January 2012

The Spectrogram

Newsletter for the Society of Telescopy, Astronomy, and Radio

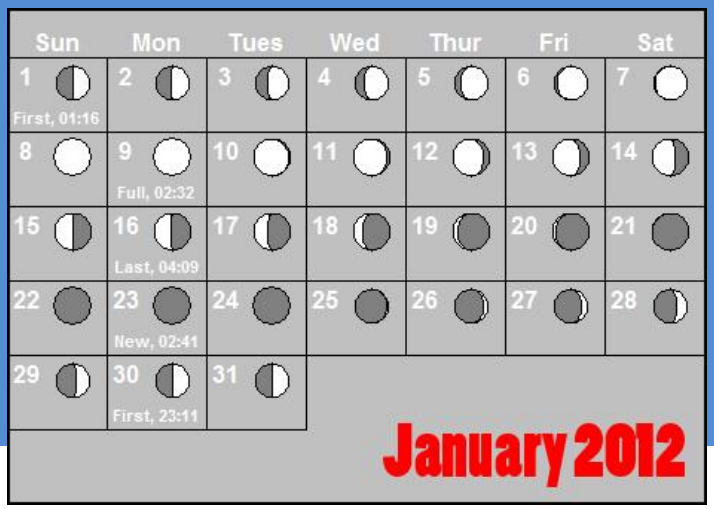
Inside this Issue:

January Meeting

The next meeting of S*T*A*R will be at 8pm on Thursday, January 5th, 2012. This month is our winter social meeting. This will be your opportunity to meet new club members and chat with friends about astronomy or any other topicEveryone is invited to bring in a favorite munchie. Possibilities include chicken wings, veggies and dip, shrimp, cookies, cupcakes. If Nancy is able to attend, perhaps she will bring her fabulous deviled eggs again. Bring something you've prepared if you like to cook, or something you've purchased. And please attend even if you aren't able to contribute anything - we had lots of food at our two previous meetings.

Calendar

- January 5th 2012 –Winter Social
- February 29th 2012 – Mill Lake Elementary School Star Party



February Issue

Please submit articles and contributions for the next *Spectrogram* by January 27th. Please email to fowler@verizon.net.

Star Parties:

Astronomy Night
NEW DATE!

Mill Lake Elementary School in Monroe Township is holding their annual Astronomy Night on Tuesday, February 29th 2012. They have asked if we could set up several telescopes for the students and parents. The school is located at 115 Monmouth Road, Monroe Township, NJ 08831.

We can arrive and set up in the rear of the school at 6:00. In the past there was pizza, subs and soda for the astronomers. The students will start to arrive at 6:30 and it should end about 8:30.

This event goes on rain or cloud. There are indoor stations where the students are engaged in hands-on activities supervised by the teachers. There will be a Starlab Planetarium and an exhibit of Moon rocks. There are about 180 students plus parents and siblings but they will come out to observe in class sized groups.

The last two years we were able to observe but the two previous years the skies were overcast and the astronomers did the observations through breaks in the clouds or came inside the gym and showed the students how their telescopes worked and viewed pictures of galaxies across the room.

Please post if you can help.
Please monitor "Events and Observation Plans" link on our web site for updates.

Russ Drum and Dennis O'Leary are contacts for the Club.

Name_____

Address_____

City_____State___Zip_____

Phone_____

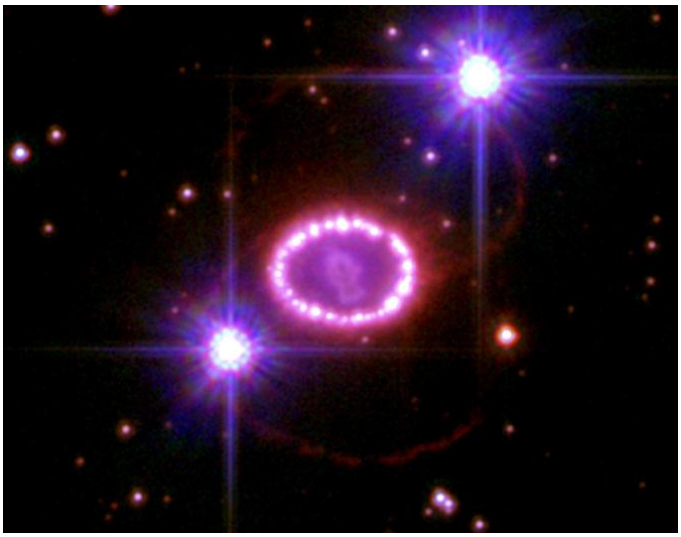
Email_____
Make checks payable to: S*T*A*R Astronomy Society, Inc. and mail to P.O. Box 863, Red Bank, NJ 07701

Are you a S*T*A*R Member?

Meetings are the first Thursday of each month, except July and August, at 8:00 PM at the Monmouth Museum on the Brookdale Community College campus. Meetings generally consist of lectures and discussions by members or guest speakers on a variety of interesting astronomical topics. S*T*A*R is a member of United Astronomy Clubs of New Jersey (UACNJ), the Astronomical League (AL), and the International Dark Sky Association (IDA).

Memberships: ( ) Individual....$35 ( ) Family...$45
( ) Student… $15

2012: Fear No Supernova



Supernova 1987A was the closest exploding star seen in modern times. It occurred in the Large Magellanic Cloud, a small galaxy that orbits our own Milky Way. Images taken by NASA's Hubble Space Telescope were combined to make this composite of the blast's expanding debris. Credit: NASA / ESA / P. Challis and R. Kirshner (Harvard-Smithsonian Center for Astrophysics)

Given the incredible amounts of energy in a supernova explosion – as much as the sun creates during its entire lifetime – another erroneous doomsday theory is that such an explosion could happen in 2012 and harm life on Earth. However, given the vastness of space and the long times between supernovae, astronomers can say with certainty that there is no threatening star close enough to hurt Earth.

Astronomers estimate that, on average, about one or two supernovae explode each century in our galaxy. But for Earth's ozone layer to experience damage from a supernova, the blast must occur less than 50 light-years away. All of the nearby stars capable of going supernova are much farther than this.

Any planet with life on it near a star that goes supernova would indeed experience problems. X- and gamma-ray radiation from the supernova could damage the ozone layer, which protects us from harmful ultraviolet light in the sun's rays. The less ozone there is, the more UV light reaches the surface. At some wavelengths, just a 10 percent increase in ground-level UV can be lethal to some organisms, including phytoplankton near the ocean surface. Because these organisms form the basis of oxygen production on Earth and the marine food chain, any significant disruption to them could cascade into a planet-wide problem.

Another explosive event, called a gamma-ray burst (GRB), is often associated with supernovae. When a massive star collapses on itself -- or, less frequently, when two compact neutron stars collide -- the result is the birth of a black hole. As matter falls toward a nascent black hole, some of it becomes accelerated into a particle jet so powerful that it can drill its way completely through the star before the star's outermost layers even have begun to collapse. If one of the jets happens to be directed toward Earth, orbiting satellites detect a burst of highly energetic gamma rays somewhere in the sky. These bursts occur almost daily and are so powerful that they can be seen across billions of light-years.

