Lunar Librarian Newsletter
March 2008

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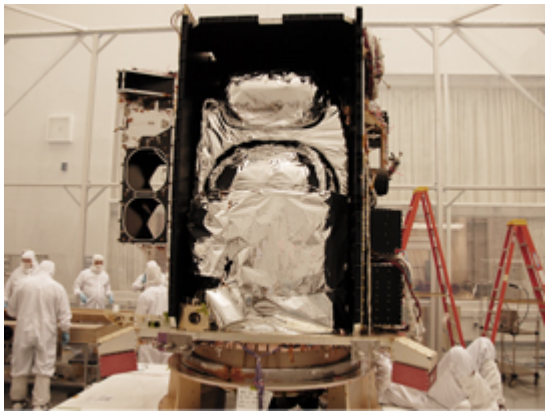
LRO News

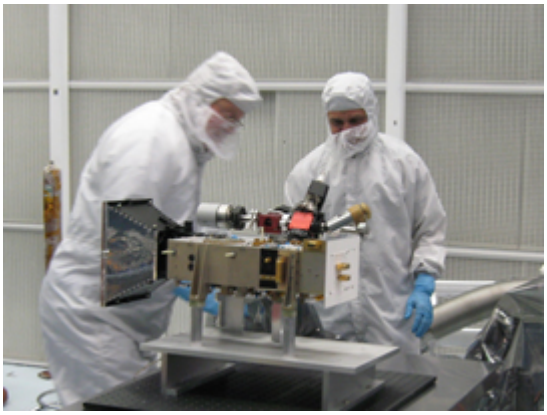
Wondering what it takes to put an orbiter together? Watch the Lunar Reconnaissance Orbiter (LRO) being assembled. Check out the video available at: http://lunar.gsfc.nasa.gov/images/multimedia/LRO-022808.wmv. This video takes place at NASA's Goddard Space Flight Center, Greenbelt Maryland. The video starts with the propulsion tank as different panels are added to the bus.



On February 28, 2008, we attached the -Y and -Z panels to the propulsion module, and we also installed the +X panel for stability. This major mechanical operation involved about a dozen engineers and technicians. Since that time, the flight Telemetry, Tracking, and Command unit arrived, and we integrated it with the spacecraft and tested it. On March 1st, the Diviner instrument arrived. We are checking it out this week.

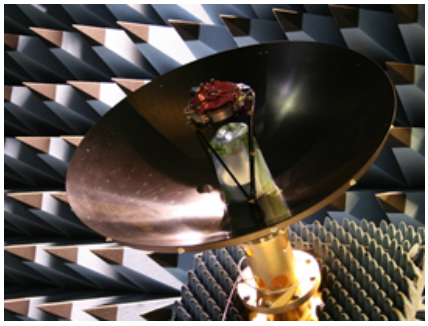
The photo to the left shows the Propulsion Module with the avionics panel (-Y) on the right and the Instrument Module panel (+Y) on the left. The panel with the reaction wheels (-Z) is on the other side of the Propulsion Module. The +X panel is on top. Our hardware is starting to look like a spacecraft.

The LAMP instrument [http://www.boulder.swri.edu/lamp/] arrived at Goddard Space Flight Center from Southwest Research Institute (SwRI) [http://www.swri.edu/]. Incoming inspection and check-out was performed. LAMP is in good shape, ready for integration. The High-Gain Antenna also arrived. The integration of the S-band feed was performed as well as some alignment checks. Currently measurements are being taken in the anechoic chamber. In the Orbiter White Room, we are cleaning up the last of some details before next week's assembly of the -y and -z panels around the propulsion module.



Mike Young and Dave Slater check out the LAMP instrument after delivery to Goddard Space Flight Center

The photo to the right shows the High-Gain Antenna in the anechoic chamber .The cones on the wall absorb radio waves, preventing reflections that would corrupt the measurements of the antenna performance. The red cover on the central feed supports a mirror-covered cube that we use for alignment measurements. The cover will be removed before flight.



Variety of Different Total Lunar Eclipses

February 21, 2008 was the last total lunar eclipse until December 21, 2010. These images, taken by Tunç Tezel, are 11 of the past 13 total lunar eclipse since February 1996. One of the images is a partial eclipse taken in September 2006.
http://antwrp.gsfc.nasa.gov/apod/ap080229.html

NASA News

Have You Seen the Moon's South Pole Lately?

