Lunar Librarian Newsletter
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LRO News

Mission Impact: The LCROSS Mission to the Moon. – by Brooke Carter

By now you realize that LRO is the next NASA mission to the Moon since the Lunar Prospector in 1994, but did you know that another spacecraft will be sent to the Moon along with LRO?

The Lunar Crater Observation and Sensing Satellite (LCROSS) will hitch a ride on the same Atlas V rocket as LRO, but that is where the similarities end. Unlike LRO, the LCROSS spacecraft is made up of two pieces, both of which will be sent on a collision course with the Moon. The primary mission of LCROSS is to impact one of the permanently shadowed regions at the poles of the Moon and analyze the resulting explosion, in order to detect the presence of water ice. During the LCROSS mission, the Upper Stage of the launch vehicle will be used as an impactor, while the Shepherding Spacecraft will be used to make observations of the impact. Shortly after the impact of the Upper Stage, the Shepherding Spacecraft will be sent on the same path to impact the Moon! On its way down, the Shepherding Spacecraft will take data from the impact plume left over from the first impact.

Water ice, if present, is expected to reside in permanently shadowed regions at the lunar poles. However, since these regions are permanently shadowed, scientists do not know with any certainty the topography of the region. LOLA data will be crucial for LCROSS to find a suitable, flat landing surface. This will reduce the speculation of what LCROSS will be hitting, e.g. scientists do not want to hit a boulder. Another of LRO's instruments, LEND, will look for areas with abundant hydrogen, which suggests the presence of water ice. These data will be combined to allow LCROSS scientists to select the best lunar impact site.

This is not the first time that NASA has purposely sent a spacecraft on a collision course with an astronomical body. On July 4, 2005, the Deep Impact Mission sent an impactor to the surface of the comet Tempel 1. The success of Deep Impact has proven that valuable data can be gathered through the observation of man-made impacts on celestial bodies. While the primary intention of LCROSS is to look for signs of water on the Moon, the data that will be returned from the mission will prove to be valuable for NASA's vision to return men to the Moon, regardless of whether or not the presence of water is confirmed.

LCROSS will impact the Moon approximately 86 days after launch, and scientists estimate that the impact will be large enough to be seen with an amateur telescope, so be on the lookout for the celestial fireworks display! For more information on LCROSS, visit the mission website:http://lcross.arc.nasa.gov/

For more information on NASA's Vision for Space Exploration, visit:
http://www.nasa.gov/mission_pages/exploration/main/index.html

NASA News

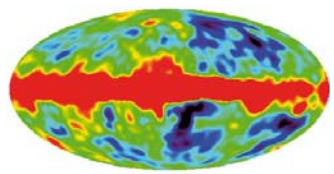
Goddard Scientist Wins Nobel Prize for Physics

"The very detailed observations that the Laureates have carried out from the COBE satellite have played a major role in the development of the modern cosmology into a precise science."

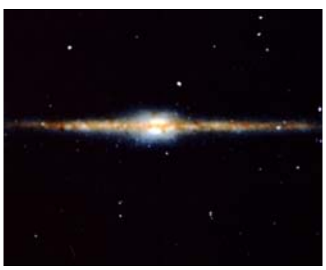
Dr. John Mather

Dr. John Mather, NASA GSFC, and Dr. George Smoot, University of California, Berkeley, were awarded the 2006 Nobel Prize for Physics, "*for their discovery of the basic form of the cosmic microwave background radiation as well as its small variations in different directions.*" (http://nobelprize.org/nobel_prizes/physics/laureates/2006/info.pdf) Their observations were made from the Cosmic Background Explorer satellite (COBE).

Dr. Mather has played a prominent role with COBE since 1974, when he organized the first proposal. He served as both the Project Scientist for COBE and the Principal Investigator for the Far Infrared Absolute Spectrophotometer (FIRAS). The FIRAS measured the cosmic microwave background radiation spectrum of the universe. The spectrum produced was a match to that of a perfect blackbody. (A blackbody is an object that absorbs all wavelengths of electromagnetic radiation incident on its surface. A blackbody then emits radiation, blackbody radiation, at all wavelengths. The spectrum produced is dependent only on the temperature of the emitting body.) The results support the theory of the Big Bang as the origins of the Universe. When the radiation was emitted, the temperature of our Universe was 3,000 degrees Centigrade. As the Universe has expanded, the background radiation has cooled. The radiation is only 2.7 degrees above absolute zero. Due to the cooling, this has caused the wavelength of the radiation to be longer. It can only be seen in the microwave wavelength.



A sky-map of the temperature variations measured by COBE. Red corresponds to higher temperature and blue to lower. The variations are minuscule – in the range of a hundred-thousandth of a degree.



COBE's View of the Milky Way – NASA image

"In addition to proving the Big Bang, the satellite discovered that the cosmic background radiation had indeed been produced in the Big Bang just as scientists originally speculated. The satellite's data even discovered the primordial temperature and density fluctuations that eventually gave rise to the Milky Way and other large-scale objects found in space today." (http://solarsystem.nasa.gov/multimedia/display.cfm?IM_ID=1799)

Currently Dr Mather is the Senior Project Scientist for the James Webb Space Telescope (JWST). The JWST is a large infrared telescope that is planned to be launched in 2013. The mission of this telescope is to study the history of the Universe from the short period after the Big Bang to formations of solar systems, including ones like ours. For more information on JWST, please see: http://www.jwst.nasa.gov/. Dr. Mather is the first NASA scientist to win a Nobel prize

NASA Goes Extreme.