A gamma-ray burst could affect Earth in much the same way as a supernova -- and at much greater distance -- but only if its jet is directly pointed our way. Astronomers estimate that a gamma-ray burst could affect Earth from up to 10,000 light-years away with each separated by about 15 million years, on average. So far, the closest burst on record, known as GRB 031203, was 1.3 billion light-years away.

As with impacts, our planet likely has already experienced such events over its long history, but there's no reason to expect a gamma-ray burst in our galaxy to occur in the near future, much less in December 2012.

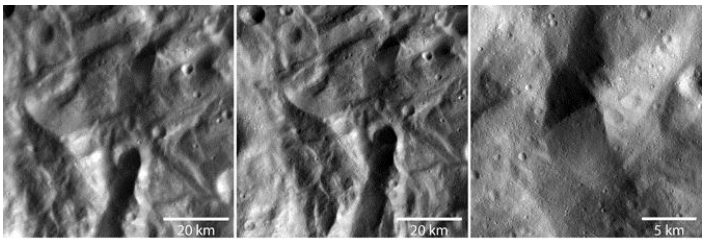
Related links:

NASA's Imagine the Universe: Supernovae

NASA's Imagine the Universe: Gamma-ray bursts

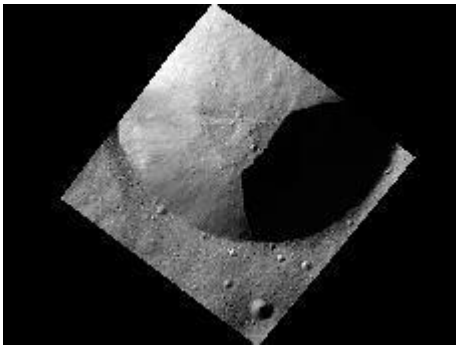
Francis Reddy
NASA's Goddard Space Flight Center

Dawn Obtains First Low Altitude Images of Vesta

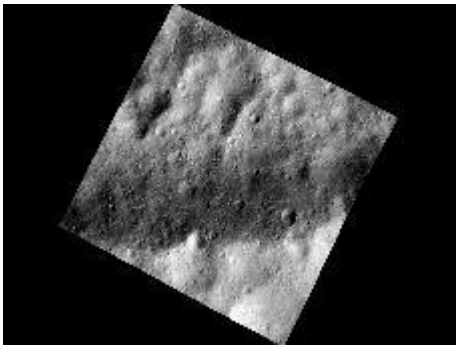


NASA's Dawn spacecraft has spiraled closer and closer to the surface of the giant asteroid Vesta. Image credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA

PASADENA, Calif. – NASA's Dawn spacecraft has sent back the first images of the giant asteroid Vesta from its low-altitude mapping orbit. The images, obtained by the framing camera, show the stippled and lumpy surface in detail never seen before, piquing the curiosity of scientists who are studying Vesta for clues about the solar system's early history.



This image, one of the first obtained by NASA's Dawn spacecraft in its low altitude mapping orbit, shows an area within the Rheasilvia basin in the south polar area of the giant asteroid Vesta. Image credit: NASA/ JPL-Caltech/ UCLA/ MPS/ DLR/ IDA



This image, one of the first obtained by NASA's Dawn spacecraft in its low altitude mapping orbit, shows a part of one of the troughs at the equator of the giant asteroid Vesta. Image credit: NASA/ JPL-Caltech/ UCLA/ MPS/ DLR/ IDA

At this detailed resolution, the surface shows abundant small craters, and textures such as small grooves and lineaments that are reminiscent of the structures seen in low-resolution data from the higher-altitude orbits. Also, this fine scale highlights small outcrops of bright and dark material.

A gallery of images can be found online at: http://www.nasa.gov/mission_pages/dawn/multimedia/gallery-index.html .

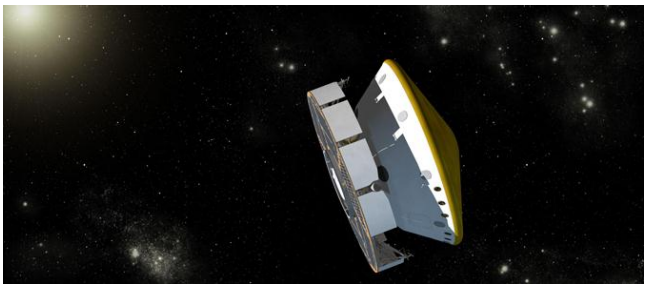
The images were returned to Earth on Dec. 13. Dawn scientists plan to acquire data in the low-altitude mapping orbit for at least 10 weeks. The primary science objectives in this orbit are to learn about the elemental composition of Vesta's surface with the gamma ray and neutron detector and to probe the interior structure of the asteroid by measuring the gravity field.

The Dawn mission to the asteroids Vesta and Ceres is managed by NASA's Jet Propulsion Laboratory, a division of the California Institute of Technology in Pasadena, for NASA's Science Mission Directorate, Washington. Dawn is a project of the directorate's Discovery Program, managed by NASA's Marshall Space Flight Center in Huntsville, Ala. UCLA is responsible for overall Dawn mission science. The Dawn Framing Cameras have been developed and built under the leadership of the Max Planck Institute for Solar System Research, Katlenburg-Lindau, Germany, with significant contributions by DLR German Aerospace Center, Institute of Planetary Research, Berlin, and in coordination with the Institute of Computer and Communication Network Engineering, Braunschweig. The framing camera project is funded by the Max Planck Society, DLR, and NASA/JPL.

More information about the Dawn mission is online at: http://www.nasa.gov/dawn and http://dawn.jpl.nasa.gov .

Jia-Rui Cook
Jet Propulsion Laboratory, Pasadena, Calif.

NASA Mars-Bound Rover Begins Research in Space



This is an artist's concept of NASA's Mars Science Laboratory spacecraft during its cruise phase between launch and final approach to Mars. Image credit: NASA/JPL-Caltech

PASADENA, Calif. -- NASA's car-sized Curiosity rover has begun monitoring space radiation during its 8-month trip from Earth to Mars. The research will aid in planning for future human missions to the Red Planet.

Curiosity launched on Nov. 26 from Cape Canaveral, Fla., aboard the Mars Science Laboratory. The rover carries an instrument called the Radiation Assessment Detector (RAD) that monitors high-energy atomic and subatomic particles from the sun, distant supernovas and other sources.

These particles constitute radiation that could be harmful to any microbes or astronauts in space or on Mars. The rover also will monitor radiation on the surface of Mars after its August 2012 landing.

"RAD is serving as a proxy for an astronaut inside a spacecraft on the way to Mars," said Don Hassler, RAD's principal investigator from the Southwest Research Institute in Boulder, Colo. "The instrument is deep inside the spacecraft, the way an astronaut would be. Understanding

the effects of the spacecraft on the radiation field will be valuable in designing craft for astronauts to travel to Mars."

Previous monitoring of energetic-particle radiation in space has used instruments at or near the surface of various spacecraft. The RAD instrument is on the rover inside the spacecraft and shielded by other components of Mars Science Laboratory, including the aeroshell that will protect the rover during descent through the upper atmosphere of Mars.

Spacecraft structures, while providing shielding, also can contribute to secondary particles generated when high-energy particles strike the spacecraft. In some circumstances, secondary particles could be more hazardous than primary ones.