With the use of Goldstone Solar System Radar, 70-metter radar dish, located in California's Mojave Desert, scientists at NASA's Jet Propulsion Laboratory (JPL) have been able to obtain data on the South Pole region of the Moon. To date, this is the highest resolution of the terrain. The images were generated from the data to create an animation showing the descent to the lunar surface of a future lunar landing mission and a flyover of Shackleton Crater.

The data was collected over a six-month period in 2006, when the Goldstone Radar was used three times to take measurements. "The antenna, three-quarters the size of a football field, sent a 500-kilowatt strong, 90-minute long radar stream 231,800 miles to the moon. The radar bounced off the rough-hewn lunar terrain over an area measuring about 400 miles by 250 miles. Signals were reflected back to two of Goldstone's 34-meter antennas on Earth. The roundtrip time, from the antenna to the moon and back, was about two-and-a-half seconds."

The resolution achieved was greater than three times the special resolution and 10 time finer vertical accuracy than the data collected in 1997 by a team lead by Cornell University scientist Jean-Luc Margot, also using Goldstone. Scott Hensley, a scientist at JPL and lead investigator for the study, described the resolution as: "With these data we can see terrain features as small as a house without even leaving the office."

The Lunar Reconnaissance Orbiter will provide even higher resolution, approximately to 1 meter, of the South Pole region and the rest of the Moon. Right now, LRO is in its assembly stage which can be seen at: http://lunar.gsfc.nasa.gov/images/multimedia/LRO-022808.wmv. For more information on the latest images of the Moon's South Pole, please visit: http://www.nasa.gov/mission_pages/exploration/mmb/moon-20080227.html

Science News

NASA Science News has published several articles last month. Please follow the links to read the full stories. Check out our RSS feed at http://science.nasa.gov/rss.xml!

New Radar Maps of the Moon
New high-resolution radar maps of the Moon's south pole reveal a fantastic land with peaks as high as Mt. McKinley and crater floors four times deeper than the Grand Canyon. NASA has used the data to create a dramatic VR movie of a moon landing from the point of view of an astronaut.
http://science.nasa.gov/headlines/y2008/29feb_radarmoon.htm?list907815

Avalanches on Mars
A NASA spacecraft in orbit around Mars has photographed an avalanche in action near the Red Planet's North Pole. http://science.nasa.gov/headlines/y2008/03mar_avalanche.htm?list907815

Auroras in Broad Daylight

Imagine living on a planet where Northern Lights fill the heavens at all hours of the day. Around the clock, even in broad daylight, luminous curtains shimmer and ripple across the sky. News flash: Astronomers have discovered such a planet. Its name is Earth.
http://science.nasa.gov/headlines/y2008/06mar_polar.htm?list907815

Dark Halos Discovered on Mercury
The surprises continue. Scientists studying the harvest of photos from MESSENGER's Jan. 14th flyby of Mercury have found several craters with strange dark halos and one crater with a curiously shiny bottom.
http://science.nasa.gov/headlines/y2008/07mar_strangecraters.htm?list907815

Librarian News

The LRO EP/O team is on the move again this month. This month the group will be heading up to Boston University to give a Lunar Librarian Workshop for the Massachusetts Librarians. If you have any advice or activity suggestions you would like to pass on to our librarians, please feel free to contact me, heather_weir@ssaihq.com.

Librarians Lynn Hahn and Ing Kalchthaler, of the Bethel Park Public Library, held a Family Space Program on March 8th. I hope it went well!

Please note we will be combining April and May issues. Find out why in May.

Contributions from Our Librarians

Angelica Sauceda from the Anaheim Public Library, Anaheim, CA, has compiled a list of books, fingerplays, songs, and puppet shows dealing with the Moon and space. Over the next couple of months, we will be sharing her list. If you have activities or recommendations you would like to share with our librarians, please feel free to send them to me, heather_weir@ssaihq.com.

