mars.

"It is easier to spot such small, rocky worlds around a brown dwarf than around stars, as dwarfs are brighter in the infrared - the wavelength range of heat - and those we can see are relatively close to us making it easier to detect the effect of any planets on their motions. With the James Webb we could search for "biomarker" molecules such as oxygen, but this would need prolonged observation"

Planets in a close-hugging brown dwarf's "habitable zone" — where liquid water could exist on their surface — could pass between the brown dwarf and Earth more than 50 times a year, enough to detect any atmosphere. At the same time, we would be studying brown dwarfs themselves — their rotations and what happens in their atmospheres. ##



## Well Beyond Kepler – NASA’s planned WFIRST–2.4 Exo-planet Telescope

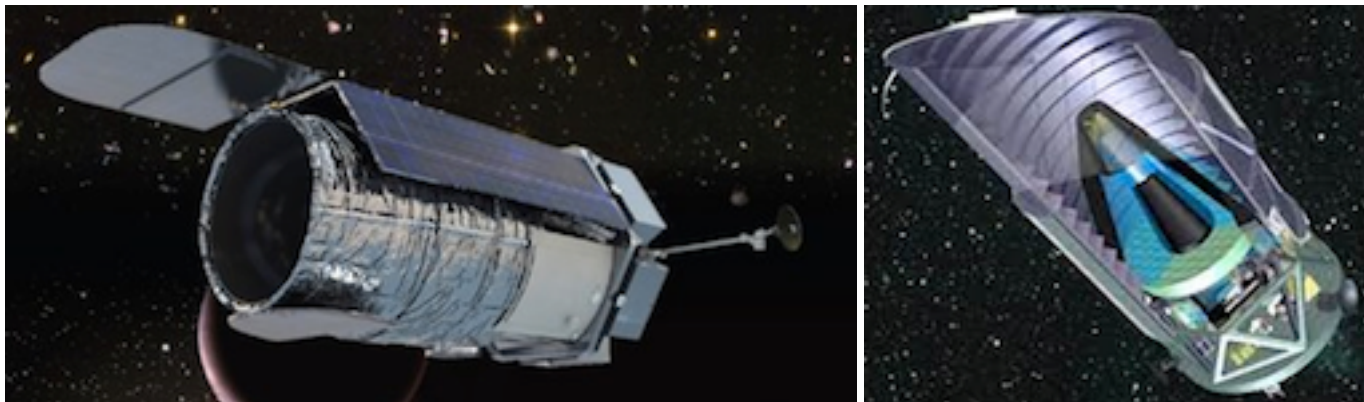
Exoplanet capabilities of WFIRST–2.4 – <http://www.thespacereview.com/article/2304/1>

Excerpts from the above May 3, 2013 Space Review Article by Philip Horzempa

[Editor’s summary. For the full article see the link above]

“New life has been breathed into NASA’s next flagship-class space telescope, the **Wide-Field Infra-Red Survey Telescope** (WFIRST), thanks to the unbidden “gift” to NASA by the National Reconnaissance Office (NRO) of two Hubble-class telescope mirrors.”

“As a bonus, this new WFIRST will be a bonanza for exoplanet studies. It would incorporate a coronagraph that will produce groundbreaking exoplanet science. In one fell swoop, the way forward for the top two priorities of the Astro 2010 team now seems clear.”



“The new WFIRST will be a powerful tool in the search for and study of exoplanets in a number of ways. The first is through microlensing, which takes advantage of the bending of space by massive objects, as first posited by Einstein. An exoplanet that passes in front of a distant background star (not its parent star) will cause the star’s light to be slightly magnified because of this space warp. This microlensing search was part of the original WFIRST mission. However, the use of WFIRST’s large 2.4-meter diameter mirror will allow the collection of three times as much light as its original design. This translates into a richer harvest of exoplanets and an increased ability to detect small terrestrial worlds. Overall, the microlensing survey should be able to detect several hundred exoplanets. Together with the results from Kepler, this will give us a better understanding of the architecture of other solar systems.”

“The plan is to search the closest 200 stars for planets. The telescope will not be able to image Earths, but it will be able to view Neptunes or Jupiters around our neighboring stars, if those planets are there. The results from Kepler indicate **that up to 50% of all stars have some type of planet orbiting about them.** Therefore, it is **likely that WFIRST will be able to image tens to hundreds of alien worlds in the solar neighborhood.**”

“WFIRST–2.4. It would be stationed in GEO, inclined 28.5 degrees. Why did the SDT choose that orbit, instead of the Earth–Sun L2 point, located about 1.5 million kilometers away? One of the main reasons concerns another aspect of the SDT design: serviceability of the telescope.”

“**Robotic servicing is envisioned for WFIRST–2.4. This may be based on planned commercial unmanned servicing of communications satellites in GEO.**” ###

## Asteroid Mining Company wants to launch a Telescope for Public Use

Space Telescope “Crowd-funding” Project Raises Over \$850,000 on First Day

<http://www.space.com/21354-crowdfunded-space-telescope-raises-167000.html>

<http://www.space.com/21523-planetary-resources-space-telescope-exoplanets.html>

<http://www.space.com/21349-arkyd-the-crowdfunded-selfie-taking-space-telescope-video.html>

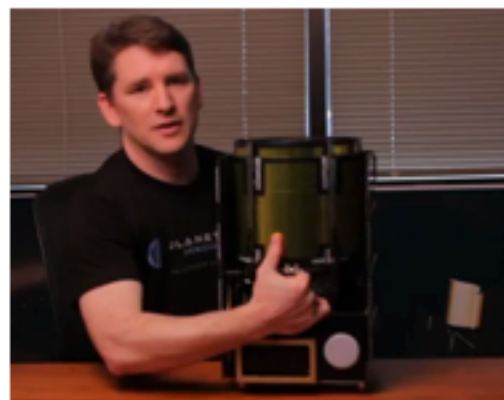
<http://www.kickstarter.com/projects/1458134548/arkyd-a-space-telescope-for-everyone-0>

<http://www.space.com/21345-asteroid-mining-crowdfunding-space-telescope.html>

<http://www.space.com/19373-planetary-resources-unveils-asteroid-hunting-arkyd-telescope-video.html>

[http://en.wikipedia.org/wiki/Crowd\\_funding](http://en.wikipedia.org/wiki/Crowd_funding) – <http://www.thespacereview.com/article/2306/1>

[Editor’s summary. For the full article see the link(s) above]



Updated June 11, 2013. **Planetary Resources [PL]**, a private venture aiming to mine near-Earth space rocks for water, minerals and other resources, announced May 29, that it would build and launch a space telescope or public use if it could raise at least \$1 million in 33 days. As of June 11th \$850,000, had been contributed, and PL has raised the stakes by pledging to upgrade the telescope to look for exo-planets if \$2 million is raised by the deadline.

The telescope will be a twin of the Arkyd spacecraft PL is developing to detect, track and study asteroids in preparation for its mining mission. A test version of the spacecraft is set for its maiden trial flight in April 2014. [<http://www.space.com/15387-asteroid-mining-planetary-resources-gallery.html>] The crowdfunded twin would launch in early 2015.

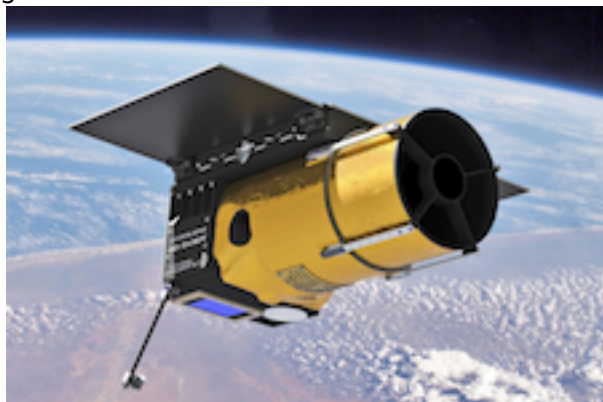
Public contributors can use the telescope to study celestial objects of their choice and can also sponsor research projects at schools, universities or museums that could use this instrument.

"For me, that's the single most exciting part of this, that it will be available to science classrooms, to astronomy classrooms, and kids will be able to do deep space exploration on this telescope on par with what's being done by NASA and other organizations that control all of the satellites," **Brent Spiner**, the actor who played Data on the "Star Trek: The Next Generation" television series, said during a webcast to raise funds for the project Wednesday night. "This one will belong to the people. I am here to represent the sci-fi crowd, and the line between sci-fi and reality is blurring more and more as time goes on and I think that's what really exciting about this."

Planetary Resources is developing an interface to serve a variety of users, from scientists to kindergarten students. "If you're a beginner, an 8-year-old, and you want to take a picture of Mars, you'll be able to do it, said co-founder and co-chairman Peter Diamandis (of the Google Lunar X-Prize team)

### Introducing "Space Selfies"

The telescope will also take "space selfies" — self portraits that show the telescope in orbit, with a user-submitted photo displayed on the instrument's screen. A camera mounted on the hull of the spacecraft will snap the photo. Already more than 200 backers have ordered selfies for \$25 and above, giving them the chance to see and feel and listen to what it's like to explore the solar system.



The crowdfunding project, hosted on the Kickstarter website, helps involve the public in PL's asteroid mission, which has garnered enthusiastic public support since its announcement in April 2012. "We really were blown away by the level of interest and excitement," Diamandis said. "We were not ready for it." The company has grand plans for public engagement, beyond the space telescope. "We're going to be looking at using this crowd that we're developing to help us do data analysis of asteroids, help us develop crowd-sourced software, and even hardware. Our goal is to democratize the access to space." ##

## Heat-Seeking, Alien-Hunting Telescope Could Be Ready in 5 Years

<http://www.space.com/21480-extraterrestrial-civilization-heat-seeking-telescope.html>

[Editor's summary. For the full article see the link above]



We might find aliens through the heat their civilizations give off, but it will take a mega-telescope to do the job. Such a telescope is planned. "Colossus," would be a massive 77m (250 ft) telescope, **more than double the aperture of any telescope yet constructed**. The sensitivity of the telescope could be enough to spot cities or other alien signs on planets as far as 60–70 ly from Earth.

"If and once the money is in hand, the telescope could be built within five years," said Jeff Kuhn, an astronomer at the University of Hawaii's Institute for Astronomy, who is on the proposal team.

Perhaps the aliens might not send out signals themselves. Perhaps they broadcast in channels we wouldn't think of using. Intelligent species may be cautious about sending out signals and alerting more advanced civilizations to their presence, as Stephen Hawking has said. This is where Colossus can shine, Kuhn said. The telescope is a passive receiver that allows astronomers to seek out extraterrestrials without alerting them to the search.

If a civilization was advanced enough to surround its star with a sphere ("the Dysons Sphere") to grab all the stars energy, some of that energy would bleed off as infrared light. From Earth, a star that is faint optically but very strong in the infrared could be an indication of such a sphere, Dyson mused.

Kuhn's team, rather than focusing on stars, is instead looking at the surfaces of alien planets. An object that was optically dark, but thermally bright, would be evidence of an extraterrestrial civilization.

### Seeking the heat

"The biggest telescopes that we're likely to see in the next 100 years or so will not be able to directly image cities or organized structures on the planet," he said. Still, he added, local heat sources could be visible.

"We can use the fact that the planet has to rotate, and that civilization is clustered either by the formation of continents or the use of land, which is agrarian versus organized into population centers. The assumption we make is that civilizations will cluster their heat use. It won't be uniform; they distribute it." Astronomers would probe heat sources in at least two different wavelengths to obtain the temperature. Natural features, such as volcanoes, should be far above the background heat of the planet whereas heat sources that are slightly above the planet's natural radiation are more likely to be signs of civilization.

The method has limitations. "It is possible to be confused on a planet which is perpetually cloud-covered, and we wouldn't be able to detect a signal on a planet where somehow the alien society managed to uniformly distribute itself around the planet so it isn't clustered," Kuhn said.

### Where Colossus might be built

There's no firm location yet for the telescope, but the San Pedro Martir mountainous area of Baja California in Mexico, close to the location of one partner in the project: the National University of Mexico in Ensenada, has been suggested. The 3,096 m peak, Picacho del Diablo, hosts a 2.1m telescope.

### Six patents pending

Kuhn's team would not compete with other astronomy projects for federal science or NASA funding. Instead, the idea is to seek private funding and money from six patent applications relating to optical technologies associated with the telescope design. The team, however, is open to partnerships with other institutions. One possibility could be the Search for Extraterrestrial Intelligence (SETI) Institute itself, but that organization prefers to focus on radio telescopes right now, Kuhn said.

An overview concept of the project was recently published in Astronomy magazine. ##

## Newfound Brown Dwarf Star System Is Third-Closest to Sun

<http://www.space.com/20197-third-closest-star-system-discovery.html>  
 (better, more accurate source) [http://en.wikipedia.org/wiki/WISE\\_1049-5319](http://en.wikipedia.org/wiki/WISE_1049-5319)  
[http://en.wikipedia.org/wiki/Brown\\_dwarf](http://en.wikipedia.org/wiki/Brown_dwarf)

[Editor's summary. For the full articles see the links above]

Editor's Note: This star system was found two years ago, but is just now being announced to the public. The quotes below are from the Wikipedia source.

**From Wikipedia:** "**WISE 1049-5319** (short for **WISE J104915.57-531906.1**), also known as **Luhman 16**, [1] is a binary brown dwarf located in the southern constellation Vela at 6.6 light years from the Sun, making these the nearest known brown dwarfs to the Solar System, and the closest system discovered since Barnard's Star (5.8 LY) in 1916. ... , pushing Wolf 359 (7.78 ly) into fourth place. The primary has a stellar classification of  $L8 \pm 1$ , and the secondary is probably near the L/T. [4] The pair orbit each other at a distance of about 3 AU [c. 450 million km, 279 million miles (comparable to the distance between the Sun and Ceres in the Main Asteroid Belt) with an period of about 25 years. [3]

"**Brown dwarfs** are substellar objects too low in mass to sustain hydrogen-1 fusion reactions in their cores, unlike main sequence, which can. They occupy the mass range between the heaviest gas giants and the lightest stars, with an upper limit around 75[1] to 80 jupiter masses."

"The system was found by comparing WISE images at different epochs to reveal objects that have high proper motions" across the sky (which is how Barnard's Star was found.)

"Eric E. Mamajek proposed the name **Luhman 16** for the system, or alternatively Luhman-WISE 1, hence the components could be called **Luhman 16A** and **Luhman 16B**."

"WISE 1049-5319 is also the nearest known star/brown-dwarf system to Alpha Centauri, 3.63 ly from it."



"The distance to this brown dwarf — is so close that Earth's television transmissions from 2006 are now arriving there," Kevin Luhman, a researcher at Penn State's Center for Exoplanets and Habitable Worlds, said in a statement. "It will be an excellent hunting ground for planets because it is very close to Earth, which makes it a lot easier to see any planets orbiting either of the brown dwarfs." (Space.com report)

[Editor's Comment's: In 1957, I did a statistical analysis of all the stars then know within 5 parsecs = 16.3 light years. It showed that the average closest distance between neighboring star systems was 6.1 light years, so we seem to be lucky to have such a fine star system as Alpha Centauri AB and C (Proxima) as close as they are, 4.3 ly. However I also found two stars that were only 1.1 light years from one another.

In general, the dimmer the class of stars, the more there are of them. There are many more M stars like Proxima Centauri and Wolf 359 than G stars like the Sun and Alpha Centauri A. It would seem then that there should be far more Brown Dwarf "star wanna-be's" than all true stars combined. If that is indeed the case, there should be many more Brown Dwarfs waiting to be discovered in our stellar neighborhood and there are probably more than one closer to us than Alpha Centauri.

Now while a Brown Dwarf does not emit enough light and heat to warm an Earth-like planet, it may well have ice-crusted ocean planets like Europa, with tidal power providing the heat. Hopefully, astronomers will locate one or two of those soon.

PK

## Messier Object Sky Wonders – Messier 13 Globular Cluster in Hercules

By Aleksandra Voinea

[http://en.wikipedia.org/wiki/Messier\\_13](http://en.wikipedia.org/wiki/Messier_13) – <http://messier.seds.org/m/m013.html>



### A magnificent sight that demands attention

In 1771, French astronomer Charles Messier was busy observing and listing comets. Certain nebulous objects however, kept interfering with his observations of comets. Therefore, he started cataloguing these objects, so that whenever he came across them, they wouldn't interfere with his observations. This became known as the Messier Catalogue.

The Messier object 13, also designated NGC 6205, is the Great Globular Cluster in Hercules. It is one of the most prominent and well known globulars in the Northern Hemisphere, and also a favourite with amateur astronomers and astrophotographers.

M13 was discovered by Edmund Halley in 1714, but catalogued by Charles Messier in 1764. His description of the Great Globular Cluster in Hercules has been reported to be: "This is but a little Patch, but it shows itself to the naked Eye, when the Sky is serene and the Moon absent."

Abundant in variable stars, Messier 13 covers an area equivalent to half the diameter of the Full Moon. It has been reported to contain several hundred thousand stars, with a diameter of 20 minutes (the Moon's apparent diameter is about 30 minutes), the equivalent of 145 lights years at some 25 000 light years away. Narrowing our perspective to the center of Messier 13, the stars are 500 times more dense than at its margins.

### A Message to anyone listening in Messier 13

The Great Globular Cluster in Hercules was one of the first targets for messages addressed to extraterrestrials. In 1974, as a proof of the capabilities of the Arecibo Observatory big radio telescope, a 3 minute, binary message was emitted in the direction of Messier 13. Although by the time the message ends its journey, M13 will have changed the position, sending the message emphasized on the importance of human possibilities of communicating with extraterrestrial beings.

It was broadcast into space via frequency modulated radio waves at the ceremony marking the remodeling of the Arecibo radio telescope, in 1974. The message consist of 210 bytes, at a frequency of 2380 MHz, and it was written by Dr. Frank Drake at Cornell University, with the help of Carl Sagan. The message contained the numbers one to ten, atomic numbers of the elements composing the DNA, the formulas for the sugars and bases in DNA, a graphic of the double helix, of a human, of the Solar System, as well as a graphic of the Arecibo radio telescope, and the dimensions of the transmitting antenna dish. [See the feature article "DNA to the Stars" by Robert McGown, just below.]