These first measurements mark the start of the science return from a mission that will use 10 instruments on Curiosity to assess whether Mars' Gale Crater could be or has been favorable for microbial life.

"While Curiosity will not look for signs of life on Mars, what it might find could be a game-changer about the origin and evolution of life on Earth and elsewhere in the universe," said Doug McCuistion, director of the Mars Exploration Program at NASA Headquarters in Washington. "One thing is certain: The rover's discoveries will provide critical data that will impact human and robotic planning and research for decades."

As of 9 a.m. PST (noon EST) on Dec. 14, the spacecraft will have traveled 31.9 million miles (51.3 million kilometers) of its 352-million-mile (567-million-kilometer) flight to Mars. The first trajectory correction maneuver during the trip is being planned for mid-January.

Southwest Research Institute, together with Christian Albrechts University in Kiel, Germany, built RAD with funding from the Human Exploration and Operations Mission Directorate, NASA Headquarters, Washington, and Germany's national aerospace research center, Deutsches Zentrum für Luft- und Raumfahrt.

The mission is managed by NASA's Jet Propulsion Laboratory for the agency's Science Mission Directorate in Washington. The mission's rover was designed, developed and assembled at JPL, a division of the California Institute of Technology in Pasadena.

Information about the mission is available at: http://www.nasa.gov/msl and at http://mars.jpl.nasa.gov/msl .

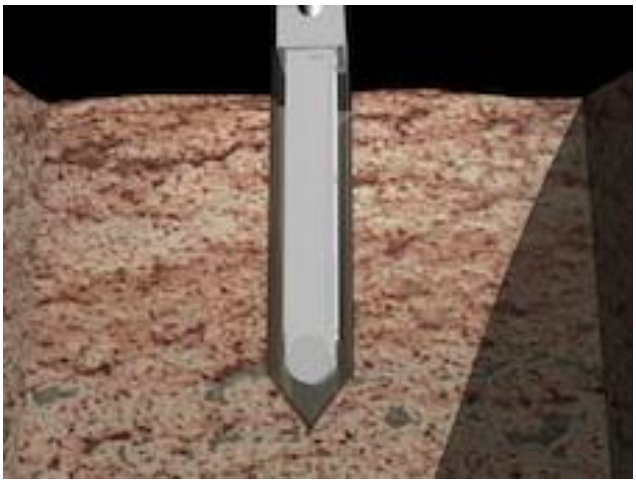
You can follow the mission on Twitter at http://www.twitter.com/marscuriosity and on Facebook at: http://www.facebook.com/marscuriosity .

Dwayne Brown
NASA Headquarters, Washington

Guy Webster
Jet Propulsion Laboratory, Pasadena, Calif.

NASA Developing Comet Harpoon for Sample Return

The best way to grab a sample of a rotating comet that is racing through the inner solar system at up to 150,000 miles per hour while spewing chunks of ice, rock and dust may be to avoid the risky business of landing on it. Instead, researchers want to send a spacecraft to rendezvous with a comet, then fire a harpoon to rapidly acquire samples from specific locations with surgical precision while hovering above the target. Using this "standoff" technique would allow samples to be collected even from areas that are much too rugged or dangerous to permit the landing and safe operation of a spacecraft.



This is an artist's concept of a comet harpoon embedded in a comet. The harpoon tip has been rendered semi-transparent so the sample collection chamber inside can be seen. Credit: NASA/Chris Meaney/Walt Feimer

Scientists at NASA's Goddard Space Flight Center in Greenbelt, Md. are in the early stages of working out the best design for a sample-collecting comet harpoon. In a lab the size of a large closet stands a metal ballista (large crossbow) nearly six feet tall, with a bow made from a pair of truck leaf springs and a bow string made of steel cable 1/2 inch thick. The ballista is positioned to fire vertically downward into a bucket of target material. For safety, it's

pointed at the floor, because it could potentially launch test harpoon tips about a mile if it was angled upwards. An electric winch mechanically pulls the bow string back to generate a precise level of force, up to 1,000 pounds, firing projectiles to velocities upwards of 100 feet per second.

This is a photo of the ballista testbed preparing to fire a prototype harpoon into a bucket of material that simulates a comet. Credit: NASA/Rob Andreoli

Donald Wegel of NASA Goddard, lead engineer on the project, places a test harpoon in the bolt carrier assembly, steps outside the lab and moves a heavy wooden safety door with a thick plexiglass window over the entrance. After dialing in the desired level of force, he flips a switch and, after a few-second delay, the crossbow fires, launching the projectile into a 55-gallon drum full of cometary simulant -- sand, salt, pebbles or a mixture of each. The ballista produces a uniquely impressive thud upon firing, somewhere between a rifle and a cannon blast.

"We had to bolt it to the floor, because the recoil made the whole testbed jump after every shot," said Wegel. "We're not sure what we'll encounter on the comet – the surface could be soft and fluffy, mostly made up of dust, or it could be ice mixed with pebbles, or even solid rock. Most likely, there will be areas with different compositions, so we need to design a harpoon that's capable of penetrating a reasonable range of materials. The immediate goal though, is to correlate how much energy is required to penetrate different depths in different materials. What harpoon tip geometries penetrate specific materials best? How does the harpoon mass and cross section affect penetration? The ballista allows us to safely collect this data and use it to size the cannon that will be used on the actual mission."

Comets are frozen chunks of ice and dust left over from our solar system's formation. As such, scientists want a closer look at them for clues to the origin of planets and ultimately, ourselves. "One of the most inspiring reasons to go through the trouble and expense of collecting a comet sample is to get a look at the 'primordial ooze' – biomolecules in comets that may have assisted the origin of life," says Wegel.

Scientists at the Goddard Astrobiology Analytical Laboratory have found amino acids in samples of comet Wild 2 from NASA's Stardust mission, and in various carbon-rich meteorites. Amino acids are the building blocks of proteins, the workhorse molecules of life, used in everything from structures like hair to enzymes, the catalysts that speed up or regulate chemical reactions. The research gives support to the theory that a "kit" of ready-made parts created in space and delivered to Earth by meteorite and comet impacts gave a boost to the origin of life.

Although ancient comet impacts could have helped create life, a present-day hit near a populated region would be highly destructive, as a comet's large mass and high velocity would make it explode with many times the force of a typical nuclear bomb. One plan to deal with a comet headed towards Earth is to deflect it with a large – probably nuclear – explosion. However, that might turn out to be a really bad idea. Depending on the comet's composition, such an explosion might just fragment it into many smaller pieces, with most still headed our way. It would be like getting hit with a shotgun blast instead of a rifle bullet. So the second major reason to sample comets is to characterize the impact threat, according to Wegel. We need to understand how they're made so we can come up with the best way to deflect them should any have their sights on us.

"Bringing back a comet sample will also let us analyze it with advanced instruments that won't fit on a spacecraft or haven't been invented yet," adds Dr. Joseph Nuth, a comet expert at NASA Goddard and lead scientist on the project.