Fingerplays:

Blastoff
Jump into your spacesuit.
Don't forget your hat. (pretend to put on)
Buckle up for take off,
Belts from head to toe. (pretend to buckle up)
Count down for ten and blast off,
Up to the moon we go!
10, 9, 8, 7,
Blastoff! (count on fingers, put palms together, and extend arms above head)

Moon Ride
Do you want to go up with me to the moon?
Let's get in our rocket ship and blast off soon! (climb in ship)
Faster and faster we reach to the sky (jump and reach)
Isn't it fun to be able to fly?
We're on the moon, now all take a look (look down)
And gently sit down and I'll show you a book (sit down gently)

Spaceship in the Sky
In a spaceship, in the sky (hold arms over head forming circle like the moon)
Spacey little conehead guy (make conehead shape with hands on top of head)
Saw an astronaut floating by (place arms and legs outwards and stand on one foot)
Knocking at my door (knock in air)
Help me, help me, help me! He said
Or the laser beam will get me, I'm afraid.
Come little astronaut, come with me (beckon with hands)
And happy we will be.

GRANDMA MOON

Grandma Moon, Grandma Moon,	(Form crescent shape with 1 hand)
You're up too soon!	(Point 1 finger towards crescent shape)
The sun is still in the sky.	(Encircle arms above head)
Go back to bed, & cover up your head,	(Lay head on hands; cover head w/hands)
And wait till the day goes by.	(Turn around)

RIDDLE

I have two strong hands to help me,	(Open & close hands)
Two strong feet to guide me,	(Point to feet, march in place)
And wide light all around me.	(Extend arms out to sides)

What am I? (A Star)

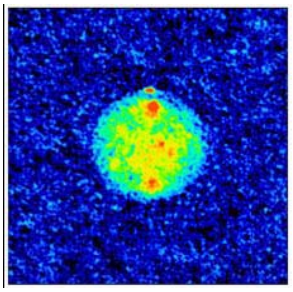
THE SOLAR SYSTEM (use with magnet board figures)
Nine planets make our solar system. / I'll call them off in case you missed 'em.
The planet closest to our sun / Is Mercury. It's number one.
The evening star, perhaps you knew, / Is Venus, and our number two.
The blue-green planet that gave you birth / Is number three; our planet Earth.
Four is brighter than the stars. / We call this crimson planet Mars.
Jupiter, with its great red spot / Is the largest planet, we are taught.
The colored rings form a pretty pattern / Around the planet we call Saturn.
The seventh planet is not too famous. / It's the one that we call Uranus.
Neptune's next, at any rate, / So we call it number eight.
The planet Pluto's next in line, / So we give it number nine.
These are the planets, one through nine. / Let's repeat them, all in a line.

Links of the Month…

- Planetary Radio - A Near Miss for Mars and Bill Nye Pays Tribute to Mercury! http://www.planetary.org/radio/show/00000271/
- INTERACTIVE CONSTELLATION DISCOVERY, Quiet Bay Networks. Try your hand at picking out key constellations in a perfectly dark sky. http://www.quietbay.net/Science/astronomy/nightsky/
- DATASTREME ATMOSPHERE, AMS. "DataStreme Atmosphere is a major precollege teacher enhancement initiative of the American Meteorological Society with the main goal of training of Weather Education Resource Teachers who will promote the teaching of science, mathematics and technology using weather as a vehicle, across the K-12 curriculum." http://www.ametsoc.org/amsedu/dstreme/index.html

Monthly Activity

Is there Ice on Mercury ? From: Space Math http://spacemath.gsfc.nasa.gov



The NASA MESSENGER spacecraft performed its first flyby of Mercury on January 14, 2008. In addition to mapping the entire surface of this planet, one of its goals is to shed new light on the existence of ice under the polar regions of this hot planet. Ice on Mercury? It's not as strange as it seems!

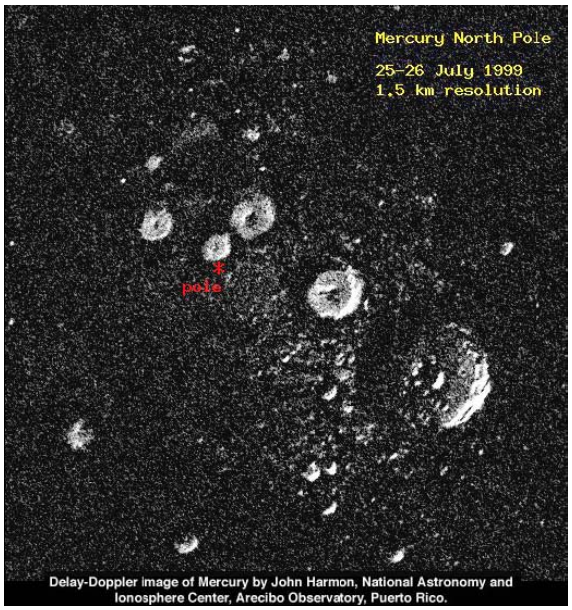
In 1991, Duane Muhleman and her colleagues from Caltech and the Jet Propulsion Laboratory, created the first radar map of Mercury. The image, shown here, contained a stunning surprise. The bright red dot at the top of the image indicates strong radar reflection at Mercury's North Pole, resembling the strong radar echo seen from the ice-rich polar caps of Mars.