13 is not only a remarkable globular cluster and a favourite amateur astronomer space object, but also one of the first Messiers to be targeted for extra-terrestrial addressed messages, the Great Globular Cluster in Hercules is one of the most interesting Messier objects.

### M 13 Links:

<http://messier.seds.org/m/m013.html>

<http://scienceblogs.com/startswithabang/2012/12/31/messier-monday-the-great-globular-cluster-in-hercules-m13/>

[http://en.wikipedia.org/wiki/Arecibo\\_message](http://en.wikipedia.org/wiki/Arecibo_message)

[http://messier.seds.org/more/m013\\_m2.html](http://messier.seds.org/more/m013_m2.html) (amateur photos of M 13)

- Aleksandra Voinea plans to introduce TTSIQ readers to a new Messier object, each quarterly issue!

## MMM–India Quarterly Editors



- L: Peter Kokh** – [kokhmmm@aol.com](mailto:kokhmmm@aol.com) – [http://www.lunarpedia.org/index.php?title=Peter\\_Kokh](http://www.lunarpedia.org/index.php?title=Peter_Kokh)  
Former President of the Moon Society – Editor of Moon Miners’ Manifesto – Life member National Space Society – Milwaukee, Wisconsin US
- R: David A. Dunlop** – [dunlop712@yahoo.com](mailto: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



- L: Madhu Thangavelu** – [thangavelu-girardey@cox.net](mailto: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
- R: Srinivas Laxman** [moonshotindia@gmail.com](mailto:moonshotindia@gmail.com), Mumbai, Times of India correspondent – author “MoonShot India”

## Collaboration at the 2013 International Space Development Conf.

By David Dunlop

The 2013 ISDC provided another example of the NSS, Moon Society and OpenLuna working together to put on the two day Lunar track at ISDC. David Dunlop and Al Anzaldua were Co-Chairs of the Lunar Track.

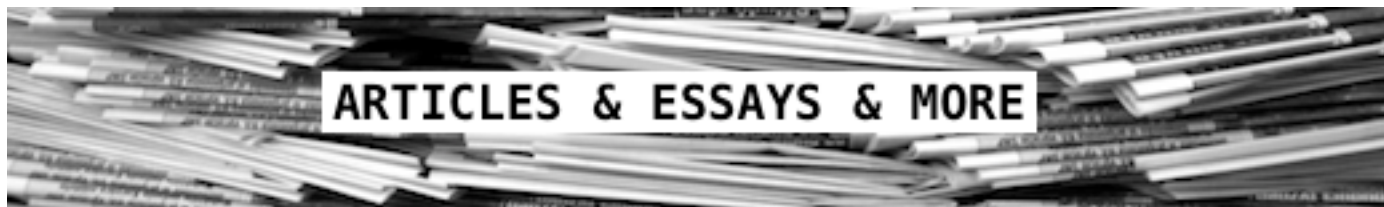
The first day programming was focused on the topic of exploration of lunar lava tubes with a program of lunar scientists including Dr. Heather Smith, NASA AMES, our Science Committee Chair, Dr. Pamela Clark, Catholic University and NASA Goddard, Dr. Penelope Boston of the National Cave and Karst Research Institute and New Mexico Tech, Dr. Aaron Parness of JPL, the participation of staff from the Lunar Mapping and Modeling Portal at JPL and Paul Graham of OpenLuna. There were presentations by Team Stellar GLXP. Rob Kelson, Robert Brand, Theo Vladich, and Maria Catalina contributed. We were deeply honored to have a presentation at the lunar by Apollo 11 Astronaut Buzz Aldrin who is also on the NSS Board of Governors.

The second day focused on cislunar economic development with presentations by Ken Murphy of the Moon Society, Al Anzaldua of the Moon Society, Dr. Dan Lester of University of Texas Austin, Dr. David Schunk, Dr. Andrew Barton of the XPrize Foundation about the GLXP, Dr. Suresh Naik of the ISS and Mitul Dikshit of ISS, and Dave Dunlop of the NSS and an additional presentation by Paul Graham of OpenLuna.

Another challenge was to utilize the GoToMeeting technology in order to provide remote presentations to the meeting in San Diego that would otherwise not have been possible due to the sequestration of NASA travel funds for many presenters. This provided experience with a blended model of conference organization and participation.

Peter Kokh built a model of a lunar lavatube for the ISDC and OpenLuna also had a booth supported by Debbie Wilkinson and other OpenLuna members in the conference display room. The Lunar track was well attended.

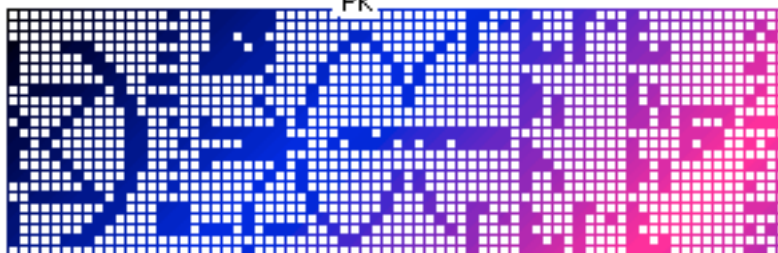
We anticipate making recorded sessions of the Lunar track available on the Moon Society web-site. DD



## DNA To The Stars

By Robert McGown

PK



The Arecibo Message – colorization by the editor

To use Newton's words, our efforts up till this moment have but turned over a pebble or shell here and there on the beach, with only a forlorn hope that under one of them was the gem we were seeking. Now we have the sieve, the minds, the hands, the time, and, particularly, the dedication to find those gems—no matter in which favorite hiding place the children of distant worlds have placed them.

– Frank Drake and Dava Sobel.

Perhaps as an advanced species in the universe our calling card is a message about our DNA. In the movie *Contact* (1997), radio astronomers receive a message from space that they can't understand and finally they figure out that the message is an instruction for a machine that will allow for space time travel through a wormhole. The engineers from Earth eventually build the machine and the \o communicate with the ancient ones of the universe. In a small way, we are trying to communicate with other civilizations today. Radio astronomers have sent out messages to target stars in space with information from Earth. Most radio telescopes are passive and you can't send messages to the stars. They are just capable listening, however some of the great ionic atmospheric bounce radio telescopes of the cold war are capable of sending messages to the stars

An early message that was sent to the stars was done on the Arecibo telescope in November 1974 by Dr. Frank Drake, Cornell University, who was the creator of the Drake equation. Drake wrote the message, with help from his colleagues Carl Sagan, and Barney Oliver founder of Hewlett-Packard. The Arecibo message was broadcast into space a single time via frequency modulated radio waves at a ceremony to dedicate the remodeling of the radio telescope.


They aimed the radio telescope at the globular star cluster M13, about 25,000 light years away because M13 was one of the largest globular clusters in the northern hemisphere. At the time they knew the stars in the globular cluster were some of the oldest stars in the galaxy. However they didn't know that stars in globular clusters tend not to have solar systems with planets, so the chance of the message going to a solar system in M-13 was very slim. The message was also sent out at 2380 MHz on a pulsar frequency instead of the cosmic watering hole so an extraterrestrial species would be looking at 1420 MHz instead of a pulsar frequency.

The Arecibo message consisted of 1679 binary digits, approximately 210 bytes, transmitted at a frequency of 2380 MHz with a broad cast time of three minutes. The signal was modulated by shifting the frequency by 10 Hz, with a power of 1000 kW. The "ones" and "zeros" were transmitted by frequency shifting at the rate of 10 bits per second. The Arecibo message is the product of two semi primes with a cardinality of 1679. It was arranged rectangular as 73 rows by 23 columns. These prime numbers were used because they would not normally found in nature together. The alternative arrangement, 23 rows by 73 columns, produces jumbled nonsense. The message forms the image shown below, or its inverse, when translated into graphics characters and spaces. Some scientists like Stephen Hawking or Martin Reese have said that maybe we should not be sending messages into space because an advanced alien race could come to Earth and take our resources.

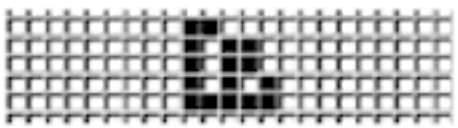
The message consists of seven parts that encode the following (from the top down) The body of this message is now included in Russian transmissions along with other information in the Teen Age message broadcast in Russian and English.

### How to decipher the original 1974 message

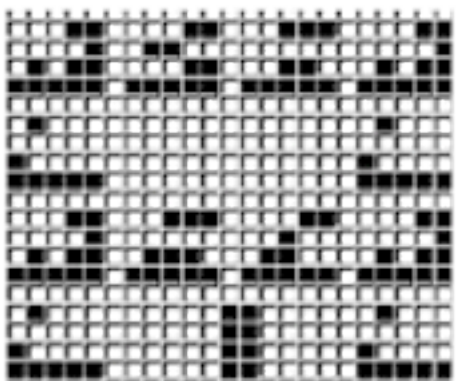
10 9 8 7 6 5 4 3 2 1      Showing decimal number 1-10




Atomic numbers of the elements which make up deoxyribonucleic acid (DNA)  
 1 - Hydrogen      6 - Carbon      7 - Nitrogen  
 8 - Oxygen      15 - Phosphorus



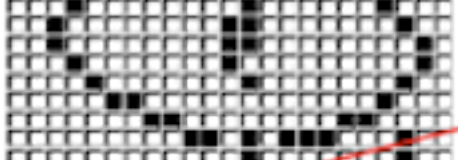
15,8,7,6,1



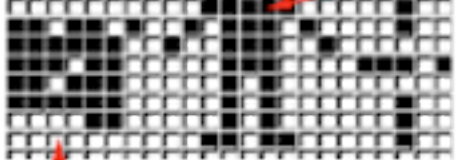
Formulas for Sugars and Bases in Nucleotides of DNA



Numbers of Nucleotides in DNA




DNA Double Helix

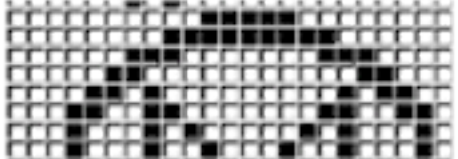


Human


Height of Human  
176.4 cm ~ 5' 9"



Population of Earth in Binary Code  
110110111111110111101111111111



The Solar System  
(highlighting Earth)



The Arecibo Telescope

Diameter of the transmitting antenna dish  
← 2430 wavelengths



Because it will take 25,000 years for the message to reach its intended destination of stars (and an additional 25,000 years for any reply), it is clear that the transmission was more a symbolic event than an actual attempt at communication.

**If we were attempting to communicate,  
we would probably send the message more than once,  
and to more than one spot in the sky.**

A 1999 press release said as much, with Cornell Professor Donald Campbell explaining, "It was strictly a symbolic event, to show that we could do it." Although the Arecibo message was more a demonstration of human technological achievement than a real attempt to enter into a conversation with extraterrestrials, the possibility remains that some intelligence could intercept the message and perhaps decode it -- and maybe, just maybe, reply.



**Left:** © OSETI Lynette Cook --- **Right:** Byrd steerable passive radio telescope, Greenbank West Virginia  
**After Arecibo: A Second Message**

In mid 2001, a group of Russian teens from the Moscow Center of Teen Activity, participated directly and via the Internet in composing a Teen-Age Message (TAM) to extraterrestrial intelligence, and in the selection of target stars. Organized by Russian Scientist Alexander L. Zaitsev, their message was transmitted in the Autumn of that year, from the Evpatoria Deep Space Center. Teen-Age Message (TAM) was transmitted at 18:00 UT on August 29, 2001 from 70-m dish of Evpatoria Deep Space Center to the Sun-like star HD 197076 in Dolphin Constellation. The total duration of TAM was 2 hours 12 minutes. The interstellar broadcast message consisted of three distinct parts.

1. Sounding Section -- coherent signal with slow Doppler wavelength tuning to imitate the transmission from Sun's center (10 min)
2. Analog Section -- Theremin concert to Aliens (15 min)
3. Digital Section -- Message: Logo of TAM, Greeting to Aliens both in Russian and English (70 min). The Coherent Sounding Signal was transmitted in order to help Aliens detect the message and to investigate some radio propagation effects in the interstellar medium. The Analog Information represents music, performed on the Theremin. This musical instrument produced quasi sinusoidal signal, which is easily detectable across interstellar distances. <http://en.wikipedia.org/wiki/Theremin>

There were 7 musical compositions in the 1st Theremin Concert for Aliens:

1. Melody of Russian romance 'Egress alone I to the ride'
2. Beethoven: Finale of the 9th Symphony
3. Vivaldi: Seasons. March. Allegro
4. Saen-Saens: Swan

5. Rakhmaninov: Vokalise
6. Gershwin: Summertime
7. Melody of Russian folk-song "Kalinka-Malinka"

The Concert program was composed by the Russian teens. The Theremin performers were Lidia Kavina, Yana Aksenova and Anton Kerchenko from the Moscow Theremin Center. A transcription of the digital TAM message the teens sent to aliens read:

#### Greetings from Teens to Aliens – TAM Text:

"Dear friends from the Universe!

We are the children from the Earth planet, sending this Message to you.

We want you to know that you are not alone in the Universe.

We offer to be your friends.

The Galaxy, where you and we live, is our common Home.

We named it the "Milky Way."

The Earth planet is moving around the star named Sun.

The planet itself is covered by ocean and land.

There are many creatures living our planet; but only people have created a technological civilization.

We live in families: parents and children. Children like to play.

We would like to show you our games, drawings, music.

The duration of our life is about 80 years.

While writing this Message, we are from 13 to 18 years old.

So, we hope to receive your answer.

People have many cultures, languages and religions.

People have reached the technical progress, but scientists have also invented horrible weapons, which may destroy the life on our Earth.

Our planet is very beautiful, but it is ill.

Our problems are wars, ecology, exhaustion of natural resources.

But we hope we shall overcome these problems and all people on Earth will be happy!

We would like (to hear) about you! Please, reply. We would be very glad.

We wish you peace and love. The children from the Earth, August-September, 2001."

#### The latest TAM target stars were:

HD designation	Constellation	Distance (ly)	Spectral type	Signal power (kW)	Date sent	Arrival date
HD197076	Delphinus	68.5	G5V	126	8/29/2001	2 - 2070
HD95128	Ursa Major	45.9	G0V	96	9/ 3/2001	7 - 2047
HD50692	Gemini	56.3	G0V	96	9/ 3/2001	12- 2057
HD126053	Virgo	57.4	G1V	96	9/ 3/2001	1- 2059
HD76151	Hydra	55.7	G2V	96	9/ 4/2001	5- 2057
HD193664	Draco	57.4	G3V	96	9/ 4/2001	1- 2059

Additional SETI research; Lynette Cook, Denise Keiser

###

**Robert McGown** is a member of the Oregon L5 Society (Portland, OR, US) Chapter of NSS

### Flash! – New Project Will Send Your Messages to Aliens in Deep Space

[www.space.com/21528-alien-intelligence-messages-lone-signal.html](http://www.space.com/21528-alien-intelligence-messages-lone-signal.html) – <http://lonesignal.com>

NEW YORK — A group of scientists, businessmen and entrepreneurs are tired of waiting for E.T. to get in touch. Instead of passively listening for signs, the **Lone Signal** project is asking people on the Internet to help beam messages into outer space when Lone Signal goes live June 18. This will be the first-ever attempt to send continuous messaging to anyone out there. **Your first text-only message is free**, but you can buy an unlimited number of text and photo messages that will be queued up and sent into space. After the first free communication, a text message costs one credit and a photo message costs three. Four credits can be purchased for \$0.99. For more information, check the websites above.

## Global Collaboration in 21st Century Space Efforts

By Paul Sudhakar\*

I believe that the Apollo space program happened purely out of the strong wish to beat Russia! Competition and cold war were the driving forces of that program. Well, it was then. things have changed a lot. Now we are in an era of globalisation. Economies have increased a lot. Countries are flourishing and developing in all fronts. But still, we humans are remaining under-achievers! yes, strange but true.

### Another image

The other day, I was in a shopping mall. The “LED lights” there caught my attention. They were shining brilliantly.

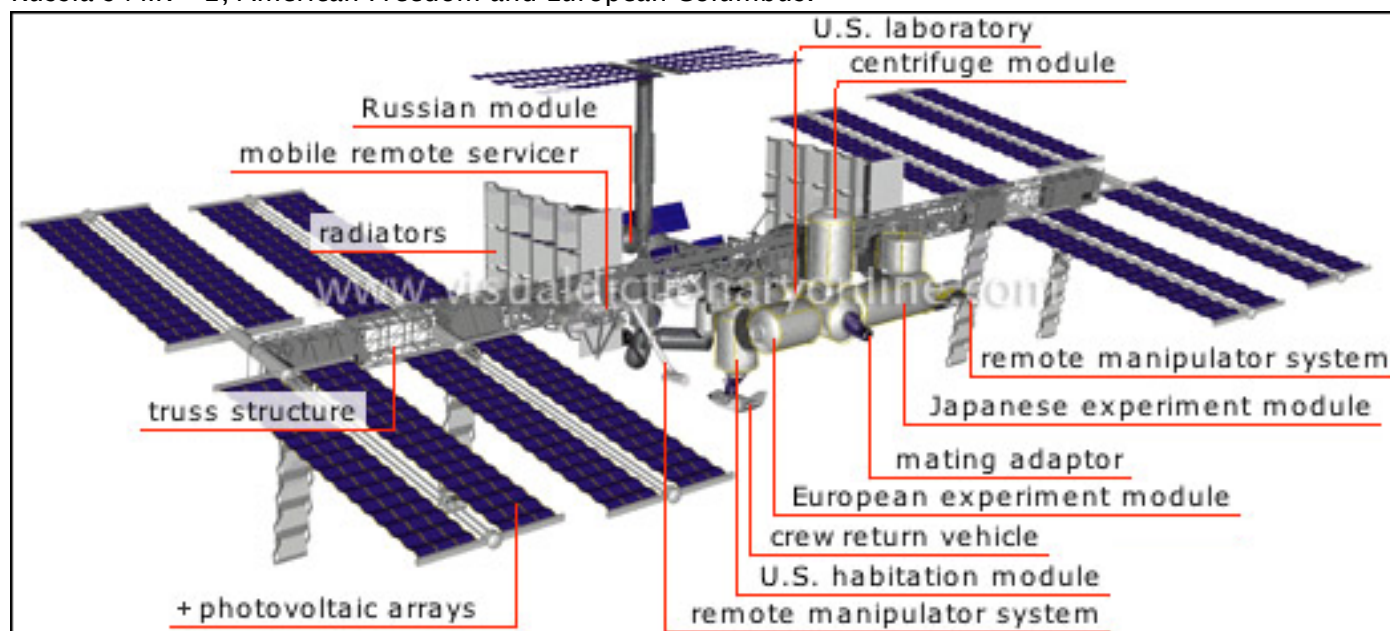


And then I thought, “well, what would happen if I separate them all and place them at different locations in the same room?” They all will glow. They will take the same energy input and they will give out the same energy out but they can't give the same amount of light the original lamp gives! Yes, when we concentrate the light emitted by all these little LEDs and beam it out through a convex lens, we get bright, sharp and powerful glow. But if we separate them and use them individually they becomes useless. Either way, we supply the same power. They emit the same light. But the way we use them makes a lot of difference in the output we get.