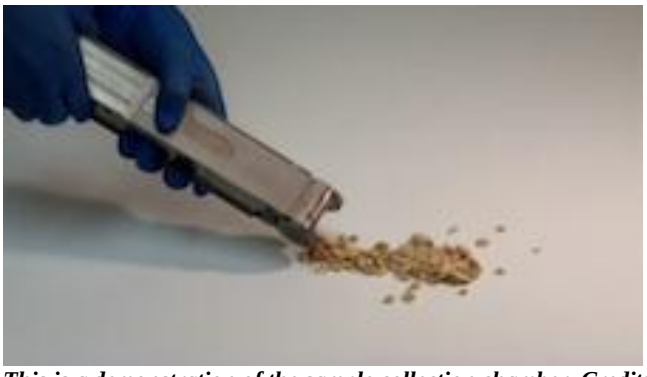
Of course, there are other ways to gather a sample, like using a drill. However, any mission to a comet has to overcome the challenge of operating in very low gravity. Comets are small compared to planets, typically just a few miles across, so their gravity is correspondingly weak, maybe a millionth that of Earth, according to Nuth. "A spacecraft wouldn't actually land on a comet; it would have to attach itself somehow, probably with some kind of harpoon. So we figured if you have to use a harpoon anyway, you might as well get it to collect your sample," says Nuth.

Right now, the team is working out the best tip design, cross-section, and explosive powder charge for the harpoon, using the crossbow to fire tips at various speeds into different materials like sand, ice, and rock salt. They are also developing a sample collection chamber to fit inside the hollow tip. "It has to remain reliably open as the tip penetrates the comet's surface, but then it has to close tightly and detach from the tip so the sample can be pulled back into the spacecraft," says Wegel. "Finding the best design that will package into a very small cross section and successfully collect a sample from the range of possible materials we may encounter is an enormous challenge."

This is a photo of a prototype harpoon tip (right) and sample collection chamber (left). Credit: NASA/Rob Andreoli

"You can't do this by crunching numbers in a computer, because nobody has done it before -- the data doesn't exist yet," says Nuth. "We need to get data from experiments like this before we can build a computer model. We're working on answers to the most basic questions, like how much powder charge do you need so your harpoon doesn't bounce off or go all the way through the comet. We want to prove the harpoon can penetrate deep enough, collect a sample, decouple from the tip, and retract the sample collection device."

The spacecraft will probably have multiple sample collection harpoons with a variety of powder charges to handle areas on a comet with different compositions, according to the team. After they have finished their proof-of-concept work, they plan to apply for funding to develop an actual instrument. "Since instrument development is more expensive, we need to show it works first," says Nuth.



This is a demonstration of the sample collection chamber. Credit: NASA/Rob Andreoli

Currently, the European Space Agency is sending a mission called Rosetta that will use a harpoon to grapple a probe named Philae to the surface of comet "67P/Churyumov-Gerasimenko" in 2014 so that a suite of instruments can analyze the regolith. "The Rosetta harpoon is an ingenious design, but it does not collect a sample," says Wegel. "We will piggyback on their work and take it a step further to include a sample-collecting cartridge. It's important to understand the complex internal friction encountered by a hollow, core-sampling harpoon."

NASA's recently-funded mission to return a sample from an asteroid, called OSIRIS-REx (Origins, Spectral Interpretation, Resource Identification, Security -- Regolith Explorer), will gather surface material using a specialized collector. However, the surface can be altered by the harsh environment of space. "The next step is to return a sample from the subsurface because it contains the most primitive and pristine material," said Wegel.

Both Rosetta and OSIRIS-REx will significantly increase our ability to navigate to, rendezvous with, and locate specific interesting regions on these foreign bodies. The fundamental research on harpoon-based sample retrieval by Wegel and his team is necessary so the technology is available in time for a subsurface sample return mission.

The team includes Wegel and Nuth of NASA Goddard as well as Javier Bernal, a student intern from the University of Puerto Rico at Mayaguez. The work was initially funded by Goddard's Internal Research and Development program, and sustained by NASA's Science and Engineering Collaboration, the Undergraduate Student Researcher Program, and Universities Space Research Programs.

Bill Steigerwald / Nancy Neal-Jones
Goddard Space Flight Center, Greenbelt, Md.

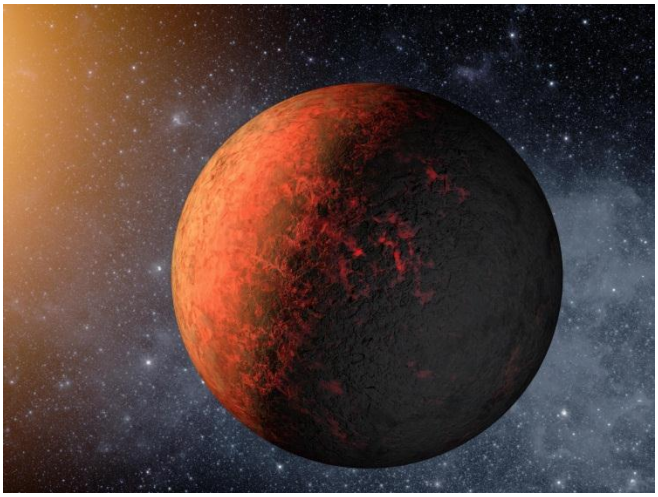
NASA Discovers First Earth-size Planets Beyond Our Solar System

MOFFET FIELD, Calif. -- NASA's Kepler mission has discovered the first Earth-size planets orbiting a sun-like star outside our solar system. The planets, called Kepler-20e and Kepler-20f, are too close to their star to be in the so-called habitable zone where liquid water could exist on a planet's surface, but they are the smallest exoplanets ever confirmed around a star like our sun.

The discovery marks the next important milestone in the ultimate search for planets like Earth. The new planets are thought to be rocky. Kepler-20e is slightly smaller than Venus, measuring 0.87 times the radius of Earth. Kepler-20f is a bit larger than Earth, measuring 1.03 times its radius. Both planets reside in a five-planet system called Kepler-20, approximately 1,000 light-years away in the constellation Lyra.

Kepler-20e orbits its parent star every 6.1 days and Kepler-20f every 19.6 days. These short orbital periods mean very hot, inhospitable worlds. Kepler-20f, at 800 degrees

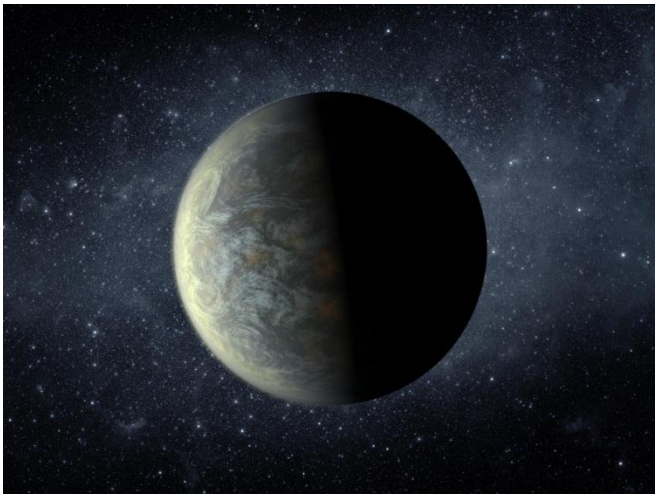
Fahrenheit, is similar to an average day on the planet Mercury. The surface temperature of Kepler-20e, at more than 1,400 degrees Fahrenheit, would melt glass.