In 1999, astronomer John Harmon at the Arecibo Observatory in Puerto Rico, repeated the 1991 study, this time using the powerful microwave beam of the Arecibo Radio Telescope. The microwave energy reflected from mercury and was detected by the VLA radio telescope array in New Mexico, where a new image was made.

The radio-wavelength image to the left shows Mercury's North Polar Region at very high resolution. The image is 370 kilometers wide by 400 kilometers tall.

All the bright features are believed to be deposits of frozen water ice, at least several meters thick in the permanently shaded floors of the craters.

Reference: Harmon, Perillat and Slade, 2001, Icarus, vol 149, p.1-15



Delay-Doppler image of Mercury by John Harmon, National Astronomy and Ionosphere Center, Arecibo Observatory, Puerto Rico.

- **Problem 1** - From the information provided in the essay, what is the scale of the image in kilometers per millimeter?
- **Problem 2** - Measure the diameters of the craters, in kilometers, and estimate the total surface area covered by the large white patches in A) square kilometers and B) square meters.
- **Problem 3** - Suppose the icy deposit is mixed into the Mercurian surface to a depth of 10 meters. What is the total volume of the ice within the craters you measured in cubic meters?
- **Problem 4** - Suppose half of the volume is taken up by rock. What is the total remaining volume of ice?
- **Problem 5** - The density of ice is 917 kilograms/cubic meter. How many kilograms of ice are present?
- **Problem 6** - If this ice were 100% water ice, and 3.8 kilograms of water equals 1.0 gallons, how many gallons of water might be locked up in the shadowed craters of Mercury?

Answer Key:

Problem 1 - From the information provided in the essay, what is the scale of the image in kilometers per millimeter?

Answer: The image is 370 kilometers wide by 400 kilometers tall. The image is 95 millimeters wide by 104 millimeters tall. The scale is therefore about 4.0 kilometers / millimeter.

Problem 2 - Measure the diameters of the craters, in kilometers, and estimate the total surface area covered by the large white patches in A) square kilometers and B) square meters.

Answer: Students should measure the diameters of at least the 5 large craters that form the row slanted upwards from right to left through the center of the image. Their diameters are about 90 km, 40 km, 30 km, 20 km and 25 km. The area of a circle is π R2, so the crater areas are 6,400 km2, 700 km2, 314 km2 and 490 km2. The total area A) in square kilometers is about 7,900 km2 or B) 7,900 x (1000 m/km) x (1000 m/km) = 7.9 x 109 meters2. Students may reasonably ask how to estimate the area of partially-filled craters such as the largest one in the image .They may use appropriate percentage estimates. For example, the largest crater is about 1/2 filled (white color in image) so its area can be represented as 6,400 x 0.5 = 3,200 km2.

Problem 3 - Suppose the icy deposit is mixed into the Mercurian surface to a depth of 10 meters. What is the total volume of the ice within the craters you measured?

Answer: Volume = surface area x height = 7.9 x 109 meters2 x 10 meters = 7.9 x 1010 meters2.

Problem 4 - Suppose half of the volume is taken up by rock. What is the total remaining volume of ice?

Answer; 7.9 x 1010 meters2 x 0.5 = 8.0 x 1010 meters2

Problem 5 - The density of ice is 917 kilograms/cubic meter how many kilograms of ice are present?

Answer: 8.0 x 1010 meters2 x 917 kg/meters3 = 7.3 x 1013 kilograms

Problem 6 - If this ice were 100% water ice, and 3.8 kilogram of water equals 1.0 gallons, how many gallons of water might be locked up in the shadowed craters of Mercury?

Answer: 7.3 x 1013 kilograms / 3.8 kg/gallon = 1.9 x 1013 gallons or 19 trillion gallons!