The same thing holds for us as humans and in particular to our space program. We, as individual nations have the ability to make our own space programs and run them efficiently. But there's a need to concentrate our efforts as one and make an integrated space plan and program for the future. Till now, we've shone individually. Now, it's the time to join our efficiencies and make a brighter and stronger impact. We've carelessly used our resources. We've recklessly damaged our home planet. We've messed up well enough not to be able to clean it up alone. So we better start working now to make our home a better place.

### The International Space Station establishes a new paradigm

The ISS was made possible only through global collaboration. We all know that ISS is the ninth space-station to be inhabited. But undoubtedly, ISS is the best ever. The reason is simple; it's a collective effort of many nations. ISS was made possible by the merging of Canadian robotics, Japanese Kibo, Russia's MIR - 2, American Freedom and European Columbus.



And we also know that ISS is the biggest space project ever even in terms of budget! It is obvious that ISS wouldn't have made it so far without the financial, technical and political support of the member nations. What better an example can be to explain the need of global collaboration in our space programs.

It is sad to see America taking controversial decisions like excluding a nation like China from its Space programs and partnership activities. It resulted in China planning to have it's own space station. What should we think about this now? Should we be happy for China or should we be sad that we're going the wrong way? Well, I personally am sad to see stuff going the wrong direction. We are wasting our resources! If China can build a space station on its own, just imagine, what amazing stuff it could do with the support of ten more nations? China is shining well. Other nations too will glow well undoubtedly. But what's the use if we're not ready to focus our energies? Our growth and glow will just go useless. It's a pure waste of valuable energy, resources and economies.

This is what I propose, This is how the future space program of the World should be:

- We should have an integrated space program for the whole world.
- Space programs should first concentrate on projects that address major problems of the world and then move to any other projects.
- Any project whatsoever should be a joint venture of all the member nations.
- Tasks should be shared and worked out simultaneously, complementing each other to sum up for the big picture.

I want to say something this context; It's really amazing to see how the private space industry is flourishing in the U.S.A. We now have Space X, Deep Space Industries, Dynetics, Virgin Galactic, Mars One etc... each one is with a different agenda and work stream. I don't see any point in these companies competing with each other, since they are of different work streams. One is working to send humans to Mars, one is designing reusable launch vehicles, one is developing space tourism and the other is trying to mine the asteroids.

Now, if Deep Space Industries wants to mine asteroids on its own, and doesn't want to join hands with anyone, it has to develop

1. Technology and machinery for mining
2. Space suites in case it plans a manned mission
3. Launch vehicles from ground to orbit
4. Deep space vehicles to travel between the orbit and the mining site and back
5. Special communications systems
6. New generation propulsion systems,
7. (and much more)

But if DSI joins hands with other private space industries and make a collaborative effort, the work will be easy and effective. For example, DSI can work on developing mining techniques and technologies. Space X can provide launch support, X-cor or some others can work on improving propulsion systems, Dynetics can provide communication systems, Mars One which is planning to send humans to mars will be working on space suits. so we can use its services for developing space suits. And there are many more endless possibilities to cooperation between commercial companies, just as between the various national space agencies.

If in the U.S.A. itself, we can do lot of collaborative work and produce amazing results, imagine what better and bigger projects we can do with international collaboration!

### **What about political issues?**

People talk about POLITICAL issues when dealing with global collaboration. And it sounds quite funny! Being global doesn't mean losing one's individuality. We should be clear about this. Having an integrated space program doesn't restrict any country from doing space programs outside of the "integrated program."

Countries are always welcome to proceed with their 'personal' projects if they are capable of investing in them even after investing in the global space program. Having a global space program and collective work plan is not a tough task. It just need willing hearts and dedicated efforts. And by the way, for those who support nationalism and individualism – 'Global efforts and collective space program' is not a choice anymore, it is a must!

Ad Astra!

PS

Paul Sudhakar, who comes from Andhra Pradesh State in SE India, is a member of the National Space Society's International Committee, and its representative in India. Paul served on the 2013 International Space Development Conference Organizing Committee (San Diego, May 23–27, 2013).

## Moving Forward with the Kalam NSS Initiative

By David Dunlop, Chair NSS International Committee

June 29, 2013

The 2013 International Space Development Conference marked as its highlight a visit and address by Dr. A.P.J. Kalam on the topic of Space Solar Power. We have not included the full address in this issue of TTSIQ but it can be accessed on the web site of Dr. Kalam: [www.abdulkalam.com](http://www.abdulkalam.com). Its Title is: "Space Solar Power: Key to a Livable Earth." and also on the NSS web-site at:

[www.nss.org/news/releases/Kalam\\_Address\\_Space\\_Future\\_June2013.pdf](http://www.nss.org/news/releases/Kalam_Address_Space_Future_June2013.pdf)

Dr. Kalam also received the Von Braun Space Pioneer award from the National Space Society. I was privileged to meet with with Dr. Kalam along with other NSS leaders during his visit to the ISDC.



**Left;** Doctor Kalam at another event    **Right:** Dave Dunlop presenting a University of Luna Award in 2010

The NSS International Committee will work with other NSS committees to advance this Kalam–NSS initiative and in representing this effort as an observer organization at the United Nations. Paul Sudhakar's article (just above) also expresses our desire to encourage the efficient use of international resources to accomplish this essential global initiative.

We look forward to reporting on the development of this program in upcoming issues of TTSIQ.

We have included below a joint statement of Dr. Kalam and Mark Hopkins regarding our joint efforts to advance the cause of Space Solar Power as a collaborative international Initiative.     DD

## Space Solar Power: Key to a Livable Planet Earth

Joint Statement of Dr. A. P. J. Abdul Kalam, Former President of the Republic of India  
and Mr. Mark Hopkins, Chairman of the Executive Committee, National Space Society

June 1, 2013

We, Dr. Kalam and Mr. Hopkins, have long shared humanity's dream of all nations living together in prosperity and peace and moving forwards through global collaboration in space to meet the challenges that now face our Planet Earth. We are conscious that all nations have to strive to make our planet livable again, after centuries of devastation of its environment and ecosystems and rapid depletion of its precious mineral resources, including fossil fuels and fresh water.

Over these last three years many of our colleagues in NSS and in India, have come together and made progress towards this international collaborative mission by sustained dialogue with mutual respect, understanding and trust. It is essentially this process that has helped us to decide that the time has arrived for us to together attempt to give a direction and momentum to this movement to realize space solar power and its enabling technologies through international collaboration that can help rebuild our environmentally vulnerable planet.

Today, Dr. Kalam and Mr. Hopkins undertake to work together in a well organized and well supported manner to realize such a 21<sup>st</sup> Century global collaboration; and together help to lay the structural foundation for an international collaboration to develop and deploy space solar power systems. We are aware that coalitions and collaborations work best if there is a shared mission and common goals, and effective leadership. We need to build strong, trusting relationships across nations through a participatory process with the active involvement of member nations and their institutions and organizations. We will work to develop an effective mission governance process and hope to evolve, jointly and together in international teams, clear operating procedures regarding decision-making, communications and accountability. We shall be working together to develop a shared vision, to build strong relationships within the leadership team, and to rotate leadership roles.

Such a shared vision shall include specific mechanisms such as the Global Space Knowledge Platform, the International Virtual Laboratory, and the International Advisory Committee that Dr. Kalam has elaborated through discussion papers with Mr. Hopkins and his Address to the 2013 National Space Society's International Space Development Conference (ISDC 2013). We hope our international collaborative mission will act as a catalyst for a livable planet which will promote prosperity and peaceful relations within and between nations.

We shall start our team building and mission structuring phase with core members from nations who we know are already networking and who are contributing to the dream of harvesting energy from space, including the US, India Japan and the UK. We shall also invite as observers, representatives in relevant domains of public policy, science and technology and management systems from other space faring nations like Russia, China and other European nations. We shall engage in open and frequent communication with people who share our values and goals in governments and societies which are important to the success of this venture. We will help accomplish this through collaborative practices that are the true hallmark of effective global cooperation for a livable planet Earth. We shall have a clear plan of action to market the idea of a livable planet Earth through space solar power to G8 or G20 nations within a year.

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Towards this end we agree to start working together by jointly identifying the core members and observer members in the joint working mechanisms that Dr. Kalam has proposed. This shall be the direction of what we must accomplish in the coming months. We shall build upon the trusting relationships we have established and consolidated these last three years between NSS, Dr. Kalam and others in India. We shall now strive to expand this relationship in an organized and well-structured manner towards an international collaborative mission to realize space solar power for all humanity.

#### **Links:**

<http://blog.nss.org/?p=2214> – National Space Society Announces the Kalam–NSS Energy Initiative  
<http://www.nss.org/news/releases/pc20101104.html>  
<http://www.nss.org/news/releases/pc20101104.html#video>  
<http://www.nss.org/news/releases/pc20101104.html#statement>  
<http://www.nss.org/settlement/ssp/library/SkysNoLimit–IDSA–Garretson–2010.pdf>  
<http://www.nss.org/news/releases/pc20101104.html#news> ##

## Visiting the Friends of Amateur Rocketry (FAR) launch facility in the Mojave

By David Dunlop

After the 2013 International Space Development Conference in San Diego, California, May 23–27 I received an invitation from Maria Catalina of the Google Lunar X-Prize Team **Stellar** to attend a rocket launch at the Friends of Amateur Rocketry (FAR) launch facility in the Mojave desert where a Freshman–Sophomore team from the University of California at San Diego (UCSD) were launching a rocket that they developed during the prior semester.

They were one of several teams launching that day at the very impressive launch site: They were also joined by the Junior–Senior UCSD team and by teams from Stanford University and Cal. State Los Angeles. Also visiting FAR was Debbie Wilkinson of [OpenLuna.org](http://OpenLuna.org) who shared a bunker with me during the launch.

The photos below show some of the teams and the facilities.

<http://friendsofamateurocketry.org/Home.html>



**LEFT:** UCSD “Clear the range and let her rip!”

**CENTER:** The FAR launch stand for serious projects!

**RIGHT:** UCSD Senior Team loading their Bad Boy on the launch rail!



**LEFT:** Hopeful UCSD Freshmen–Sophomores Ready for Launch

**RIGHT:** Dave Dunlop and OpenLuna’s Debbie Wilkinson happy to be in the launch bunker!

In addition to buildings for preparing the rockets, and the launch bunkers the FAR launch site has an array of launch equipment including a large launch rail, test stand, static firing rigs, and a large surrounding landing range.

These facilities have been developed in the last ten years or so and are also used on occasion by commercial companies who lease these superb facilities for their launch activities from FAR. During the launch the facility had an FAA Waiver for a 40,000 launch attempt by the Stanford team. DD

### Mojave Air & Space Port

[http://en.wikipedia.org/wiki/Mojave\\_Air\\_and\\_Space\\_Port](http://en.wikipedia.org/wiki/Mojave_Air_and_Space_Port)

<http://mojaveairport.com>

**VIDEO:** <http://www.youtube.com/watch?v=-g6EBnBvg-I>

## Landing on the Moon: NASA's Project Morpheus

Background information from David Dunlop

1 <http://morpheuslander.jsc.nasa.gov/>

2 <http://voices.yahoo.com/landing-moon-nasas-project-morpheus-12176174.html?cat=15>

3 <http://www.houstonchronicle.com/news/nation-world/article/After-failure-NASA-mission-flies-again-4603199.php?t=8103b139d6057dc840>

Jun 17, 2013 Ever since President Obama decided to bypass the Moon and send the next human explorers to an asteroid, development of a vehicle capable of landing people on the lunar surface has been set aside. That doesn't mean that technology development has stopped.



One of the small scale prototypes that is being developed and tested that might lead to a lunar lander is called Morpheus, a project by a small engineering team at Johnson Spaceflight Center.

Morpheus, according to the NASA Morpheus site [first link above], is a test bed vehicle capable of landing 1,100 pounds of cargo on the lunar surface, say a robot, a small rover, or a plant to extract oxygen from lunar soil. It incorporates a number of new technologies. Its rocket engine burns methane and oxygen. Methane has some advantages over liquid hydrogen. It is not only easier to store in space, not being as susceptible to boil off, but can be extracted from local resources, such as ice on the Moon or Mars. 1,000 pounds of methane a year is produced on the International Space Station and is expelled as waste which could instead be used by spacecraft with engines like Morpheus. Methane is also more suited for in-space transfer from an orbiting fuel depot.

Morpheus is also testing a precision landing hazard avoidance system. This would allow a landing craft to land autonomously on the surface of the Moon or Mars and, with some modifications, rendezvous with an asteroid.

Currently the second version of Morpheus is undergoing a series of tests, which included flight tests while attached to a tether. Eventually Morpheus will be tested in a free flight at the Kennedy Space Center. The previous version of Morpheus crashed and was destroyed during a free flight test.

If the new version of Morpheus passes a series of free flight tests, the next obvious step would be to use a space-worthy version to land a payload on the Moon. Indeed Morpheus was an outgrowth of a proposal floated at NASA called "Project M," which would have landed a version of the Robonaut now being tested on the International Space Station.

However flying something to the moon would require not only funding, but an alteration of official NASA policy that has eschewed the moon as a destination. But, considering that Morpheus was evolved from vertical takeoff and landing experiments conducted by Armadillo Aerospace and that NASA seems to be open to supporting a private sector return to the moon, perhaps a lunar mission could be conducted in partnership with one or more commercial companies. DD

## NASA's Morpheus Lander Technology Demonstration Mission

By David Dunlop

Somehow NASA's Morpheus Lander project at Johnson Space Center has escaped the prior attention of TTSIQ which is rather curious for a publication which has a significant focus and interest in any and all lunar missions. Perhaps this because this has not had a Science Mission Directorate sponsorship but rather a technology development initiative in the Exploration and Operations Mission Directorate of NASA. For advocates of a continuing lunar exploration program that is indeed fortunate as most new missions



proposals over the last three or four years with a lunar destination have remained unfunded. The last of the string of NASA funded lunar missions, LADEE is now scheduled for launch in September of this year.

The development work of liquid oxygen–methane engines and a hazard avoidance and landing system have application not only to lunar destinations but could also be part of a Mars or even asteroid landing mission. So we sincerely hope that this technology demonstration program will ultimately remain funded and yield another NASA lunar landing mission, the first NASA landing since Apollo 17 left the Moon's surface. Perhaps a successful Chinese landing in 2013 will encourage the US Congress and NASA HQ commitment to “make it so.”

But these two technology demonstrations do not define others that might also be added to this technology demonstrator mission. Clearly a capable chemical propulsion system will be needed for a lander which could deliver up to 1100 lbs to the lunar surface. This is more than double the payload capacity of the GLXP Moon–X or Astrobotic landers and of a magnitude which could permits In Situ Resource demonstration payloads.

NASA's new Space Technology Mission Directorate has a variety of additional technology development initiatives. These technology initiatives might also be useful demonstrators for testing in cislunar space.

One of these which will make its first flight on LADEE is an **optical laser communication system**. So I would propose that a Morpheus lander might provide an additional test of this laser communications system down to the lunar surface.

### **Solar Electric Ion Propulsion System Technologies**

- A 2nd initiative is a **22 newton ion thruster engine** which might be used with redundant units to provide propulsion for a low energy trajectory to the Moon and to also provide for changing Lunar orbits once at the Moon.
- A 3rd technology project addition could be the demonstration of **composite tanks for xenon fuel** as another component of an ion thruster system.
- A 4th technology project addition could be the **large solar panel array and deployment mechanism** to provide power for the solar–electric propulsion system.
- A 5th technology project is the development of **Power Processing Units** from the solar panel arrays.
- A 6th technology project is the development of **integrated solar sail and reflect array antenna** for cube satellites. These might have great utility for long duration cislunar positioning system satellites.
- A 7th technology project is the development of a **miniaturized high precision timing atomic clocks** which would provide another critical component for a cislunar positioning system.

My point in providing this laundry list from the NASA Space Technology Mission Directorate funded projects is that a variety of new technologies have great utility in cislunar space in general, and specifically on the way to the Moon, in orbits near the Moon, and as part of missions with both lander and orbiter components. I hope that the Morpheus Project is merely the first of a series of technology demonstrator missions which can be usefully tested in cislunar space and or all the way down to the lunar surface.

If the Space Technology Mission Directorate and Exploration (STMD) and Exploration and Operations Mission Directorate (OEMD) are funding rides to the Moon's surface we also hope that opportunities to provide planetary science instruments can also be afforded even if science is not the primary purpose. STMD's funding of SBIR, and TTR initiatives can encourage private investment in such demonstrations. The Innovative Lunar Data Demonstration Model can also be integrated with cislunar technology demo missions so that a variety of funding elements can be leveraged to provide both engineering demonstrations, demonstrations of commercial feasibility and the utility of a commercial market in accessing the lunar surface, and the ability to do useful science to boot.