Artist's Concept of Kepler-20e Image credit: NASA/Ames/JPL-Caltech

“The primary goal of the Kepler mission is to find Earth-sized planets in the habitable zone," said Francois Fressin of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., lead author of a new study published in the journal Nature. "This discovery demonstrates for the first time that Earth-size planets exist around other stars, and that we are able to detect them.”

The Kepler-20 system includes three other planets that are larger than Earth but smaller than Neptune. Kepler-20b, the closest planet, Kepler-20c, the third planet, and Kepler-20d, the fifth planet, orbit their star every 3.7, 10.9 and 77.6 days. All five planets have orbits lying roughly within Mercury's orbit in our solar system. The host star belongs to the same G-type class as our sun, although it is slightly smaller and cooler.

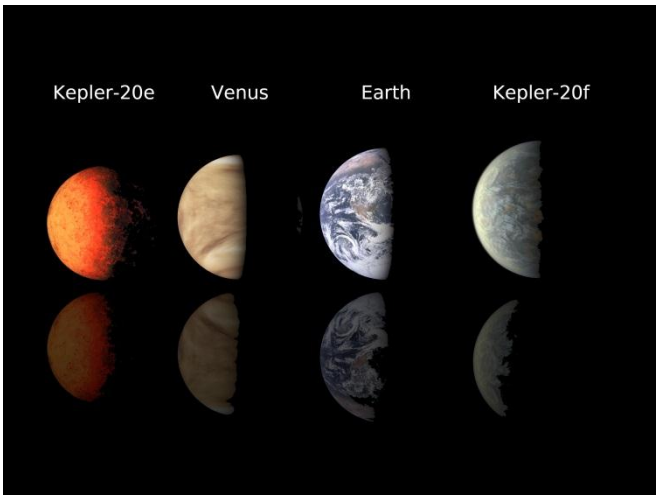


Artist's Concept of Kepler-20f Image credit: NASA/Ames/JPL-Caltech

The system has an unexpected arrangement. In our solar system, small, rocky worlds orbit close to the sun and large, gaseous worlds orbit farther out. In comparison, the planets of Kepler-20 are organized in alternating size: large, small, large, small and large.

"The Kepler data are showing us some planetary systems have arrangements of planets very different from that seen in our solar system," said Jack Lissauer, planetary scientist and Kepler science team member at NASA's Ames Research Center in Moffett Field, Calif. "The analysis of Kepler data continues to reveal new insights about the diversity of planets and planetary systems within our galaxy."

Scientists are not certain how the system evolved but they do not think the planets formed in their existing locations. They theorize the planets formed farther from their star and then migrated inward, likely through interactions with the disk of material from which they originated. This allowed the worlds to maintain their regular spacing despite alternating sizes.



This chart compares the first Earth-size planets found around a sun-like star to planets in our own solar system, Earth and Venus. Kepler-20e is slightly smaller than Venus with a radius .87 times that of Earth. Kepler-20f is a bit larger than Earth at 1.03 times the radius of Earth. Venus is very similar in size to Earth, with a radius of .95 times that our planet. Prior to this discovery, the smallest known planet orbiting a sun-like star was Kepler-10b with a radius of 1.42 that of Earth, which translates to 2.9 times the volume. Both Kepler-20e and Kepler-20f circle in close to their star, called Kepler-20, with orbital periods of 6.1 and 19.6 days, respectively. Astronomers say the two little planets are rocky like Earth but with scorching temperatures.There are three other larger, likely gaseous planets also know to circle the same star, known as Kepler-20b, Kepler-20c and Kepler-20d. Image credit: NASA/Ames/JPL-Caltech

The Kepler space telescope detects planets and planet candidates by measuring dips in the brightness of more than 150,000 stars to search for planets crossing in front, or transiting, their stars. The Kepler science team requires at least three transits to verify a signal as a planet.

The Kepler science team uses ground-based telescopes and the Spitzer Space Telescope to review observations on planet candidates the spacecraft finds. The star field Kepler observes in the constellations Cygnus and Lyra can be seen only from ground-based observatories in spring through early fall. The data from these other observations help determine which candidates can be validated as planets.

To validate Kepler-20e and Kepler-20f, astronomers used a computer program called Blender, which runs simulations to help rule out other astrophysical phenomena masquerading as a planet.

On Dec. 5 the team announced the discovery of Kepler-22b in the habitable zone of its parent star. It is likely to be too large to have a rocky surface. While Kepler-20e and Kepler-20f are Earth-size, they are too close to their parent star to have liquid water on the surface.

"In the cosmic game of hide and seek, finding planets with just the right size and just the right temperature seems only a matter of time," said Natalie Batalha, Kepler deputy science team lead and professor of astronomy and physics at San Jose State University. "We are on the edge of our seats knowing that Kepler's most anticipated discoveries are still to come."

NASA's Ames Research Center in Moffett Field, Calif., manages Kepler's ground system development, mission operations and science data analysis. JPL managed the Kepler mission's development.

Ball Aerospace and Technologies Corp. in Boulder, Colo., developed the Kepler flight system and supports mission operations with the Laboratory for Atmospheric and Space Physics at the University of Colorado in Boulder.

The Space Telescope Science Institute in Baltimore archives, hosts and distributes Kepler science data. Kepler is NASA's 10th Discovery Mission and is funded by NASA's Science Mission Directorate at the agency's headquarters in Washington.

For more information about the Kepler mission and to view the digital press kit, visit: http://www.nasa.gov/kepler

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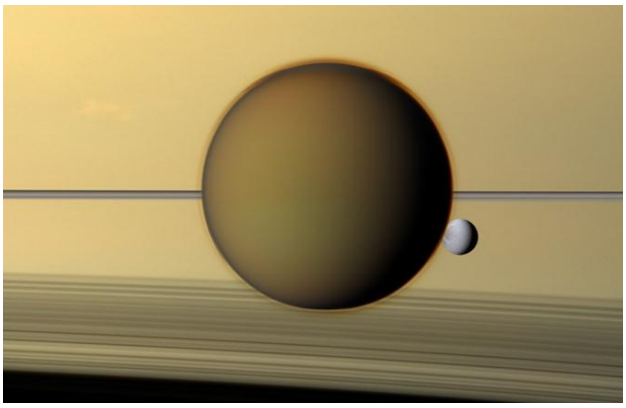
NASA's Cassini Delivers Holiday Treats From Saturn

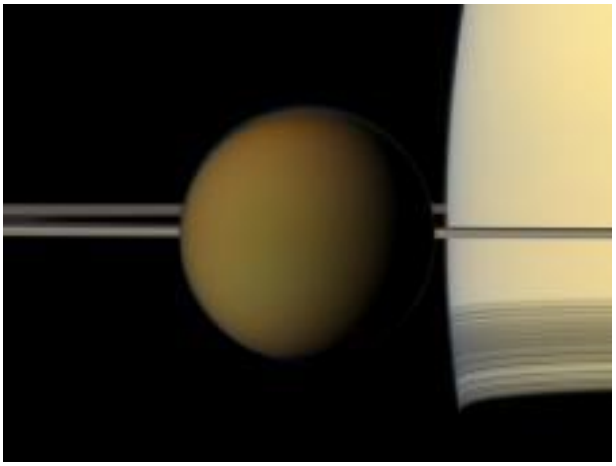
PASADENA, Calif. -- No team of reindeer, but radio signals flying clear across the solar system from NASA's Cassini spacecraft have delivered a holiday package of glorious images. The pictures, from Cassini's imaging team, show Saturn's largest, most colorful ornament, Titan, and other icy baubles in orbit around this splendid planet. The release includes images of satellite conjunctions in which one moon passes in front of or behind another. Cassini scientists regularly make these observations to study the ever-changing orbits of the planet's moons. But even in these routine images, the Saturnian system shines. A few of Saturn's stark, airless, icy moons appear to dangle next to the orange orb of Titan, the only moon in the solar system with a substantial atmosphere. Titan's atmosphere is of great interest because of its similarities to the atmosphere believed to exist long ago on the early Earth.