In a previous issue we reported on NASA Deputy Administrator, Lori Garver's statement to the AIAA organization that “NASA has not abandoned the Moon”. The Morpheus mission is another example that this is true. NASA's technology development program is also supportive of changing to a climate where more new and more cost effective technologies and the commercial sector can provide services previously only a government monopoly could fund. The finding constraints on NASA in general because of the down turn of the US economy since 2008, and the consequent withdrawal of SMD funding for new lunar missions is making for a long and difficult birth of commercial model of lunar access. This economic climate has also proved difficult for the GLXP teams and program experience.

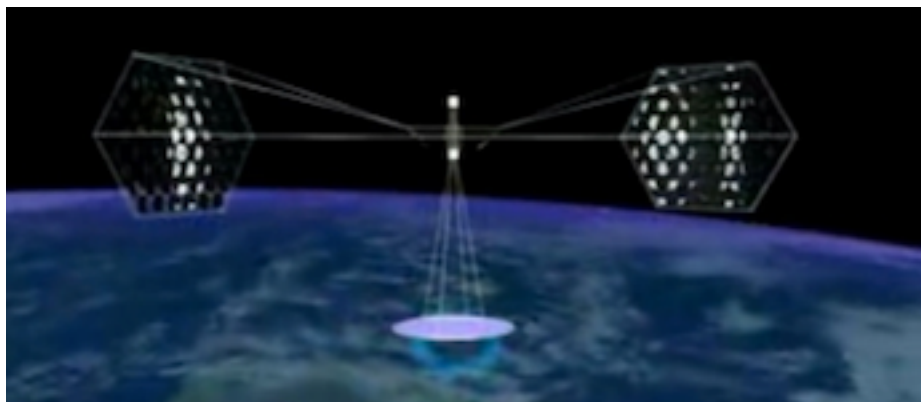
Nevertheless, we hope that NASA's continuing role in lunar development and the efforts of the GLXP program can provide successful demonstrations and confound both the critics and skeptics. We hope that these efforts will ultimately follow a path like that of Comsat and Intel Sat in the 1960's, which combined both national and multinational investments as well as commercial investments to create the foundations of a thriving commercial satellite industry now worth over \$200 Billion annually. DD

## Shaping A Global Strategy for Space Solar Power Advocacy and the Kalam–NSS Initiative

By David Dunlop

### Dr. Kalam's Challenge

Elsewhere in this issue we reported on the visit of Dr. Abdul Kalam to the National Space Society International Space Development Conference in San Diego his address mapping advocating a Global Knowledge Platform and Virtual Research Institute, and a Joint Press release in this regard with Mark Hopkins, Chair of the NSS Executive Committee. Paul Sudhakar wrote about the rationality of using global combined resources in this regard. Dr. Kalam, who served from 2004 to 2008 as the President of India is a globally recognized scientist and statesman.



### The Kalam–NSS Initiative

Now the the hard work of shaping a program to create a global space solar power initiative begins. One might ask what the National Space Society can achieve in reaching a goal of such immense proportions and how we might go about that. The role of NSS is important in developing a refined strategy and an expanded network of support.

1. The National Space Society has played a unique and historic role in space advocacy tracing its roots to Dr. Werner Von Braun and the its predecessor organizations the National Space Institute and the L5 Society one of whose founders Keith Henson is still active in promoting the vision of space settlement and the expansion of the Earth's economy focusing on solving the problem of creating low cost access to space. The promise of Space Based Solar Power has been on our radar from the beginning. The beginning proposals of Dr. Peter Glaser in the 1960's presented the prospects of the creation of space solar power satellites. **NSS has followed the progress on research on SSP since its inception in its Ad Astra publication.**
2. **NSS has documented this research on it Space Solar Power web–site library especially through the dedicated efforts of David Brand–Erichsen.** This is one foundation piece of the Global Knowledge Platform proposed by Dr. Kalam. A. At least one generous offer of a mirror web–site was provided when Dr. Kalam gave his speech at the ISDC. B. A network of global servers will be needed to support collaborative activities by global participants.
3. **An International network of universities that are academic collaborators on Space Solar Power is another component of this Global Knowledge Platform.**
  - A. NSS is fortunate in its current university connections:
    - a. Dr. Peter Schubert at the Richard Luger Alternative Energy Center of Indiana and Purdue Universities.
    - b. Darell Preble of the Space Solar Power Institute at Georgia Tech.
    - c. Dr. Nobu Kaya of Kobe University of Japan, a frequent contributor and supporter of SSP research and development and close supporter of Kalam –NSS SSP initiative.
  - B. The scope of the Space Solar Power research and development program must also be structured to provide many opportunities for Universities and the students they are training to participate in this enterprise and to propose and implement new technology and engineering projects. The Cube satellite paradigm is one that provides affordable opportunities to design, build, launch, operate, and test new ideas and techniques in space.

- C. One area of significance for the international collaborative SSP technical roadmap is to both solicit and encourage the financial, design, and launch support of such beginning demonstrator projects by national space agencies in the areas of space solar power. This is a way that both national space agencies and participating universities can work together on affordable projects and to use web-based tools and communication to encourage global collaboration as a standard practice in building a global workforce. These are the kinds of initiatives a Global Knowledge Platform and a Virtual Research Institute can define and where the NSS can be a strategic catalyst.
4. **The NSS can advocate for increased US government support** for this initiative through its legislative blitz and advocacy and education role with the United States Congress.
5. **NSS can work to develop a strategic Space Solar Power technology roadmap** that can guide international discussions about funding of needed research and development and also about areas where collaborative international efforts can arise.

- A. Some of this work is occurring in the NSS Policy Committee under the leadership of Dr. Paul Werbos of the National Science foundation.
- B. NSS is also to have the strong support of Dr. John Mankins, formerly head of NASA's Space Solar Power program and the Editor of the International Academy of Astronautics First International Study of Space Solar Power in 2011. Dr. Mankins is also a leader in the IAA Space Solar Power Working Group at its International Astronautical Congress meetings and annual meeting in Paris. Dr. Mankins has also been an anchor of our SSP track at the ISDC.
- C. The NSS International Committee can also advance these efforts through its outreach activities and its position as an observer organization at the United Nations.

The NSS roadmap for SSP research and development may be another arena where international joint projects and demonstration projects might be proposed. The biggest international collaboration in space to date is the International Space Station (ISS) so there is ample precedent for multi-national collaboration on the largest scale of operations.

A large demonstration project of a Solar Power Satellite in GEO will no doubt be a significant milestone in a SSP research and development roadmap, but such as project would hardly be the starting point with today's launch costs and space infrastructure development. Many smaller scale research and demonstration projects that are both economically, organizationally and politically feasible must come before. There are precursor space infrastructure developments such as a cislunar positioning system and cislunar communicate that are needed and which may create opportunities for both governmental and private commercial investment. It is important to propose the use of current assets and launch systems to provide starting points for SSP collaboration. Yet it is important to propose and provide a wide range of project options for SSP from those that might include the ISS which has the largest array of solar panels to those that provide smaller satellite based projects to test new ideas and technologies in space as well as ground based research.

6. **NSS can also use its web-site, and publications to educate the global community** about both the environmental and economic necessity of space based solar power as a global clean energy solution. Both Dr. Werbos and Mark Hopkins are economic experts and highly focused on making both the research and develop case as well as the economic case for space solar power. It is a truism that "Money makes the world go around" and it is no less true that energy is the economic life blood of the global economy.

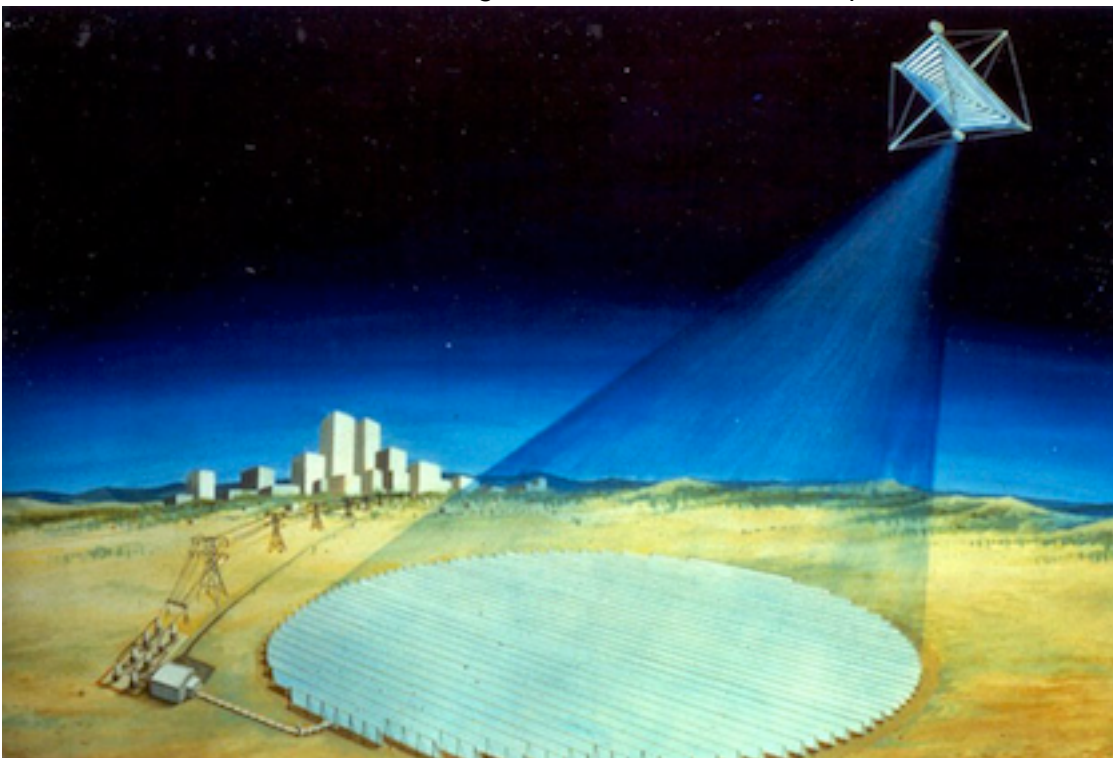
The global fossil fuel economy has many costs which have heretofore been treated as "externalities". That is to say many costs have been "hidden" by not actually being calculated in the user price of energy. These hidden costs are often associated with environmental pollution and destruction, such as the increase in global CO<sub>2</sub> as a result of carbon emissions from fossil fuels, acid rain, and climate change impacts on global ecosystems.

The "business case" for fossil fuels is weakening as consumers and governments face massive and increasing costs for these "externalities." The business case for space solar power is currently not competitive with fossil fuels but improving as a drop in launch cost is anticipated and as improvements in the efficient use of power can be made as discussed by Dr. Kalam in his address. The business case for space solar power in an "apples to apples" comparison with existing fossil may well be much more competitive when the externalities of future fossil use are calculated with those of much more environmentally benign solar power. The strategic demand for energy is relentless and the demand for clean energy makes the development of space based solar power essential for the continued peaceful development of the global economy and for the preservation and restoration of the global environmental systems.

7. **NSS can be assisted by its International friends to advance the cause of Space Based Solar power.**
- A. NSS Australia, has its own conference and chapter network and Kirby Ikin, an Australian is Chairman of the NSS Board.
  - B. Space Canada is another organization that has strongly supported the cause of Space Solar Power and been a generous and active participant in the ISDC conferences, including this most recent one in San Diego as well as in organizing conferences and activities in Canada under the leadership of George Dieterich.
  - C. Another organizational friend is the International Space Society in India. The Chairman of the ISS Dr. Suresh Naik, and the Executive Director Mitul Dikshit were present at the ISDC in San Diego, participated in the Lunar Track. They met many of the NSS leaders and developed an organizational agreement for future collaboration. ISS holds its own large educational and space conferences in India and NSS will cooperate in these and other activities with NSS. Dr. Naik was a former colleague of Dr. Kalam at the Indian Space Research Organization (ISRO) and is also a strong advocate of Space Solar Power.
  - D. NSS member of the BOD and Board of Governors Howard Bloom has a Space Settlement Steering Committee which has developed a SpaceSolarPower.org web-site which also promotes Space Solar Power development. While these friendly partnerships are a good beginning it is clear that for the Kalam-NSS Initiative for SSP to succeed that we must greatly expand our international contacts and working friendships in all the G-20 countries and others.
  - E. The NSS can also use its good offices to represent the cause Space Solar Power in International contexts such as meeting concerning energy development and planning policy, energy and environmental issues that are intertwined such as those connected with fresh water supplies, environmental damages that can be avoided or remediated with SSP, and future concerns and scenarios about about national economic growth and productivity.

### Conclusion

NSS has a formidable and significant role to play in shaping the global advocacy movement for the development for Space Solar Power. It has many avenues it can explore and promote in providing specific opportunities for international collaboration. To The Stars International Quarterly will provide continuing coverage of this campaign to realize the benefits of the economic development of space for the benefit of humanity and the Earth's environment and the growth of the Earth's econosphere. DD



Solar Power beamed to a kilometers-wide rectenna. Agriculture and grazing underneath would be safe.

## What if some stellar wonder were right in our backyard?

By Peter Kokh

When I was growing up in Milwaukee (150 km north of Chicago on the west shores of Lake Michigan) in the late 1940s and through the 1950s, you could see many more stars in the nighttime urban sky than you can now. However, in 1946, after the war (WW2) was over, I went with my maternal grandparents “up north” to their hometown, Florence, Wisconsin, just across the state line from Iron Mountain, Michigan, and there they bought 2 acres on a dead end road, with an old farm house, and empty fields to the South and East. Years later, in 1969, I bought an old 2.4x10.6m 1955 “house trailer” (or “caravan”) and put it along the East fence. Every year since 1946, except 1961 (I was in England all year), I have spent time up there. And one of the things I most treasure is the awesome nighttime skies, full of stars, the likes of which a city dweller could only dream.

In a way, except for the Milky Way, Earth’s skies, are rather prosaic. This is perhaps fortunate as far as legends and religions go. If that seems a weird statement, consider the impact on early cultures if one of the sights below were near enough to literally “dominate” the heavens, to the point of “being in our face?”



M31 Andromeda 2.6 million light years from us



The Whirlpool Galaxy 23 million light years



Omega Centauri Globular Cluster 16 thousand ly



“Double Cluster” – h & χ Persei 7.5 thousand ly

If one of these objects were located at a tenth the distance and thus a hundred times as brilliant, and dominated the sky for part of the year, what would have been the effect on early “prophets?” Would one of these sights be “God?” Or his “angels?” Should we be thankful our skies are just generally magnificent, or “so so?”

Actually, the galaxies relocated a tenth the distance, would still not be that bright. The photos are bright only because of the length of time the film was exposed. As to the Double Cluster, brought much closer, its stars would mix with other bright stars in the background, as is the case with the Big Dipper, most of whose stars belong to a very nearby cluster.

The only object above that would be a real “wow” scene would be the large Globular Cluster, Omega Centauri. With nothing comparable elsewhere in the heavens that bright, it could well have shaped religions and cosmologies prior to the invention of the telescope, when we would find many other similar clusters. But having a globular that close would be unlikely, as their domain is generally well above or below the galactic plane.

Actually, the Northern Lights or Aurora Borealis, has played a significant role in Eskimo/Inuit/Samoyed legends, the swiftly dancing lights with shifting colors seems “mischievous, evil, something to worry about” – but hardly the apparently immutable brilliance of a nearby globular cluster.

But there is another thing to be thankful for – the thick dust clouds which hide our own galactic core, which lurks behind them, unsuspected, in the constellation Sagittarius. Without the dust clouds, Our “hub” might make an incredibly awesome sight, extraordinary enough to affect legends and myths and early religions. As to the rest of our Milky Way galaxy, as it extends around the heavens 360°, it is too decentralized a sight to attract “deification” even though it is in itself an awesome wondrous sight from a location far from city lights on cloudless nights. PK

## Refueling Stations Beyond Low Earth Orbit: The Stage is Set. Mining Asteroids? – or Dormant Comets? – Pros & Cons

By Peter Kokh

The Moon, having been formed “hot” is relatively depleted in the volatiles necessary to support life: hydrogen, carbon, and nitrogen. We do now know that the permanently shaded areas of the Lunar Poles harbor comet-derived ices, most likely including water and nitrogen and carbon oxide ices. What we do not know, and what many writers and enthusiasts trivialize, is how difficult it will be to “mine” or “harvest” these precious reserves given the near absolute zero “cryogenic” temperatures. Will the electronics work? If no lubricants will work, will all moving parts require super-magnetic bearings? Any equipment we now have would likely fail in short order. Carefully planned experiments in cryogenic labs here on Earth will be needed before we go through the expense of sending a “Lunar Polar Ice Surveyor/Sampler” to the Moon.

**What about the class of asteroids known as “carbonaceous chondrites”?**

[http://en.wikipedia.org/wiki/Carbonaceous\\_chondrite](http://en.wikipedia.org/wiki/Carbonaceous_chondrite) 8 classes of carbonaceous chondrites.

“Several groups of carbonaceous chondrites, notably the CM and CL groups, contain high percentages (3% to 22%) of water, as well as organic compounds. They are composed mainly of silicates, oxides and sulfides, while the minerals olivine and serpentine are characteristic. The presence of volatile organic chemicals and water indicates that they have not undergone significant heating (>200°C) since they formed, and their compositions are considered to be close to that of the solar nebula from which the Solar System condensed.”

Putting aside for the moment, how we would process these ice-enriched rocks, unless we can do this in fully automated and robotic manner, the big hurdle would be the the life support and consumables needed to support human crews in such a recovery project.

But now, NASA, has come up with a brilliant idea: sending a small probe to “capture” or “bag” a small carbonaceous chondrite “astrochunk,” under 8 meters in diameter, and slowly bring it back to Earth space, parking it in an orbit easily accessed by human crews, who can then experiment with various processes to find the most efficient way to harvest the water and other volatiles. NASA thinks it can do this for an estimated \$100 million. And support for such a mission is growing both in the US Congress and among space enthusiasts.