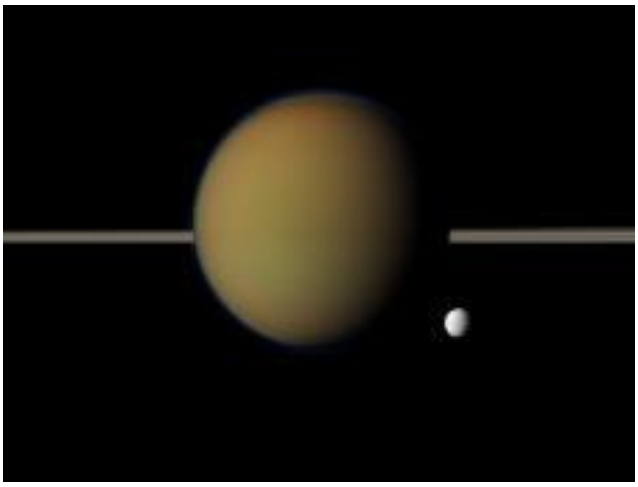
Saturn's third-largest moon Dione can be seen through the haze of its largest moon, Titan, in this view of the two posing before the planet and its rings from NASA's Cassini spacecraft. Image credit: NASA/JPL-Caltech/Space Science Institute

The images are online at: http://www.nasa.gov/cassini, http://saturn.jpl.nasa.gov and http://ciclops.org .

While it may be wintry in Earth's northern hemisphere, it is currently northern spring in the Saturnian system and it will remain so for several Earth years. Current plans to extend the Cassini mission through 2017 will supply a continued bounty of scientifically rewarding and majestic views of Saturn and its moons and rings, as spectators are treated to the passage of northern spring and the arrival of summer in May 2017.



The colorful globe of Saturn's largest moon, Titan, passes in front of the planet and its rings in this true color snapshot from NASA's Cassini spacecraft. Image credit: NASA/JPL-Caltech/Space Science Institute



Saturn's moon Tethys, with its stark white icy surface, peeps out from behind the larger, hazy, colorful Titan in this Cassini view of the two moons. Image credit: NASA/JPL-Caltech/Space Science Institute

"As another year traveling this magnificent sector of our solar system draws to a close, all of us on Cassini wish all of you a very happy and peaceful holiday season, " said Carolyn Porco, Cassini imaging team lead at the Space Science Institute, Boulder, Colo.

More information about Cassini mission is online at http://www.nasa.gov/cassini and http://saturn.jpl.nasa.gov .

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. The Jet Propulsion Laboratory, a division of the California Institute of Technology in Pasadena, manages the Cassini-Huygens mission for NASA's Science Mission Directorate, Washington. The Cassini orbiter and its two onboard cameras were designed, developed and assembled at JPL. The imaging team is based at the Space Science Institute in Boulder, Colo.

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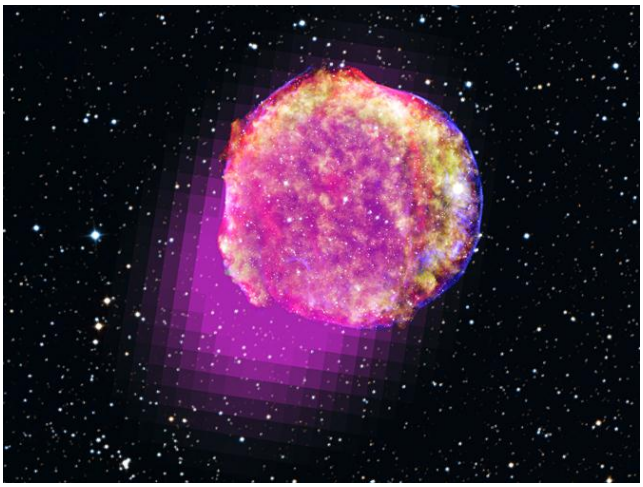
NASA's Fermi Shows That Tycho's Star Shines in Gamma Rays

In early November 1572, observers on Earth witnessed the appearance of a "new star" in the constellation Cassiopeia, an event now recognized as the brightest naked-eye supernova in more than 400 years. It's often called "Tycho's supernova" after the great Danish astronomer Tycho Brahe, who gained renown for his extensive study of the object. Now, years of data collected by NASA's Fermi Gamma-Ray Space Telescope reveal that the shattered star's remains shine in high-energy gamma rays.



Gamma-rays detected by Fermi's LAT show that the remnant of Tycho's supernova shines in the highest-energy form of light. This portrait of the shattered star includes gamma rays (magenta), X-rays (yellow, green, and blue), infrared (red) and optical data. (Credit: Gamma ray, NASA/DOE/Fermi LAT Collaboration; X-ray, NASA/CXC/SAO; Infrared, NASA/JPL-Caltech; Optical, MPIA, Calar Alto, O. Krause et al. and DSS)

The detection gives astronomers another clue in understanding the origin of cosmic rays, subatomic particles -- mainly protons -- that move through space at nearly the speed of light. Exactly where and how these particles attain such incredible energies has been a long-standing mystery because charged particles speeding through the galaxy are easily deflected by interstellar magnetic fields. This makes it impossible to track cosmic rays back to their sources.

"Fortunately, high-energy gamma rays are produced when cosmic rays strike interstellar gas and starlight. These gamma rays come to Fermi straight from their sources," said Francesco Giordano at the University of Bari and the National Institute of Nuclear Physics in Italy. He is the lead author of a paper describing the findings in the Dec. 7 edition of The Astrophysical Journal Letters.

Better understanding the origins of cosmic rays is one of Fermi's key goals. Its Large Area Telescope (LAT) scans the entire sky every three hours, gradually building up an ever-deeper view of the gamma-ray sky. Because gamma rays are the most energetic and penetrating form of light, they serve as signposts for the particle acceleration that gives rise to cosmic rays.

"This detection gives us another piece of evidence supporting the notion that supernova remnants can accelerate cosmic rays," said co-author Stefan Funk, an astrophysicist at the Kavli Institute for Particle Astrophysics and Cosmology (KIPAC), jointly located at SLAC National Accelerator Laboratory and Stanford University, Calif.

In 1949, physicist Enrico Fermi -- the satellite's namesake -- suggested that the highest-energy cosmic rays were accelerated in the magnetic fields of interstellar gas clouds. In the decades that followed, astronomers showed that supernova remnants may be the galaxy's best candidate sites for this process.

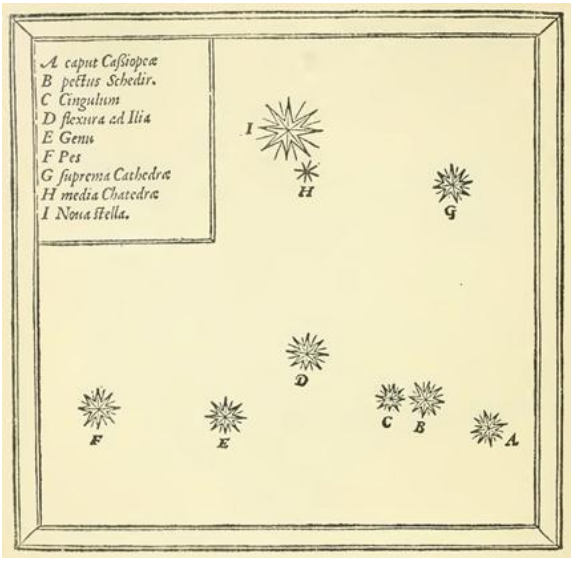
When a star explodes, it is transformed into a supernova remnant, a rapidly expanding shell of hot gas bounded by the blast's shockwave. Scientists expect that magnetic fields on either side of the shock front can trap particles between them in what amounts to a subatomic pingpong game.

"A supernova remnant's magnetic fields are very weak relative to Earth's, but they extend across a vast region, ultimately spanning thousands of light-years. They have a major influence on the course of charged particles," said co-author Melitta Naumann-Godo at Paris Diderot University and the Atomic Energy Commission in Saclay, France, who led the study with Giordano.

As they shuttle back and forth across the supernova shock, the charged particles gain energy with each traverse. Eventually they break out of their magnetic confinement, escaping the supernova remnant and freely roaming the galaxy.

The LAT's ongoing sky survey provides additional evidence favoring this scenario. Many younger remnants, like Tycho's, tend to produce more high-energy gamma rays than older remnants. "The gamma-ray energies reflect the energies of the accelerated particles that produce them, and we expect more cosmic rays to be accelerated to higher energies in younger objects because the shockwaves and their tangled magnetic fields are stronger," Funk added. By contrast, older remnants with weaker shockwaves cannot retain the highest-energy particles, and the LAT does not detect gamma rays with corresponding energies.

The supernova of 1572 was one of the great watersheds in the history of astronomy. The star blazed forth at a time when the starry sky was regarded as a fixed and unchanging part of the universe. Tycho's candid account of his own discovery of the strange star gives a sense of how radical an event it was.



Tycho's map shows the supernova's position (largest symbol, at top) relative to the stars that form the constellation Cassiopeia. (Credit: Gerstein Science Information Centre, Univ. of Toronto)

The supernova first appeared around Nov. 6, but poor weather kept it from Tycho until Nov. 11, when he noticed it during a walk before dinner. "When I had satisfied myself that no star of that kind had ever shone forth before, I was led into such perplexity by the unbelievability of the thing that I began to doubt the faith of my own eyes, and so, turning to the servants who were accompanying me, I asked them whether they too could see a certain extremely bright star…. They immediately replied with one voice that they saw it completely and that it was extremely bright," he recalled.

The supernova remained visible for 15 months and exhibited no movement in the heavens, indicating that it was located far beyond the sun, moon and planets. Modern astronomers estimate that the remnant lies between 9,000 and 11,000 light-years away.

After more than two and a half years of scanning the sky, LAT data clearly show that an unresolved region of GeV (billion electron volt) gamma-ray emission is associated with the remnant of Tycho's supernova. (For comparison, the energy of visible light is between about 2 and 3 electron volts.)

Keith Bechtol, a KIPAC graduate student who is also based at SLAC, was one of the first researchers to notice the potential link. "We knew that Tycho's supernova remnant could be an important find for Fermi because this object has been so extensively studied in other parts of the electromagnetic spectrum. We thought it might be one of our best opportunities to identify a spectral signature indicating the presence of cosmic-ray protons," he said.

The science team's model of the emission is based on LAT observations, along with higher-energy TeV (trillion electron volt) gamma rays mapped by ground-based facilities and radio and X-ray data. The researchers conclude that a process called pion production best explains the emission. First, a proton traveling close to the speed of light strikes a slower-moving proton. This interaction creates an unstable particle -- a pion -- with only 14 percent of the proton's mass. In just 10 millionths of a billionth of a second, the pion decays into a pair of gamma rays.

If this interpretation is correct, then somewhere within the remnant, protons are being accelerated to near the speed of light, and then interacting with slower particles to produce gamma rays, the most extreme form of light. With such unbelievable goings-on in what's left of his "unbelievable" star, it's easy to imagine that Tycho Brahe himself might be pleased.

Related Links
› NASA's Fermi Closes on Source of Cosmic Rays

› NASA'S Chandra Finds New Evidence on Origin of Supernovas

› A New View of Tycho's Supernova Remnant

› Reproduction of Tycho's book on the 1572 supernova

Francis Reddy
NASA's Goddard Space Flight Center, Greenbelt, Md

Powerful Pixels: Mapping the "Apollo Zone"

Grayscale pixels – up close, they look like black, white or grey squares. But when you zoom out to see the bigger picture, they can create a digital photograph, like this one of our moon.

For NASA researchers, pixels are much more – they are precious data that help us understand where we came from, where we've been, and where we're going.

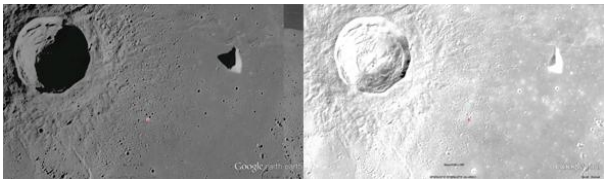
Mosaic of the near side of the moon as taken by the Clementine star trackers. The images were taken on March 15, 1994. Credit: NASA

At NASA's Ames Research Center, Moffett Field, Calif., computer scientists have made a giant leap forward to pull as much information from imperfect static images as possible. With their advancement in image processing algorithms, the legacy data from the Apollo Metric Camera onboard Apollo 15, 16 and 17 can be transformed into an informative and immersive 3D mosaic map of a large and scientifically interesting part of the moon.

The "Apollo Zone" Digital Image Mosaic (DIM) and Digital Terrain Model (DTM) maps cover about 18 percent of the lunar surface at a resolution of 98 feet (30 meters) per pixel. The maps are the result of three years of work by the Intelligent Robotics Group (IRG) at NASA Ames, and are available to view through the NASA Lunar Mapping and Modeling Portal (LMMP) and Google Moon feature in Google Earth.

"The main challenge of the Apollo Zone project was that we had very old data – scans, not captured in digital format," said Ara Nefian, a senior scientist with the IRG and Carnegie Mellon University-Silicon Valley. "They were taken with the technology we had over 40 years ago with imprecise camera positions, orientations and exposure time by today's standards."