**Check the following linked reports and videos:**

<http://www.space.com/20591-nasa-asteroid-capture-mission-feasibility.html>

<http://www.space.com/20431-nasa-asteroid-capture-mission-funding.html>

<http://www.space.com/20606-nasa-asteroid-capture-mission-images.html>

<http://www.space.com/20605-nasa-budget-asteroid-lasso-2014.html>

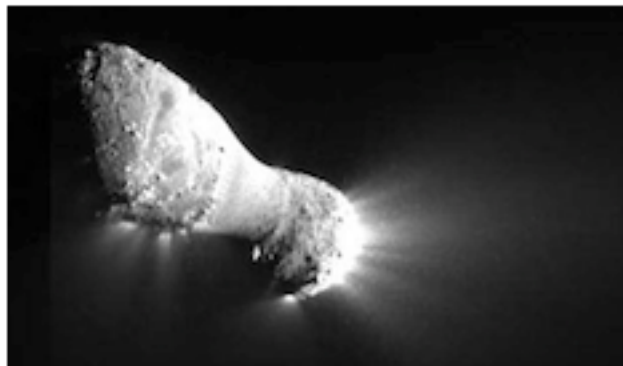
<http://www.space.com/20601-animation-of-proposed-asteroid-retrieval-mission-video.html>

<http://www.space.com/15391-asteroid-mining-space-planetary-resources-infographic.html>

If this project identifies the most efficient means with the least massive and most automated equipment, we may have found a way to build refueling stations in various inner solar system locations. That could be most helpful in opening up Mars to human endeavors, as well as to support manned missions to Jupiter’s moons.

**An Overlooked Alternative – Dormant “Comets in a Coma”**

While astrochunks with a water/volatile content on the order of 20% are relatively “soaked” in comparison with the Moon (polar permashade reserves excepted), comets are far richer. Now we had always thought of comets as “dirty snowballs.” That conception was smashed when we saw the amazing photographs taken of Comet Halley by the European Space Agency’s *Giotto* probe, revolutionizing our picture of what comets are like.



These photos show that the bright "tail" does not emanate from the entire surface of the comet, but only from a few active "pores!" Now we know that **comets accumulate slag crusts**, and that the only reason we can see them is that the slowly growing slag layer has not yet plugged every last pore! With each pass into the inner solar system nearer to the sun, the deeper and more extensive this slag crust becomes.

Prior to this discovery it was the common belief that comets continue to outgas, getting ever smaller, until they just waste away to nothing. That is probably not their common fate. Instead it **now seems far likelier that comets eventually suffocate themselves, plug their flashpores and "turn off," retiring into a cocoon of slag that they have gradually spun for themselves.**

They await a metamorphosis, a butterfly transformation into rich water reservoirs for thirsty "homo circumsolaris." For the vast bulk of the original endowment of dusty ice/snow remains "dormant," undercover, preserved inside. Comets, in general then, do not die. They fall into a deep coma, awaiting some future "resurrection."

Now, if we could find a dormant comet in with a low inclination orbit, and not too far out from Earth's orbit, that could become "THE" Refueling Station. The odds would seem against us. Unlike asteroids which are largely confined to a narrow range above and below the general plane of the Solar System, comets visit us from all directions: not only from highly inclined orbits, but some also from the opposite retrograde direction.

The next step, with the highest priority and urgency, will be to do a thorough spectrographic, photometric, and radar studies of supposed asteroids in unusual orbits and see if some of them have a common tell-tale signature. We suspect this will be the case. If so, they may not be asteroids at all, but dormant comets.

If we have found a tell-tale "signature," we can then turn our attention back to the vast majority of asteroids with ecliptic-hugging orbits and examine them one by one for the same giveaway quirks in the light they reflect towards us. For some small percentage of dormant comets may be hiding in asteroid-typical orbits.

We do have a list of "short period comets." [http://en.wikipedia.org/wiki/List\\_of\\_periodic\\_comets](http://en.wikipedia.org/wiki/List_of_periodic_comets)

That is ample reason to believe that there may be undiscovered dormant ones posing as asteroids. **If we find just one fully dormant or "comatose," we may well have won the jackpot.** They might be of significant size: a few kilometers long with enough water/volatiles to fuel many rockets for many years.

**Next question:** Could we mine a short-period comet like **Encke** if it is partially slag crusted? We have not gotten close enough to Encke to see to what extent if any it may be slag crusted.

[http://en.wikipedia.org/wiki/Comet\\_Encke](http://en.wikipedia.org/wiki/Comet_Encke) This comet's eccentric orbit brings it in from 4.11 AU in to 0.332 AU making an orbit every 3.3 years, and inclined to the ecliptic by only 11.76° - it is fair size, 3 mi/4.8 km in diameter. Its next approach to Earth will be on October 17, 2013 (at a distance of 0.48 AU or 44.4 million miles/71.8 million km). Close approaches to Earth usually occur every 33 years.

Best image: [http://upload.wikimedia.org/wikipedia/commons/a/a1/Comet\\_Encke.jpg](http://upload.wikimedia.org/wikipedia/commons/a/a1/Comet_Encke.jpg)

**Biggest disadvantages:** (1) This comet is still quite active. And we do not know from what percentage of its surface it is still outgassing. (2) Getting into its eccentric orbit will require considerable fuel.

This idea may be new and revolutionary to most readers, and perhaps even to many astronomers and space scientists. But those MMM readers who have been with us from the start will be familiar with it.



Read "**Wildcatting Comet Crude**" in MMM # 35 - May 1990 (23 years ago). This article has been reprinted in our Asteroids Theme Issue:

[http://www.moonsociety.org/publications/mmm\\_themes/mmm\\_t\\_asteroids.pdf](http://www.moonsociety.org/publications/mmm_themes/mmm_t_asteroids.pdf)

This and 14 other theme issues, all in pdf format, can be freely downloaded from

[http://www.moonsociety.org/publications/mmm\\_themes/](http://www.moonsociety.org/publications/mmm_themes/)

Enjoy!

PK

## Could the Best Place to Mine Asteroids be on the Moon?

Previously published in Moon Miners' Manifesto #239, October 2010, pp. 4-5

See the current space news article above in the Cislunar/Moon News Section:

**“Surprise! Moon Craters May Hold Ancient Asteroid Pieces“**

By Peter Kokh

Hey, the asteroids are way out beyond the Moon! But how do you think the Moon got all its craters? Volcanic origins were ruled out long ago. Yes, asteroids are “out there.” But now and then one is gravitationally dislodged into the inner solar system, and sometimes, the Moon or Earth itself is in the way and splat!

The amount of asteroid-sourced material in the moondust or regolith may be relatively small. Much of the impacting asteroid material may have been thrown out into space. But some must remain. Now most of the near Earth asteroid objects seem to be of the stony type, and we have enough rock powder on the Moon! What would be of interest are left-overs from metal-rich asteroids. In general, the Moon is deficient in some of the elements most needed for a technological civilization: copper, zinc, gold, silver, and the most prized element of all: platinum, involved in some 25% of all current manufacturing processes. It is the catalyst of choice for hydrogen-oxygen fuel cells, for example. Copper is so important that a 1% ore on Earth is considered “rich.”

PGMs – Platinum Group Metals – are the focus of the recently published science fiction novel by Bill White, a Moon Society member: “Platinum Moon” which was reviewed in the August issue, MMM #237. PGMs were also the focus of Dennis Wingo’s work “MoonRush.”

**Why not mine Platinum and associated metals on asteroids where they are concentrated?** John Lewis and many others talk about this extensively. But there are a few awkward details that they aren’t sharing with us.

1. **There is an “inconvenient” Catch-22 in Orbital Mechanics that says the closer two bodies (Earth and a target asteroid) are in period (the time they take to go around the Sun, the farther apart on the average are the launch windows from one to the other.** The wait between launch windows between Mars and Earth in either direction is some 25+ months. Between Earth and a really close NEA or NEO that window may open every two decades or longer! The upshot is that NEOs are hit and miss “targets of opportunity” at best.
2. **But the delta V, the amount of change in velocity (or powered acceleration needed is very low.** Again a Catch-22 – **the lower the delta-V needed, the longer the trip from one to the other.**
3. **But you save so much fuel!** Well, that’s okay if you are sending robotic prospectors and miners. But if you are sending humans, **the extra consumables you will need to send along will probably outweigh the saved fuel.** The journey could take many months, and the wait for a window home could be years, and then the long trip back.

No one told you that? Hmm! I wonder why? We are not opposed to exploring, mining, and even settling the asteroids. In fact there have been many articles about asteroids and the possibilities for using them in past issues of Moon Miners' Manifesto. We have gathered them and republished them in a special Asteroids theme issue. This is a free PDF file download from

[www.moonsociety.org/publications/mmm\\_themes/](http://www.moonsociety.org/publications/mmm_themes/)

Our point is that lunar pioneers can’t afford to wait until asteroid mining has developed to the point where shipments from the Belt or elsewhere can fill the settlements’ needs for these metals. There must be areas on the Moon where these metals are to be found in amounts worth the prospecting and extracting efforts. No Lunar orbiter yet flown has been equipped to find these metals, especially in small local concentrations.

### **What do we need to detect and mine PGMs**

Until now, the instruments chosen to fly on lunar orbiters have been selected to map concentrations of key elements we know to be fairly abundant on the Moon: iron, aluminum, magnesium, titanium, thorium; and it is fair to say that the driving curiosity has been what the geography of these concentrations says about how the Moon was formed and how it got to its present condition, rather than a search for “resources.” Planetary scientists are in charge, and that is appropriate at this stage of the game. The only element that has also been the target of orbital mapping as a resource, is hydrogen, which together with overly abundant oxygen gives us water, water ice, and hydrates. But that is because, water is essential to outposts whether they get into the lunar materials industry business or not. Plus scarce water can be stolen from the precious lunar reserves for one-use non-recyclable exploitation as rocket fuel, when, in the Moon’s low gravity environment, other more abundant options are available.



Now some of the targeted elements have usual partners: where there is thorium, there is probably uranium and lead, for example. So we know more.

Additionally, Apollo missions 12, 14, 15, and 17 all found KREEP deposits, rich in Potassium (K), Rare Earth Elements, and Phosphorus primarily in the Mare Imbrium splashout zone. Lunar Prospector in 1998–9 mapped these deposits at low resolution.

Could future lunar orbiter instruments detect PGMs and other valuable but less common elements on the Moon? Both the resolution and sensitivity of the needed instruments would have to be very high. But as so much is at stake, even sketchy indications of where best to look with on the surface techniques would be most helpful, by weeding out extensive areas where concentrations are lower. That said, to the extent that PGMs are a gift from the sky and not from the lunar interior, a statement that may not be totally correct, then their geographic concentrations should not follow well-known surface terrane “provinces” such as the highlands and/or maria. Nor will they be found in connection with certain types of craters, as crater types go by size, density, speed, and impact angle of the object creating them, and not by the object’s makeup. That said, after a few PGM concentrations are found, it is possible that we will detect a pattern that will suggest where else on the Moon, the “prospecting prospects” are promising.

Do we need an army of human prospectors? This will be tedious work, and until definite concentrations that might be worth “mining” are found, expensive human efforts would be unwarranted and wasteful. So what can we do?

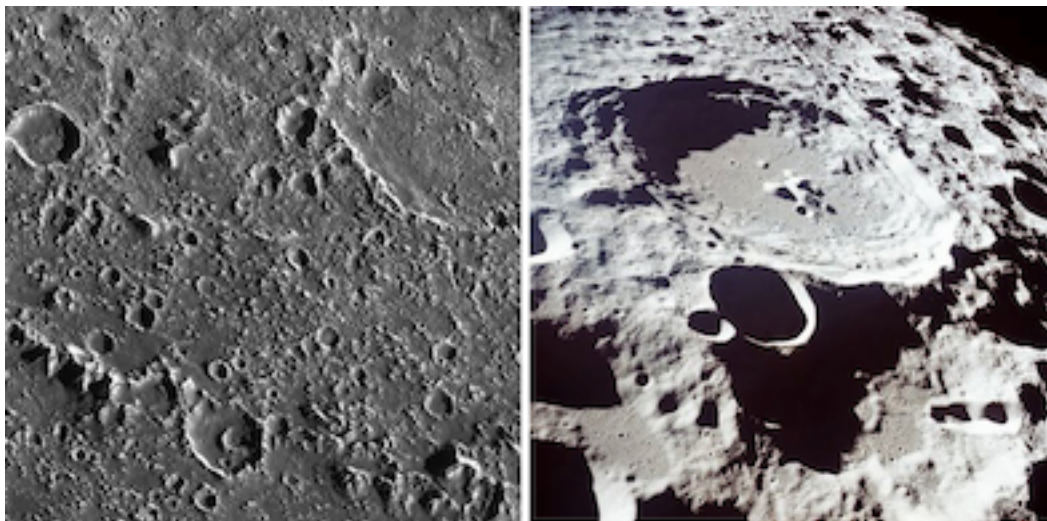
Orbiter instruments that successfully find some evidence of PGMs should be reflown on orbiters with eccentric orbits that carry them very close to the surface, say 10 kilometers (6 miles) or so, and keep adjusting the orbit until the entire Moon, farside as well as nearside, is mapped to produce the first crude map of PGM abundances. This map may suggest where to look on the surface itself. And here we need robotic rovers.

But because we will need many such assistants, and because there is an area as big as Africa and Australia together to cover, we suggest micro-rovers, working in teams, what I have called “robo-ants.” I wrote about these handy critters way back in MMM #45, May 1991, almost twenty years ago. An updated version of this article was recently published in our Moon Miners’ Manifesto India Quarterly, issue #5, a free download at: [www.moonsociety.org/india/mmm-india/](http://www.moonsociety.org/india/mmm-india/) or directly at:

[http://www.moonsociety.org/india/mmm-india/m3india5\\_Winter2010.pdf](http://www.moonsociety.org/india/mmm-india/m3india5_Winter2010.pdf)

We need to develop these handy “social mini-bots” anyway. They will come in handy as exospeleologist scouts, creating initial surveys of the interiors of lava tubes on Moon and Mars, and going elsewhere in terrain difficult for humans to traverse, and scour, whether in spacesuits or pressurized vehicles. Now of course, human guidance and teleoperation of these handy assistants from a nearby pressurized field vehicle is certainly an option.

PGMs have not been confirmed on the Moon and that is no surprise. We have not fielded the equipment and technologies needed. But we have every reason to believe that they are there, and that for the very practical reasons outlined above,



**The Moon’s crater-pocked surface: every crater made by an astrochunk**

**The Moon is the best place to mine Asteroid wealth!**

The time to start planning how to recover this wealth is now!

**PK**

## Why Plants & Animals must accompany us to the Moon, Mars, & Beyond

### Outposts & Settlements should Maximize Green Space

By Peter Kokh

#### Factual and Fictional Situations

- “Star Trek” TV series and films: token vegetation and animals (pets, exo-terrestrial zoo specimens)
- “Soylent Green” – [http://en.wikipedia.org/wiki/Soylent\\_Green](http://en.wikipedia.org/wiki/Soylent_Green) – a 1973 American science fiction film. It depicts “a dystopian future suffering from pollution, overpopulation, depleted resources, poverty, dying oceans, and a hot climate due to the greenhouse effect. Much of the population survives on processed food rations, including “soylent green,” a green wafer advertised to contain “high-energy plankton” but by implication, probably also from harvested deceased humans.
- “Silent Running” – [http://en.wikipedia.org/wiki/Silent\\_Running](http://en.wikipedia.org/wiki/Silent_Running) – a 1972 environmentally-themed American science fiction film. “depicts a future in which all plant life on Earth has been made extinct. Only a few specimens have been preserved in enormous, geodesic dome greenhouses attached to a fleet of space freighters, just outside the orbit of Saturn, .... When orders come from Earth to jettison and destroy the domes (with nuclear charges) and return the freighters to commercial service, Lowell rebels and saves the forests and animals on his ship.” (Why the orders were issued is the kicker – Ed.)
- **Common depictions** of future off-Earth settlements (in space, on the Moon, on Mars, etc.) suggest a token minimum of house pets, house plants.

#### We must foster Expanded Expectations of “plant and animal rich” off-Earth settlement biospheres

- **Modular Biospherics:** each residential/activity module has vegetation-based waste water treatment.
- **Agriculture** integrated into vegetational decor in home, office, school, work place, and commercial.
- **Wildlife** integrated into plantings, water features.
- **Neighborhood cell loop air circulation**
- **“Tri-treme” plumbing systems** replacing the 4,000 year-old Mohenjo-Daro “monotreme” system.

#### At stake is our descendants’ vision of what humans are and how we fit into the universe

Yes, this will be orders of magnitude more expensive. But our descendent residents will retain a connection to the world context of our origins. Lose this, and the sense in which we remain “human” will be considerably restricted. We need this connection to plant and animal life. Even now, when computer art and manufactured items dominate our lives and homes and other spaces, we still treasure handmade arts and crafts, home and garden plants, urbanized wildlife, and pets. Doing away with these connections restricts our humanity.

We see all too many science fiction depictions in which those roots, those companion life forms with which we have co-evolved, are at best given token representation. If you are not familiar with the two films cited, I strongly recommend renting them.

#### Yes, we are discouraged by the results of Biosphere II, but the lessons learned were worth it.

We expected too much. The goal is to “maximize the portion of life support supplied by mini-ecospheres.” Even if we must occasionally, even regularly resort to chemical make-up injections, the psychological and personal rewards of living in “as Earthlike” a setting as practical will be considerable both for mental health and for general sense of retaining and engaging the roots of our existence and of our cultural as well as our biological evolution.

This is important both for surface settlements in which individual living and working units are shielded one by one as constructed, and the settlement commons spaces of pressurized walkways, streets, parks, and plazas links all living and working spaces in a growing miniature Earth-like bioplex.

In Lava tubes, where shielding is a given, larger residential town or neighborhood units that provide pressurization, air and water systems, and abundant greenery and compatible wildlife – more along the lines of “space settlements” are possible.