The researchers overcame the challenge by developing new computer vision algorithms to automatically generate the 2D and 3D maps. Algorithms are sets of computer code that create a procedure for how to handle certain set processes. For example, part of the 2D imaging algorithms align many images taken from various positions with various exposure times into one seamless image mosaic. In the mosaic, areas in shadows, which show up as patches of dark or black pixels are automatically replaced by lighter gray pixels. These show more well-lit detail from other images of the same area to create a more detailed map.



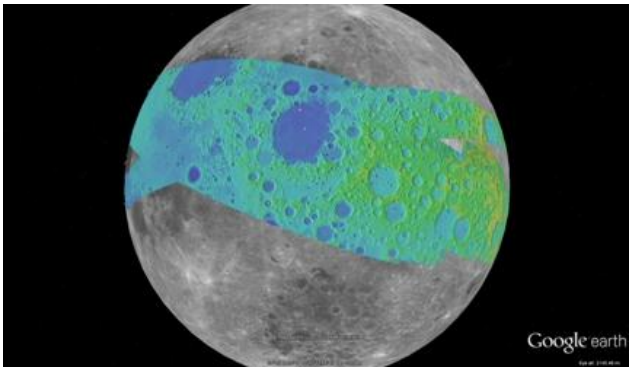
Left: A normal one-camera image of the lunar surface. Right: A composite Apollo Zone image showing the best details from multiple photographs. Credit: NASA/Google Earth

"The key innovation that we made was to create a fully automatic image mosaicking and terrain modeling software system for orbital imagery," said Terry Fong, director of IRG. "We have since released this software in several open-source libraries including Ames Stereo Pipeline, Neo-Geography Toolkit and NASA Vision Workbench."

Lunar imagery of varying coverage and resolution has been released for general use for some time. In 2009, the IRG helped Google develop "Moon in Google Earth", an interactive, 3D atlas of the moon. With "Moon in Google Earth", users can explore a virtual moonscape, including imagery captured by the Apollo, Clementine and Lunar Orbiter missions.

The Apollo Zone project uses imagery recently scanned at NASA's Johnson Space Center in Houston, Texas, by a team from Arizona State University. The source images themselves are large – 20,000 pixels by 20,000 pixels, and the IRG aligned and processed more than 4,000 of them. To process the maps, they used Ames' Pleiades supercomputer.

The initial goal of the project was to build large-scale image mosaics and terrain maps to support future lunar exploration. However, the project's progress will have long-lasting technological impacts on many targets of future exploration.



The color on this map represents the terrain elevation in the Apollo Zone mapped area. Credit: NASA/Google Earth

"The algorithms are very complex, so they don't yet necessarily apply to things like real time robotics, but they are extremely precise and accurate," said Nefian. "It's a robust technological solution to deal with insufficient data, and qualities like this make it superb for future exploration, such as a reconnaissance or mapping mission to a Near Earth Object."

Near Earth Objects, or "NEOs" are comets and asteroids that have been attracted by the gravity of nearby planets into orbits in Earth's neighborhood. NEOs are often small and irregular, which makes their paths hard to predict. With these algorithms, even imperfect imagery of a NEO could be transformed into detailed 3D maps to help researchers better understand the shape of it, and how it might travel while in our neighborhood.

In the future, the team plans to expand the use of their algorithms to include imagery taken at angles, rather than just straight down at the surface. A technique called photoclinometry – or "shape from shading" – allows 3D terrain to be reconstructed from a single 2D image by comparing how surfaces sloping toward the sun appear brighter than areas that slope away from it. Also, the team will study imagery not just as pictures, but as physical models that give information about all the factors affect how the final image is depicted.

"As NASA continues to build technologies that will enable future robotic and human exploration, our researchers are looking for new and clever ways to get more out of the data we capture," said Victoria Friedensen, Joint Robotic Precursor Activities manager of the Human Exploration Operations Mission Directorate at NASA Headquarters. "This technology is going to have great benefit for us as we take the next steps."

This work was funded by NASA's LMMP, and supported by collaborators at NASA's Marshall Space Flight Center, Huntsville, Alabama, NASA's Goddard Space Flight Center, Greenbelt, Maryland, NASA's Jet Propulsion Laboratory, Pasadena, Calif. and the United States Geological Survey (USGS).

To view the maps, visit the LMMP site or view in Google Earth:

1. Download Google Earth at: http://earth.google.com
2. Click here to download a KML file for viewing in Google Earth: http://byss.ndc.nasa.gov/stereopipeline/dataviz/apollo_metric.kml
3. Once you open that file in Google Earth you will have options to view these "Apollo Zone" maps overlaid on Google Earth's "Moon mode".

Jessica Culler
Ames Research Center, Moffett Field, Calif.

Year of the Solar System
Evolving Worlds

This lovely, otherworldly evening was captured by the rover Spirit in 2005 as it peered toward the western sky from its perch in Gusev Crater on Mars. Image Credit: NASA/JPL/Texas A&M/Cornell

Like people, planets grow old. They start out full of energy, but over billions of years, they change. Instead of losing their hair, planets can lose their atmospheres and oceans. Instead of wrinkles, they may gather craters. And rather than becoming frail, planets cool and shrink, becoming more dense as they move into their senior years.

Mars is an example of a planet past its youth. Planetary scientists envision a warmer, wetter early Mars, with flowing rivers and ocean and a thicker atmosphere, all surrounded by a protective global magnetic field. As Mars cooled, its core could no longer generate a magnetic field. Its interior became too cool to produce the volcanic eruptions that built and maintained the atmosphere. Without the protective shield of the magnetic field, the solar wind gradually eroded away Mars' diminished atmosphere. Water, once flowing across the surface, evaporated or became trapped in the subsurface or polar ice caps. Exploring how worlds evolve will help us understand more about Earth's own future -- and help us in our search for habitable planets!

Join us for December and January as we investigate how planets evolve! Check out the calendar for events these months and the upcoming observing event opportunities. Jupiter AND Venus are bright in the evening sky and if you're lucky, you may catch a glimpse of some meteors from the Geminid or Quadrantid meteor showers!

In the Eyepiece

Here is a list of objects for this month. This is reproduced from www.skyhound.com with the kind permission of its creator and author of SkyTools Greg Crinklaw.

Object(s)	Class	Con	RA	Dec	Mag
NGC 1501	Planetary Nebula	Camelopardus	04h06m59.4s	+60°55'14"	13.3
Cleopatra's Eye	Planetary Nebula	Eridanus	04h14m15.8s	-12°44'21"	9.6
The California Nebula	Diffuse Nebula	Perseus	04h03m12.0s	+36°22'00"	5.0
NGC 1664	Open Cluster	Auriga	04h51m04.4s	+43°42'04"	7.2
MSH 04-12	Quasar	Eridanus	04h07m48.4s	-12°11'36"	14.8
NGC 1360	Planetary Nebula	Fornax	03h33m14.6s	-25°52'18"	9.6
Crystal Ball	Planetary Nebula	Taurus	04h09m17.0s	+30°46'33"	10.0
Palomar 2	Globular Cluster	Auriga	04h46m06.0s	+31°22'54"	13.0
K 2-1	Planetary Nebula	Auriga	05h07m07.1s	+30°49'18"	13.8
NGC 1624	Open Cluster	Perseus	04h40m25.4s	+50°26'49"	11.8

Coordinates are epoch 2000.0