If the goal is to cram as many people as possible into a space by doing away with vegetation and relying only on chemical life support, the quality of life will be a contortion of what it should be, and we can expect the rise of psychosis, crime, and other maladjustments. And we’ve seen a number of “dystopia” type science fiction films that prophecy the results quite well. Cost be damned. If we want something livable on the long term, we must replicate “terra” beyond Earth, not just human prisons. NASA’s focus on artificial life support must be abandoned. PK

**Links:** <http://weather.aol.com/2013/04/24/do-green-cities-boost-happiness/>

[http://www.moonsociety.org/publications/mmm\\_themes/mmmt\\_EdenOnLuna.pdf](http://www.moonsociety.org/publications/mmm_themes/mmmt_EdenOnLuna.pdf)

213 pages – a compilation of lunar biosphere articles from 25 years of Moon Miners’ Manifesto

The film “Soylent Green” – [http://en.wikipedia.org/wiki/Soylent\\_Green](http://en.wikipedia.org/wiki/Soylent_Green)

## To Settle inside Lava Tubes – or on the Surface under a Moondust Blanket?

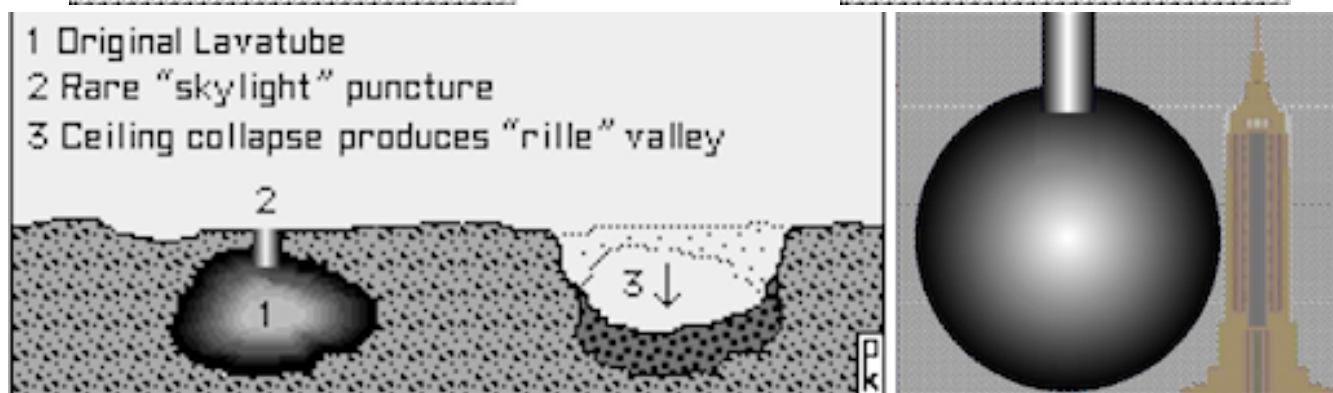
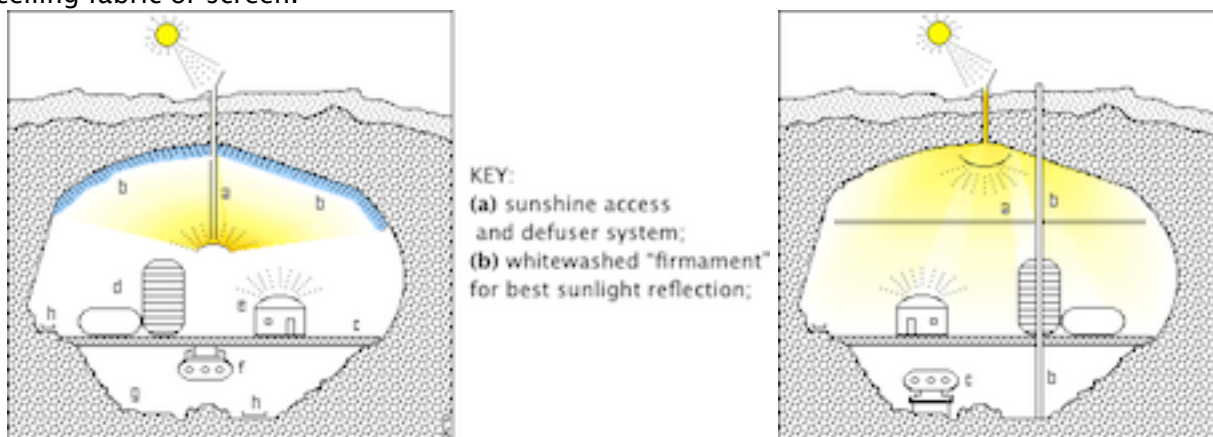
By Peter Kokh

### Advantages of Living and Working in a Lava Tube Settlement

- Temperatures are stable, relatively moderate
- Maximum Shielding from Cosmic Radiation and micrometeorite rain and impacts
- Earth Calendar 24-hour-day-friendly
- Three job shifts with neutral day/night schedules (no reason to want one over the others) unless the tube itself was lit, and not lit on a schedule that favored “day shift.”

### Disadvantages of Lava Tube Environments

- Psychological risk of being cut-off from the lunar surface, from the star-filled heaven, and from Earth
- Loss of benefits of a “lunar” calendar: the unique 14.75 day “Dayspan” and equal “Nightspan” with a welcome twice a “sunth” change of pace (energy-intensive activities during dayspan; energy-light tasks during nightspan)  
Read: “Sunth, sunthtime” <http://www.moonsociety.org/publications/m3glossary.html#ST>
- Less opportunity to personalize habitats (lot size, design and shape, other things). Looking like a “company town”
- Town architectures are constrained: long narrow towns in lavatubes many, many times longer than wide)
- The basalt surfaces are very dark and light absorbing. It would be difficult to uplift the overhead portion of the tube to create a semblance of “daylight” without installing a hanging “sky blue” faux ceiling fabric or screen.



Right: scale of a typical lunar lava tube compared with the Empire State Building in New York City

### A More Ideal Arrangement? Splitting ‘what goes where’ might give better results

- Lava tube & Surface Site Pairing: the Best of “Both” Worlds?
- Lava Tubes: Acre-hungry manufacturing industrial parks, warehouse operations, agriculture, archives
- Surface Moondust-Shielded: Settlements/Outposts that blend into the moonscapes, open to the stars.
- Surface towns could arise around the entrance to a lava tube: integrating residential and industrial areas, making worker access to work sites convenient.

### Importance of Exercising and Maintaining Contact with the Moon’s Surface

Without planned regular contact with the surface, possible psychosis (fear of the open sky, of the “outvac,” and of the universe at large could develop not only in children, but in some adults. This could lead to psychosis and/or unhealthy cults. Some counter measures that might be considered:

✓ **Children would go on surface excursions from an early age.**

Such “outings” would introduce them to the starry heavens, to Earth as our home world (if they lived on the Moon’s nearside or limbs); to the Sun, Mars, and other planets. But they would also learn to appreciate the scenery of the Moon’s surface.

- Rover excursions;
- Engaging in fun surface sports and activities
- Visiting surface communities.
- See the surface world of the Moon, and of Earth and other worlds in cinema, television news, etc.
- Fun space hopper trips
- Go to surface/subsurface amusement parks and more.
- Visit their own settlement’s skylight or rille entrances.

✓ **It will be important for adults to maintain contact with the “outside world” as well**

**They can do this on vacations;** in temporary service in “out top” jobs as well as job–related and continuing education–related assignments. But to avoid a shift to the opposite extreme, viewing their lava tube town as a kind of cult sanctuary, they should visit other lava tube towns as well as their own. Stressing how the two kinds of communities, surface and in–tube, complement each other and increase personal options, will cultivate a balanced outlook.

This is parallel to the widespread practice in the United States of having students from rural areas make field trips to the “big city” and vice versa.

**Pairing surface and Lava Tube settlements, where possible, will lead to a more broad and diverse culture. ##**

**“Yuri’s Night” seeks help to celebrate the annual World Space Party in 2014**

From V.A. Zabala–Aliberto <[Veronica.Zabala@NSS.org](mailto:Veronica.Zabala@NSS.org)>

Yuri’s Night is seeking web designers, ruby developers, media managers, and more to be the backbone of the world space party in 2014.

July 2, 2013 -- Yuri’s Night, the world space party, celebrated each April 12 by thousands of people in hundreds of locations around the world since 2001 is looking for new volunteers to help the organization continue to grow its mission to educate and develop the next generation of space explorers around the world.

The Yuri’s Night global team is a small group of volunteers around the world that provide support for all Yuri’s Night events hosted around the globe by local space enthusiasts. This group provides the Yuri’s Night website and party registration system to organizers worldwide, promotes Yuri’s Night to the press, provides resources for events, and works with partners and advertisers to promote Yuri’s Night to the general public.

All positions on the global team are on a part–time, volunteer basis, and open positions involve server maintenance, web design, social media, online promotion, outreach, and much more. The full list of positions and application form can be found at <https://yurisnight.net/apply/> . All applications to Yuri’s Night are due by July 22 and the new team will be announced by August 15 on <http://yurisnight.net> .

Dr. Ryan Kobrick, Executive Director of Yuri’s Night noted today, “It’s an exciting time for our team to welcome applications from talented individuals that will add to our diverse and skilled all–volunteer effort.” Yuri’s Night provides a unique STEM outreach opportunity for venues ranging from small classrooms to large science centers around the world. The new global team will help to share this event with more people in more countries than ever before. In 2013, supporters hosted 355 events on all 7 continents, and in 2014 they will host many more.

**About Yuri’s Night:** Yuri’s Night is a global non–profit organization dedicated to hosting celebrations of humanity’s past, present and future in space each April 12 in commemoration of Yuri Gagarin’s first manned space flight and the inaugural launch of the Space Shuttle. In 2013, Yuri’s Night celebrated 52 years of human spaceflight with 355 events in 57 countries on all seven continents, including Los Angeles, Tokyo, Moscow, and the Second Life virtual world. For more information, visit [www.yurisnight.net](http://www.yurisnight.net).



## International Space Advocacy Organizations Encouraging Student Participation

### National Space Society (US) – <http://www.nss.org> – NSS

NSS currently has chapters in Australia (3), Canada, Germany, France, Netherlands, Brazil, and India (3) – <http://chapters.nss.org/a/lists/>

### NSS' International Space Development Conference

The "ISDC" is usually held the last weekend of the last Monday in May (Memorial Day weekend) in various locations, hosts students from around the world, many of them presenting their entries to NASA's annual Space Settlement Design Contest. Usually, The Moon Society and SEDS participate in this conference.

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

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.

The Moon Society's **Moon Miners' Manifesto India Quarterly** – the "older sister" to To The Stars International Quarterly, has been going to students and others in India and Elsewhere since August 2008. Older issues are available as free pdf downloads at: <http://www.moonsociety.org/india/mmm-india/>

### 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 any other Space organization.

How to Start a SEDS Chapter – [http://wiki.seds.org/index.php?title=Start\\_a\\_SEDS\\_Chapter](http://wiki.seds.org/index.php?title=Start_a_SEDS_Chapter)

<http://seds.org/chair/ChapterExpansionKit30.pdf>

SEDS-Earth – <http://earth.seds.org/index.php> – This is the international chapter.

There are chapters of SEDS around the world: (USA), **India**, **Nigeria**, **UK**, **Philippines**, and more; SEDS-Earth is a central node for communication between these worldwide chapters.

SEE page 2–3 for a more complete list

## Indian-American Astronaut Sunita Williams calls for Student Experiments on ISS

[timesofindia.indiatimes.com/city/mumbai/Mumbai-is-beautiful-says-Sunita-Williams/articleshow/s19391170.cms](http://timesofindia.indiatimes.com/city/mumbai/Mumbai-is-beautiful-says-Sunita-Williams/articleshow/s19391170.cms)

[Editor's summary. For the full article see the link(s) above]

April 4, 2013 by Srinivas Laxman

MUMBAI: Indian-American astronaut, Sunita Williams (47), who was relaxing at the Taj Mahal hotel in Colaba, got a telephone call late on Wednesday night, from someone 400 km above Earth, Canadian astronaut, Chris Hadfield, on the International Space Station (ISS). He clicked on a photo of Mumbai from space and sent it to her, she told students and teachers at the Nehru Science Centre in Worli.



Left: Sunita Williams waves Flag of India on ISS on India Day – Right Kalpana Chawla

Speaking to the 300-plus youngsters, she urged Indian university students to contribute experiments to the ISS. "The space station will operate for another decade and NASA was looking for new experiments. ISRO and NASA are exploring new areas of collaboration. Indian students must contribute experiments to the space station.

Sunita holds the record for the longest space flight by a woman astronaut (322 days) and also broke the world record for the longest spacewalks totaling 50 hours and 40 minutes. While she was born in the United States, her father was born in Gujarat and she is proud of her Indian ancestry. She was in India on an invitation from the National Council of Science Museums of the ministry of culture. She earlier addressed students in New Delhi and Kolkata.

"I am keen to see that India's mission to the Red Planet is successful and I wish it a lot of luck," she said. She rejected criticism among international space experts like Robert Zubrin that the space station and shuttle were a sheer waste of money. "The space station is a natural stepping stone to Mars. We got to learn before we humans fly to Mars," she said. ##

## Dead Satellite built by Indian Students comes back to life

<http://timesofindia.indiatimes.com/india/Dead-satellite-comes-alive/articleshow/19642509.cms>

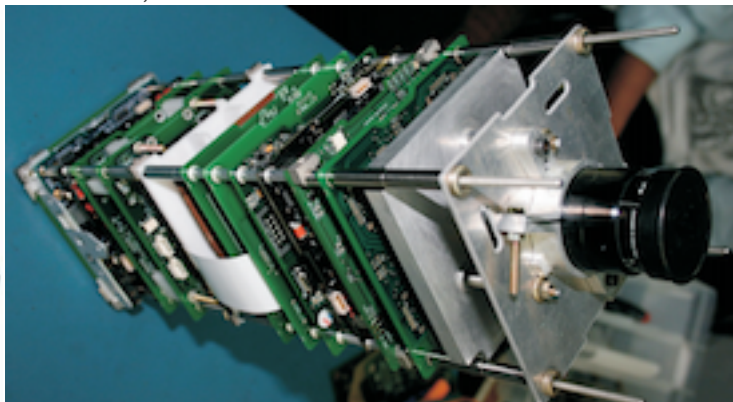
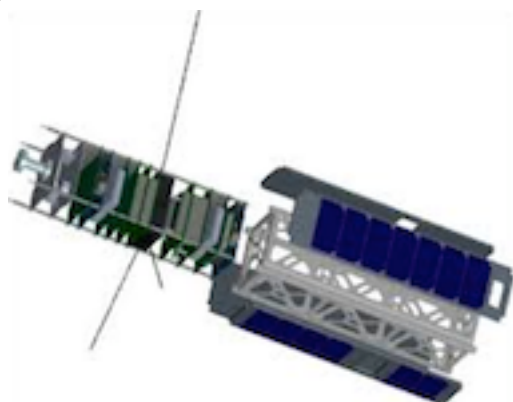
[http://articles.timesofindia.indiatimes.com/2013-04-20/india/38692872\\_1\\_jugnu-ns-vyas-main-satellite](http://articles.timesofindia.indiatimes.com/2013-04-20/india/38692872_1_jugnu-ns-vyas-main-satellite)

[Editor's summary. For the full articles see the links above]

By Srinivas Laxman

BANGALORE: What was given up as dead, turned out to be alive! India's first IIT-made student satellite, Jugnu, a product of the students and staff of IIT-Kanpur. The three-kg student satellite was launched October 12, 2011, along with SRMSat of SRM University in Chennai and VesselSat-1 of Luxembourg. The main satellite was the Indo-French Megha-Tropiques.

Chief co-ordinator of Jugnu, NS Vyas, said that the mission life of the satellite was one year. "We had stopped tracking it. But when we came to know from the Nitte Amateur Satellite Tracking Centre in Bengaluru that it was after all still alive we were thrilled," he said.



While its signals were still strong, some of its internal functions had weakened. Explaining how Jugnu was tracked, Sankar Dasiga, coordinator of satellite projects of the Bengaluru-based Nitte Meenakshi Institute of Technology, said that on April 9 while he and his team were monitoring the tracking centre located on the third floor of the college premises they noticed a signal. "We were surprised to find that it was from Jugnu which everyone thought had stopped operating and was dead.

But, to our delight and surprise its heart was still beating and we were extremely happy. We tracked it clearly and we knew it was Jugnu, because the signal carried its name. Five of us were in the tracking centre when the signal came in. The Jugnu transmission lasted for less than a second and during this brief moment all the data was available. ISRO and ITT-Kanpur were notified.

Jugnu has now been added to their regular tracking list. The expectation is that it will transmit at regular periodicity when the satellite's on-board is strong enough.

.On February 25, 2013 the Nitte satellite tracking centre received signals from a UK-made student satellite, STRand-1 which was placed in orbit along with six other satellites by ISRO. The main satellite was the Indo-French Saral, and the rocket was ISRO's highly-proven four-stage Polar Satellite Launch Vehicle.

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## Paintings by Indian School Students from Tamil Nadu are headed for Mars

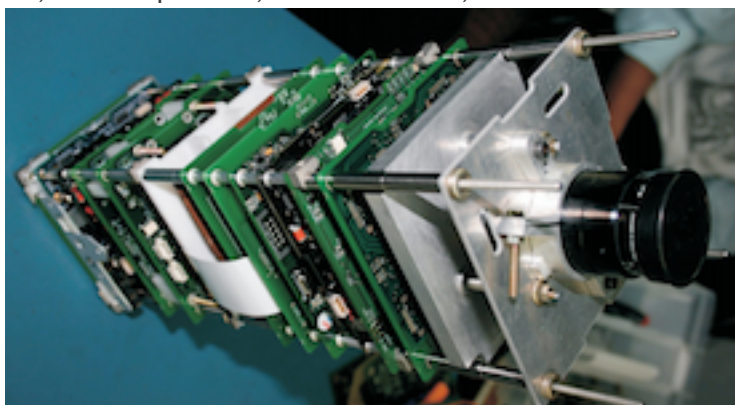
<http://timesofindia.indiatimes.com/home/science/Paintings-by-Indian-school-students-are-headed-for-Mars/articleshow/20255035.cms>

By Srinivas Laxman

MUMBAI: Tamil Nadu will be flying on NASA's next mission to Mars provisionally slated for lift off on November 18, 2013. Called **Maven** (Mars Atmosphere and Volatile Evolution), the primary role of the one-year mission is to study the Martian upper atmosphere. NASA has partnered with the University of Colorado and University of California for this mission.



Tamil Nadu's participation in this mission is not through scientists or engineers, but through school students. They participated in a global art competition relating to the Maven programme. According to NASA and University of Colorado, the worldwide contest concluded on May 15 and was followed by an online public vote to determine the first and second place winners globally. Second place went to a youngster from Tamil Nadu, Mohanapoorani, who secured 8,651 votes from all over the world.



And Tamil Nadu did it again with the Maven's principal investigator's (PI) choice going to a student, Nithyashree. The PI is Bruce Jakosky. A contribution from Tamil Nadu has also secured what is known as a school-based award with an entry from Raghavan being chosen. The education co-ordinator for Raghavan was Hafiz. (Tamil Nadu is a major state in SE India. Its capital is Chennai, previously known as Madras.) ##

## IIIT students meet Abdul Kalam at International Space Development Conf.

<http://www.thehindu.com/todays-paper/tp-national/tp-andhrapradesh/iiit-students-meet-abdul-kalam-at-nasa-meet/article4755194.ece>

On Sunday, May 26, 2013 Students of International Institute of Information Technology (IIIT), Nuzvid, met former President and Indian scientist A.P.J. Abdul Kalam, at the Annual International Space Development Conference (ISDC), being held at San Diego in USA, May 23-27.

Thirteen students who designed projects on the topic, '**Creating alternative living for the mankind on Space**', for NASA Ames Space Settlement Design Contest - 2013, were attending the ISDC. The young scientists presented their projects during the ongoing space meeting.



The students met scientist Dr. Abdul Kalam, who also attended the conference and explained the theme of their projects. The former President of India praised the RGUKT students who designed the projects on settlement on moon with innovative ideas by using latest technologies

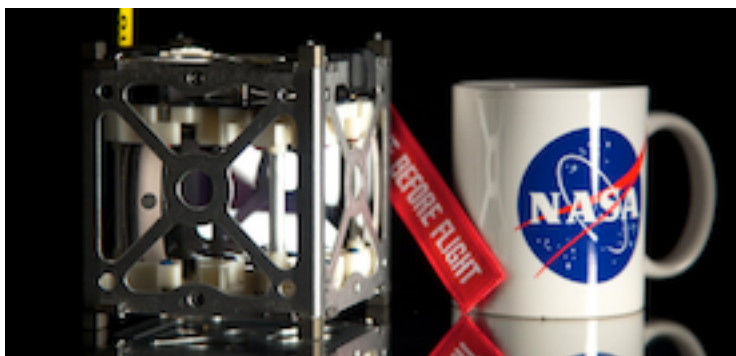
The students met scientist Dr. Abdul Kalam, who also attended the conference and explained the theme of their projects. The former President of India praised the RGUKT students who designed the projects on settlement on moon with innovative ideas by using latest technologies. ##

## A Challenge for Student Teams: Design mini-sats with Smartphone Brains

<http://www.space.com/20772-nasa-phonesats-smartphone-satellites.html>

<http://www.space.com/18686-phonesat-small-satellites-use-smart-phones-for-brains-video.html>

[Editor's summary. For the full article see the link(s) above]



A trio of small NASA satellites flying around Earth may give new meaning to the phrase, "Can you hear me now?" Three off-the-shelf smartphones were just launched to space as part of a NASA initiative to make powerful satellites cheaper. The trio of PhoneSats — aptly named Alexander, Graham and Bell — were successfully launched into orbit Sunday (April 21) during the inaugural test flight of Orbital Sciences Corp's [Antares rocket](#). The new private rocket launched from NASA's Wallops Flight Facility located on Wallops Island along Virginia's Eastern Shore. All three are now in orbit and beaming back information.

They may stay up for 2 weeks but the mission will only last a few days, enough to see how they work. "We expect them to stay up for about 2 weeks, but actually our mission with these is only going to last a few days.

The phones will basically function as the brain of the satellite. The three 1.4 kh (3 lb) cubes won't be used for communication purposes, and cannot send or receive calls or text messages. While most satellites can cost more than \$1 million, the three PhoneSats cost \$3,500 to \$7,000 each. ##



## Space Warriors' Hallmark Movie Features Space Camp Training

<http://www.space.com/21369-space-warriors-movie-video.html>

<http://www.space.com/21358-exclusive-clip-from-space-warriors-video.html>

[Editor's summary. For the full articles & videos see the links above]

Since 1982, Space Camp has provided a place for kids to train as Mission Controllers and space flyers on simulated shuttle millions. Now, it's the setting for a science-fiction film.



"Space Warriors" is a fictional story about a group of teens who compete to win a trip to space. Two teams — the Warriors and the Titans — go head to head in challenges designed to test their skills in math, science and engineering to win seats onboard a spacecraft. The kids get more than they bargained for, however, when scientists from the Marshall Space Flight Center call upon the students for help solving a life-or-death problem onboard the International Space Stations. Robonaut has a bit part. ##

## Can Students in Arab Countries Resurrect Interest in Astronomy?

"Hundreds of stars and constellations have Arabic names, such as **Altair, Deneb, Vega** and **Rigel**. Today, more than 20 lunar craters bear the names of Muslim astronomers, including Alfraganus (al-Farghani), Albategnius (al-Battani) and Azophi (al-Sufi)."

Writes Nidhal Guessoum, a professor of Physics and Astronomy at the American University of Sharjah in the United Arab Emirates.

<http://www.space.com/21532-arab-nations-astronomy-renaissance.html>

[Editor's summary. For the full article, see the link above]

### More Quotes

"It's time for the Arab Muslim world to reclaim its lost tradition of astronomical learning."

"Astronomy has a natural place high in the landscape of Arab Islamic culture."

"Astronomy flourished in the Muslim world from the 9th through 16th centuries A.D., with great observatories being built in what is now Iraq, Syria, Turkey, Iran and Uzbekistan."

"When Arab nations gained their independence, they tended to prioritize applied sciences such as petrochemical engineering and pharmaceuticals."

"Today, there are just two operational medium-size telescopes in the entire Arab world, he noted — one in Algeria and one in Egypt."

"The current state of Arab astronomy research [can be judged] by analyzing peer-reviewed papers published in the field from 2000 through 2009. Of every 1,000 science papers with a first author from an Arab nation, only three were in astronomy."

"The entire Arab world published fewer astronomy papers than Turkey alone, and substantially fewer than South Africa or Israel."

"The region has a number of good observatory sites, high-altitude places with clear, dry air. And funding large telescopes is eminently achievable, as a number of Arab countries — such as Saudi Arabia and the United Arab Emirates — have considerable oil wealth at their disposal." ##

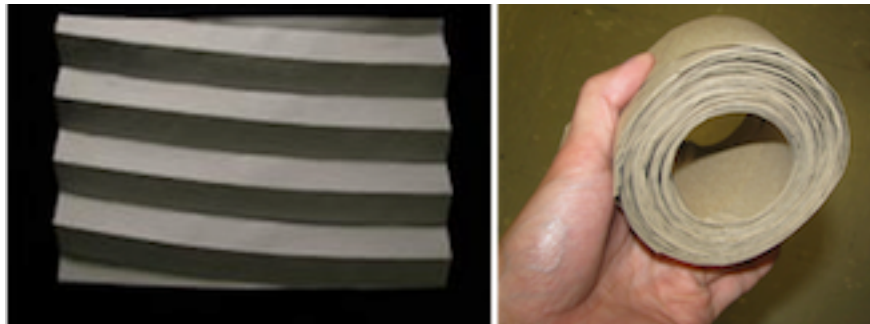
## LEGO to Roll Out Mars Rover Curiosity as Toy Model

<http://www.space.com/21596-mars-rover-curiosity-lego-model.html>



## Paper-Folding Trick May Help Tiny Satellites Use Sails in Space

<http://www.space.com/20917-tiny-satellites-space-sails.html>



**Above:** To fit a big sail in a small box, scientists are using a zig-zag fold at an angle, which ensured that the creases do not bunch up aboard a tiny cubesat satellite

<http://i.space.com/images/i/000/028/579/original/cubessat-micrometeoroid-sail-still.jpg?1367429884>

**Video:** <http://www.space.com/20899-cubesat-sail-deployment-tested-on-zero-g-flight-video.html>

## NASA's Great Moonbuggy Race Won by Puerto Rican Teams

<http://www.space.com/20947-nasa-moonbuggy-race-winners.html>

[Editor's summary. For the full article see the link(s) above]

May 2, 2013 – 600 participating student drivers, engineers and pit crews came to the U.S. Space & Rocket Center outside Huntsville, Alabama, for a two-day event on Apr. 26 and 27. A total of 89 teams from the **United States, Puerto Rico, Canada, India, Germany, Mexico and Russia** took up the challenge to design, built and race lightweight, pedal-powered mock moon buggies. Students from two different schools in Puerto Rico won first place in both High School and College divisions. The event was hosted by NASA's Marshall Space Flight Center in Huntsville.



**Above:** the winning team in the High School Division from Teodoro Aguilar Mora Vocational High School in Yabucoa, Puerto Rico. They mastered the rugged 800 m trail in 3 min 21 sec, 8 seconds faster than the winning College Division team from the University of Puerto Rico at Humacao. ##

## Student wins NASA Contest to Name Asteroid to be sampled in 2018

<http://www.planetary.org/press-room/releases/2013/nine-year-old-names-asteroid.html>

<http://www.space.com/20923-nine-year-old-names-asteroid.html>

[Editor's summary. For the full article see the link(s) above]

A near-Earth asteroid that will be visited by a NASA spacecraft in 2018 now has a more approachable name. A North Carolina third-grader, nine-year-old Michael Puzio's suggestion beat out more than 8,000 other entries in an international student contest that sought to rename potentially dangerous asteroid (101955) 1999 RQ36, the target of NASA's Osiris-Rex sample-return mission.

His winning name was **Bennu** (pronounced ben-oo), for an Egyptian god usually depicted as a gray heron. Puzio nominated the name because he thought Osiris-Rex's Touch-and-Go Sample Mechanism arm (TAGSAM) and solar panels looked like Bennu's neck and wings, contest officials said.

## NASA's Fourth Annual Lunabotics Mining Competition – May 20–24, 2013

<http://www.nasa.gov/offices/education/centers/kennedy/technology/lunabotics.html>

<https://www.facebook.com/media/set/?set=a.10151646507594183.1073741827.79294804182&type=3>

Kennedy Space Center Visitor Complex, Kennedy Space Center, Florida

[Editor's summary. For the full articles see the links above]



1st Place – Iowa State University in collaboration with Nebraska Indian Community College & Wartburg College

## How Competing in NASA's Space Settlement Contest changed my Future

By Aleksanda Voinea, Bucharest, Romania

I was never interested in Physics, or any other STEM fields [Science, Technology, Engineering, Mathematics]. I was going to apply to med school and become a surgeon, probably a brain surgeon. I was fascinated with brain cells, synapses, control centres and so on, and med school seemed to be the place for me.

Then, in 10th grade, I decided to compete in NASA's Space Settlement Design Contest. Being a rather thorough person, I wanted to make my entry as good as possible. I didn't enjoy the contest much at first. Working on an individual submission, I had tons of research to do, not to mention the fact that I had to become familiar with a multitude of programs and... Physics.

Halfway through, while still working on "**Solaris**" (my submission), sometime in mid-winter, I came to realize that I actually enjoyed Physics, computer graphics, STEM fields. I was catching the space bug.

This epiphany never came as "I should become an aerospace engineer." But much rather as "I couldn't do anything else with my life except aerospace engineering."

If I hadn't competed in this contest, I would have gone to med school, and probably realized halfway through that this was not my path. I still regret disliking Physics before 10th grade, but I am glad and thankful that I discovered it when I did, and not later.

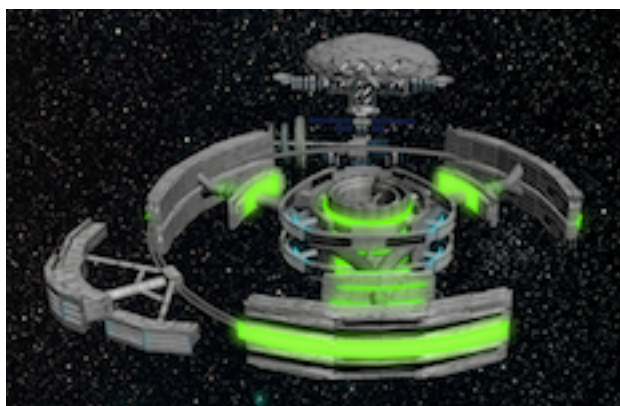
That was my first connection to the contest. I ended up winning First Prize Individual, and attending ISDC. I met lots of people, to which I am very thankful (Al Globus, Lynne Zielinski, Karen Mermel), propulsion engineers (Tim Pickens) and lots of students, some of them as enthusiastic as I was. At the 2012 ISDC, in Washington DC, I met my 2013 team members.

Nicky (Nikhil) was one of the most vivacious and involved students I have ever met, and, having had our project presentations successively, I got to attend his, and he watched mine.

Still, what got my attention wasn't Nikhil's enthusiasm, but the fact that his team used the same solar panel technology as I did... gallium arsenide ones. We teamed up for the 2013 edition, Nicky bringing along Aneek, (life sciences) and together **winning, as an international Romania-US team, First Prize Small Team, as well as Second Prize Literature.**

Our artwork (the settlement, as well as the asteroid mining module) also won **Grand Prize and Honorable Mention in NSS Roadmap Competition.** Consequently, Neo Space Settlement got to be displayed on all the conference diplomas (coming to us as a great surprise, as well as an honor).

The 2013 International Space Development Conference, held in San Diego, California, was even more productive for me than the one in 2012. I met so many people I greatly admired, it is very hard to keep track. We got to see astronaut Mae Jemison, commander Chris Ferguson, Chris Lewicki, head of Planetary Resources, Mike Sonter, working with Deep Space Industries, Discovery Science Producer Ian McNeil and Deep Space Industries artist Bryan Versteeg, whose artwork I was greatly inspired by when designing "Neo." Last, but definitely not least, I got to meet Buzz Aldrin, and have my copy of "Mission to Mars" signed by him. **Below from Left: Aleksandra, Astronaut Mae Jemison, Aneek, Nikhil**



Left: NEO topside



Right: NEO from the side

One of my favourite quotes belongs to Audrey Hepburn: "I owe so much, to so many people"

I owe most of my experience to Al Globus, Lynne Zielinski and Karen Mermel. If it weren't for their sustained enthusiasm and determination, their encouragements and support, I would have probably dropped the idea of pursuing a space career, catching up on my Physics, and even competing again in the 2013 edition. I am thankful for this incredible opportunity, for meeting old friends and making new, and for attending some of the most interesting and motivating space talks. In the future, I plan on helping other teams, making new international ones, and pursuing my interest in aerospace. **AV**

**Grade 9-10 First Prize** <http://settlement.arc.nasa.gov/Contest/Results/2012/>

- "Solaris", **Alexandra V.**, District 1, Romania ("Tudor Vianu" National High School of Computer Science), Individual.

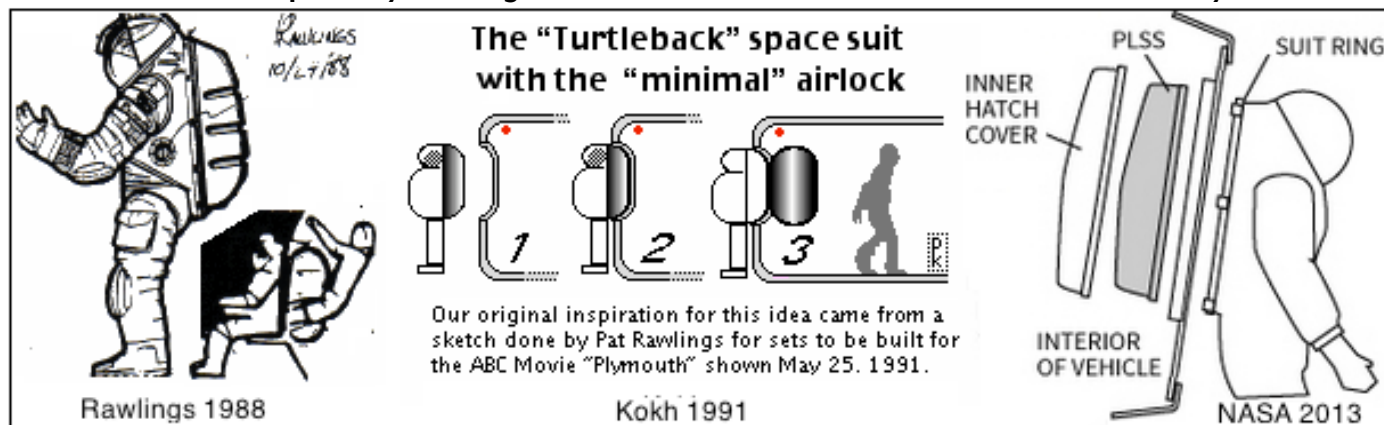
**Grade 11 First Prize** <http://settlement.arc.nasa.gov/Contest/Results/2013/>

- "Neo" Space Settlement, Bucharest, Romania ("Tudor Vianu" National High School of Computer Science) (**Aleksandra**) and Bridgewater Raritan High School, New Jersey, Small Team (**Nikhil**)

[We are especially delighted to see this "international" teaming between Aleksandra and Nikhil. – Ed.]

## NASA's Next Generation "Z-1" Space Suit built on sketches proposed in 1988-91

Suit feature inspired by Rawlings Illustration for ABC Made for TV Sci-Fi movie "Plymouth"



By Peter Kokh

The idea behind the "turtleback" or "clamshell" suit is to avoid tracking moondust into interior spaces without the expense of sizable and complex "car wash" airlocks. It would also avoid discharging into the lunar void precious nitrogen and oxygen each time the airlock cycled. Ideally, the back of a turtleback would include the back of the helmet as well, as shown in our original illustration at left, but not in Pat Rawlings' illustration at right, which was the original inspiration. The wearer would back into a conformally shaped dock, with the suit locking to it. The dock and the suit back would open together into the habitat space, and the wearer would reach up inside to a grab bar and pull himself out of the suit. The dock would close and the suit taken away for storage outside as in a dry cleaners rack. Very little inside air would escape in a tight cycle process. The idea has now been engineered by NASA in its Desert Rats Lunar Rover development. <http://www.youtube.com/watch?v=lxNaZ6F92bY> Video

And now NASA has come out with a whole new spacesuit design which incorporates this feature and many other innovations to make activities in space and on the Moon or Mars easier, and less tiresome.

For NASA's new totally reengineered space suit design, study this Space.com Infographic:

<http://www.space.com/18998-nasa-z-1-spacesuit-graphic.html>

## Four Winners Announced in NASA's Space Apps Challenge

<http://www.space.com/20959-nasa-space-apps-virtual-winners.html>



<http://spaceappschallenge.org/>

[Editor's summary. For the full article see the link(s) above]

May 3, 2013 – NASA's second 2-day **International Space Apps Challenge**, April 20–21, yielded dozens of new tools and concepts. "From Kansas City to Kathmandu," artists, developers, engineers and scientists from around the world came together in person to come up with "new programs, designs and solutions to improve life on Earth and in space." In addition, more than two thousand people participated online. 170 projects in all were submitted.

**The four winners chosen by NASA:**

- **Inbound:** A minimalist LED display that lights up to show when the Earth is being bombarded with coronal mass ejections erupting from the sun.

- **Mars Watchtower:** An interactive web-app that allows users to check the weather on Mars, much like they would check the weather on Earth.
  - **Asterank NEO Database:** A tool for browsing roughly 600,000 cataloged near-Earth asteroids and visualizing the path of these space rocks in our inner solar system.
  - **Waystation:** This iPhone app alerts users when to spot the International Space Station in the sky above.
- Local prizes were given out at the end of each in-person event. From these winners and the virtual awardees participating online, an international judging panel will select global winners for each of the following four categories:
- Best use of data;
  - Best use of hardware;
  - Most inspiring;
  - Biggest galactic impact (or most likely to improve life on Earth or in space).
- There will also be an online public poll; the project that gets the most votes will win the **People's Choice award**. The winners will be announced on May 22. ###

## Newly Illustrated Versions of the NSS Roadmap to Space Settlement

To the NSS Students Email List – May 18, 2013

A newly illustrated version of the National Space Society's Roadmap to Space Settlement is now available in three new formats: (1) A free downloadable PDF edition, (2) a free online full-screen flip-book edition, and (3) a quality full-color magazine-style printed edition for \$9.95 (think Father's Day?). Some new and striking art work appears for the first time in these new editions of the NSS Roadmap. Let these artists show you some of the possible paths to space development and settlement. These new editions provide you with additional ways to read and distribute this material to help promote the NSS Vision.

Just go to [nss.org/roadmap](http://nss.org/roadmap) where the entire Roadmap is online in web page format with links to (1) the new downloadable PDF version, (2) the online flip-book version (use the "Read Now" link on the right), and (3) the full-color print version available for purchase.

As originally announced in Ad Astra, this Roadmap was adopted by the NSS Board of Directors in 2012, updating the original NSS Roadmap published in 2000.

### **ABOUT THE ROADMAP** (from Ad Astra, Fall 2012)

The Roadmap has two major goals: First, to inspire and having the entire sweep of future space history in an easily readable form in one's hands is inspiring. Second, by delineating and discussing specific Milestones, to make it easier for you to formulate and advocate policies that are most likely to advance the day when the NSS Vision becomes a reality.

There are many possible paths to achieving each Milestone, and steps toward one are likely also to be steps to others. The NSS Roadmap does not predict which exact paths will be selected or in what order.

What the Roadmap does do, as you read the full text, is enable you to see (a) that there are discrete and individual steps that need to be taken, (b) that for most of the Milestones the first steps can be taken now, and (c) that those steps are reasonably achievable. To paraphrase the old maxim, journeys of millions of miles begin with simple steps.

### **What do we want people to DO with this Roadmap?**

- Distribute copies of the NSS Roadmap to others who already care about our space future, and to those who do not but who might get inspired.
- Understand what steps are immediately doable, and then whenever appropriate contact your local political leaders to encourage them to create the budgets and legal structures that will more quickly achieve the various near-term Milestones.
- Write responses, short or long, to space articles in your local or national media. Write rebuttals whenever our space goals are challenged as being either not desirable or not reasonably achievable. Write praises both for commentaries that support our goals and for news items reporting achievements that bring us closer to those goals. The media welcome such submissions.
- Continue your support of NSS so it can increase its efforts to achieve the various Milestones. You can do so immediately by making an additional contribution to our common cause at [www.nss.org/giving/roadmap](http://www.nss.org/giving/roadmap).

Delve into the Roadmap, and then do what you can to push us further along the road to space!

## Space.com “Infographics” – How to learn a lot about 150+ Space-related topics

<http://www.space.com/infographics/>



These “Poster-Size” Information-packed compositions of images, diagrams, outlines, and text help one understand the topic as no principally text-based article can do. Whether you are a student, a teacher, or neither, you will find these one-page explanations most helpful.

The originals are all 575 pixels wide (5 times the width shown above) but vary considerably in length, as this selection shows, with many shorter, some much longer than these sample.

You can open each of these to learn more, or print some for educational exhibits.

Our congratulations to Space.com for this excellent educational project!

We urge all readers to bookmark the above link. If you go through one a day, it will take you six months to absorb it all, and by then, Space.com will have added some more! – The editor.

### Wonderful to watch and listen to!

A revised version of David Bowie's Space Oddity,  
Recorded by Commander Chris Hatfield  
On board the International Space Station.

Guitar and Vocals: Chris Hatfield Music recorded on Earth

Published May 12, 2013 – Enjoy!

[http://www.youtube.com/watch?v=KaOC9danxNo&feature=youtube\\_gdata\\_player](http://www.youtube.com/watch?v=KaOC9danxNo&feature=youtube_gdata_player)

As of late May, this video has gone viral, with over 60 million hits!

### More Chris Hatfield Hits

<http://www.space.com/21298-hatfield-hits-how-to-shave-in-space-video.html>

<http://www.space.com/21518-chris-hatfield-career-highlights.html>

## GREAT BROWSING LINKS

### SPACE STATIONS + COMMERCIAL SPACE

<http://www.space.com/20006-deep-space-missions-private-companies.html>

<http://www.space.com/20444-nasa-deep-space-station-skylab2.html>

<http://www.space.com/20499-dark-matter-space-station-ams.html>

<http://www.space.com/20635-private-moon-mission-golden-spike.html>

<http://www.space.com/20737-space-station-spacewalk-photos-expedition35.html>

<http://www.space.com/20712-private-antares-rocket-launch-success.html>

**NASA seeks coders to help Robonaut 2 on ISS “see better” First flight 4-29-2014**

[http://www.nbcnews.com/id/51407519/ns/technology\\_and\\_science-space/#.UV924L-0Lww](http://www.nbcnews.com/id/51407519/ns/technology_and_science-space/#.UV924L-0Lww)

A commercial launch site for Space-X in Texas? - [www.thespacereview.com/article/2271/1](http://www.thespacereview.com/article/2271/1)

**A commercial approach for human space exploration.** <http://www.thespacereview.com/article/2278/1>

**SpaceShipTwo: Payload Users Guide** [www.virgingalactic.com/uploads/VG\\_Web\\_PayloadUsersGuide\\_20130103.pdf](http://www.virgingalactic.com/uploads/VG_Web_PayloadUsersGuide_20130103.pdf)

<http://moonandback.com/2013/01/13/ride-along-view-of-spacex-grasshopper/>

<http://www.space.com/73-orion-capsule>

<http://arstechnica.com/science/2013/04/how-nasa-brought-the-monstrous-f-1-moon-rocket-back-to-life/>

<http://www.space.com/20869-spaceshiptwo-first-rocket-test-photos.html> - **1st flight 4-29-2014**

**Commercial access suborbital space** [www.spacecalendar.com/june-17-23-2013-vol-32-no-24-hawaii-island-usa/](http://www.spacecalendar.com/june-17-23-2013-vol-32-no-24-hawaii-island-usa/)

**What’s ahead in (commercial) Newspace?** <http://newspace.spacefrontier.org>

### MOON

<http://www.space.com/20439-moon-asteroid-vesta-violent-history.html>

<http://www.space.com/20628-private-moon-missions-golden-spike-photos.html>

### MARS

<http://www.space.com/20434-buzz-aldrin-mars-mission-book.html>

<http://www.space.com/20446-valles-marineris.html>

<http://www.space.com/20680-mars-one-colony-astronaut-selection.html>

<http://prafulla.net/graphics/photography/mind-blowing-artistic-rendering-of-mars-by-dutchman-kees-veenenbos/>

<http://www.dailymail.co.uk/sciencetech/article-2287777/Mars-mission-couple-coat-spacecraft-walls-POO-protect-cosmic-rays.html>

<http://www.space.com/20512-mars-comet-crash-2014-odds.html>

<http://www.space.com/20669-mars-rover-curiosity-top-discoveries.html>

<http://www.space.com/20775-mars-life-search-manned-missions.html>

### ASTERIODS + COMETS

<http://www.space.com/20260-comet-ison-nasa-campaign.html>

<http://www.space.com/20591-nasa-asteroid-capture-mission-feasibility.html>

<http://www.space.com/20431-nasa-asteroid-capture-mission-funding.html>

<http://www.space.com/20606-nasa-asteroid-capture-mission-images.html>

<http://www.space.com/20605-nasa-budget-asteroid-lasso-2014.html>

<http://www.space.com/20601-animation-of-proposed-asteroid-retrieval-mission-video.html>

<http://www.space.com/20439-moon-asteroid-vesta-violent-history.html>

[http://en.wikipedia.org/wiki/2013\\_Russian\\_meteor\\_event](http://en.wikipedia.org/wiki/2013_Russian_meteor_event)

<http://www.space.com/19656-comet-ison-nasa-spacecraft-photos.html>

[http://www.spacedaily.com/reports/Beer\\_Cans\\_For\\_Deep\\_Space\\_999.html](http://www.spacedaily.com/reports/Beer_Cans_For_Deep_Space_999.html)

[http://www.spacedaily.com/reports/More\\_Treasures\\_from\\_Asteroids\\_999.html](http://www.spacedaily.com/reports/More_Treasures_from_Asteroids_999.html)

**Planetary Resources Co:** <http://www.youtube.com/watch?v=h5fwjsOOGm4>

### OTHER PLANETS + MOONS

<http://www.space.com/20426-mercury-meteorite-discovery-messenger.html>

<http://www.space.com/20528-jupiter-moon-io-volcanoes-location.html>

**Saturn’s “turned around” moon Dione** - [www.space.com/20481-dione-moon.html](http://www.space.com/20481-dione-moon.html)

### ASTRONOMY + ASTROBIOLOGICS

<http://www.space.com/20080-nasa-trajectory-website-interplanetary-missions.html>

<http://www.space.com/20753-antares-rocket-test-flight-launches-from-wallops-video.html>



<http://www.space.com/20542-darkened-cities-night-sky-photos.html>  
<http://www.space.com/20513-sun-heartbeat-cycles.html>  
<http://www.space.com/20566-exoplanet-debate-astrobiology-nasa-part-2.html>  
<http://weburbanist.com/2012/07/08/watch-out-10-eerie-abandoned-observatories/>  
<http://www.space.com/20571-nasa-mit-google-to-examine-life-in-outer-space.html>  
<http://www.space.com/21145-alien-planet-debate-exoplanet-missions.html>  
[http://www.huffingtonpost.com/2013/04/12/green-nebula-video-eso-milky-way-ghostly-gas-cloud\\_n\\_3063665.html](http://www.huffingtonpost.com/2013/04/12/green-nebula-video-eso-milky-way-ghostly-gas-cloud_n_3063665.html)

1. <http://www.space.com/20495-exoplanet-debate-astrobiology-nasa.html>
  2. <http://www.space.com/20566-exoplanet-debate-astrobiology-nasa-part-2.html>
  3. <http://www.space.com/20627-alien-planet-debate-habitability.html>
- <http://www.space.com/21543-habitable-alien-planets-binary-stars.html>  
<http://www.space.com/21553-hubble-most-distantly-orbiting-exoplanet.html>  
<http://www.space.com/21551-alien-life-sunless-photosynthesis.html>  
<http://www.space.com/21416-large-magellanic-cloud-ultraviolet-images.html>

#### Future Exo-planet missions

<http://www.thespacereview.com/article/2167/1>

<http://www.thespacereview.com/article/2170/1>

### EDUCATION + OUTREACH + MEDIA

<http://lightyears.blogs.cnn.com/201>

<http://www.space.com/20500-mars-moon-mission-student-challenge.html>

## GREAT SPACE VIDEOS

<http://www.space.com/20477-evolution-of-spiral-galaxy-arms-simulated-using-supercomputer-video.html>  
<http://www.space.com/20471-new-coding-for-robonaut-2-called-for-in-nasa-contest-video.html>  
<http://www.space.com/20497-mars-wind-flaps-curiosity-s-parachute-video.html>  
<http://www.space.com/20641-ancient-mars-had-thicker-atmosphere-curiosity-finds-video.html>  
<http://www.space.com/20250-curiosity-finds-ancient-mars-habitable-opportunity-not-so-much-video.html>  
<http://www.space.com/20496-ams-data-delivered-with-amazing-accuracy-video.html>  
<http://www.space.com/20525-jupiter-moon-s-volcanic-plume-seen-by-spacecraft-video.html> (Io)  
<http://www.space.com/20510-tom-cruise-wants-to-fly-sub-orbital-on-virgin-galactic-video.html>  
<http://www.space.com/20552-nasa-considers-plan-to-lasso-an-asteroid-for-study-video.html>  
<http://www.space.com/20601-animation-of-proposed-asteroid-retrieval-mission-video.html>  
<http://www.space.com/20551-nasa-s-sextant-mission-to-navigate-by-neutron-stars-video.html>  
<http://www.space.com/20616-astronaut-space-life-video-guide.html>  
<http://www.space.com/19373-planetary-resources-unveils-asteroid-hunting-arkyd-telescope-video.html>  
<http://www.space.com/10751-kepler-reveals-amazing-amount-planets-habitable.html>  
<http://www.space.com/21531-marks-on-mars-dunes-caused-by-dry-ice-video.html>  
<http://www.space.com/21530-students-test-flame-in-space-video.html>  
<http://spacestationlive.nasa.gov>

**Golden Spike:** [http://www.youtube.com/watch?v=Z\\_SrR1Y4m8s](http://www.youtube.com/watch?v=Z_SrR1Y4m8s)

**Comet Ison:** [http://science.nasa.gov/science-news/science-at-nasa/2013/18jan\\_cometison/](http://science.nasa.gov/science-news/science-at-nasa/2013/18jan_cometison/)

**The Storytelling of Science:** [http://www.youtube.com/watch?v=\\_J4QPz52Sfo](http://www.youtube.com/watch?v=_J4QPz52Sfo)

[http://lasvegascitylife.com/sections/opinion/knappster/george-knapp-infinity\\_-and-beyond.html](http://lasvegascitylife.com/sections/opinion/knappster/george-knapp-infinity_-and-beyond.html)

<http://www.space.com/20873-spaceshiptwo-rises-on-a-tail-of-fire-video.html>

**Cosmography of the Local Universe** - <http://vimeo.com/64868713>

## FILMS

<http://www.space.com/21224-europa-report-dramatizes-human-mission-to-jupiter-s-moon-video-trailer.html> - The Europa Report - Science Fiction Trailer - in US Theaters August 2, 2013  
<http://www.space.com/21559-space-movies-2013-countdown.html>

## Moon Miners' Manifesto Resources

<http://www.moonsociety.org/chapters/milwaukee/mmm/>

MMM is published 10 times a year (except January and July, since December 1986).

Most issues deal with the **opening of the Lunar frontier**, suggesting how pioneers can best use **local resources** and 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 **other space destinations** are discussed: asteroids, Europa (Jupiter), Titan (Saturn), even the cloud tops of Venus.

Issues #145 (May 2001) through current are available as pdf file downloads with Moon Society username/ password. International membership with MMM pdf file: \$35 US; \$20 students/seniors –

[www.moonsociety.org/register/](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. These issues are freely accessible to all at:

[www.moonsociety.org/publications/mmm\\_classics/](http://www.moonsociety.org/publications/mmm_classics/)

**MMM Classic Theme Issues:** introduced a new series to collect the same material as in the Classics, but this time organized by theme. **Eden on Luna** (environmental issues underlying lunar settlement).

**Asteroids, Mars, Tourism, Research, Select Editorials, Analog Programs, Lunar Economy, Arts & Crafts, Constructions, Surface Activities and more.** – [www.moonsociety.org/publications/mmm\\_themes/](http://www.moonsociety.org/publications/mmm_themes/)

**MMM Glossary:** The publishers of MMM, the Lunar Reclamation Society, has published a new Glossary of “MMM–Speak: new words and old words with new meaning” as used in Moon Miners' Manifesto.

[www.moonsociety.org/publications/m3glossary.html](http://www.moonsociety.org/publications/m3glossary.html)

The initial edition includes over 300 entries, many illustrated. More entries will be added. We hope that 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 M3IQ 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 around the world, especially students and young people, it must become a truly International publication. We look for people from many countries 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: [mmm-india@moonsociety.org](mailto:mmm-india@moonsociety.org) [This 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 educating people around the world, and in the education of young people on whom the future the world will rest.

### Guidelines for Submissions

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**Thanks to the many contributors to this, our biggest MMM India Quarterly yet!**

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