Led by astronaut Sandra H. Magnus, astronauts Army Lt. Col. Timothy L. Kopra, Army Col. Timothy J. Creamer, and Air Force Maj. Robert L. Behnken recently partook in a seven-day underwater mission on NOAA's Aquarius underwater laboratory. The Aquarius, located three miles off Key Largo, is a 45-foot-long, 13-foot-diameter laboratory found 62 feet below the surface in the Florida Keys National Marine Sanctuary. During the NASA Extreme Environment Mission Operations (NEEMO) 11, the astronauts/aquanauts simulated a variety of tasks that may be used during return missions to the Moon. Some of the tasks preformed were moonwalks, using a various spacesuit configurations and weights to simulate lunar gravity, communication and navigation techniques, sample retrieval, construction, and the use of remote-controlled robots.

The crew member is wearing a reconfigurable center of gravity backpack to simulate moon walking.

For more information on this and previous NEEMO missions, please visit: http://www.nasa.gov/mission_pages/NEEMO/.

Science News

NASA Science News has published several articles last month. Please follow the links to read the full stories.

Surprises from the Edge of the Solar System

NASA's Voyager 1 spacecraft has entered a new realm of space, and it's beaming back some surprises.
http://science.nasa.gov/headlines/y2006/21sep_voyager.htm?list907815

Strange Moonlight

When the Harvest Moon rises on Oct. 6th, go outside. You may notice a few puzzling things.
http://science.nasa.gov/headlines/y2006/28sep_strangemoonlight.htm?list907815

Novarupta

The most powerful volcanic eruption of the 20th century happened in Alaska at a volcano named Novarupta. Because Novarupta was located so near the Arctic, it did some curious things to Earth's climate. Almost a century after the blast, researchers are beginning to understand what happened.
http://science.nasa.gov/headlines/y2006/03oct_novarupta.htm?list907815

2006 Transit of Mercury

Mark your calendar: On Wednesday, Nov 8th, the planet Mercury will pass directly in front the Sun.
http://science.nasa.gov/headlines/y2006/20oct_transitofmercury.htm?list907815

Librarian News

Here's what's going with some of the librarians who participated in the workshops

Seven of the librarians from "Moon and Beyond" will be attending 2006 National Conference on Aviation and Space Education, October 19-21. The keynote speakers are NASA retired astronauts Buzz Aldrin and Hoot Gibson and Dr James Garvin from GSFC.

What's going on at your library??

Email Heather, heather_weir@ssaihq.com, with your library's space program activities by September 24, and it will be included in the next Lunar Librarian Newsletter. Feel free to send along pictures from your workshops.

Did you know?? Where can I find??

Need a NASA scientist or a speaker to come and talk at your library?

Please feel free to contact either Brooke Carter (brooke_carter@ssaihq.com 301-867-2112) or Heather Weir (heather_weir@ssaihq.com 301-867-2083) with details on what you are looking for and what you want to cover. Also, if you could provide a schedule of when you want to plan your event, this would be helpful.

Monthly Lunar Activity

Cookin' Up a Comet

Available at: http://btc.montana.edu/messenger/teachers/Modules/Lessons/Comets.pdf

Comet Composition

The objects that reside in the Kuiper Belt and Oort Cloud are not the spectacular comets that are seen when they come to the inner Solar System. They are made of water, carbon dioxide, ammonia, and methane ices, as well as dust and rock, and organic (carbon-based) substances. They have been described as "dirty snowballs," a description that Harvard astronomer Fred Whipple (1906-2004) came up with in 1950. Comets may have impacted the Moon and could be a source of ice (if there is any) in the permanently shadowed regions of the Moon. The main part of the comet is called the nucleus. They are usually a few kilometers across and are darker than charcoal. This is the form of the comets during most of their orbit around the Sun; in the outer Solar System this is the only part of the comet. When a comet's orbit brings it nearer to the Sun, its ices begin to sublimate: change directly from solid to gas. This forms a cloud of gas and dust particles around the nucleus, called the coma. The coma's size depends on the comet's distance from the Sun, and when a comet approaches perihelion (its closest approach to the Sun), the coma becomes as big as the Earth, and can even reach the size of the Sun!

The solar wind—a stream of fast-moving particles flowing from the Sun—and radiation pressure—pressure exerted by sunlight—push the coma particles away from the nucleus, forming the third component of the comet, its tail. It is not unusual for the tails of comets to extend more than 1 AU. Because the tail is formed by forces coming from the Sun, it always points away from the Sun. Therefore, the tail follows the nucleus on the comet's way into the inner Solar System, but leads on the way out. This is similar to a windsock, which always points away from the direction from which the wind is coming. The different particles of the tail are accelerated away from the comet's head (nucleus and coma) at different rates, due to their different sizes and properties. Often, the result is two tails: one made of the gas particles, and one made of the dust particles. The gas tail is accelerated almost straight out from the Sun by the solar wind. The dust tail is created by radiation pressure and can appear to be slightly curved with respect to the direction of the Sun.

Comet Hale-Bopp in 1997.
(Picture credit: http://antwrp.gsfc.nasa.gov/apod/ap001227.html)

Activity

Students will create a model of a comet and compare their model to a real comet. This can also be done as a demo since the activity does use dry ice.

Teacher Materials

- Protective eye goggles
- Heavy dishwashing gloves
- Overhead projector
- Hair dryer
- Plastic wrap (enough to cover the glass top of the overhead projector)
- Hammer (or mallet)
- Large metal tub (at least 20 liters in capacity)

Student Materials
(per group of 3 unless otherwise specified)

- Measuring cup (at least 1 c. capacity)
- 3 cups of water
- A few drops of sudsing ammonia
- A handful of sand
- A splash of cola
- Large wide mixing bowl
- Large wooden or plastic spoon for stirring
- Heavy dishwashing gloves (2 pairs per group)
- Protective eye goggles (1 pair per student)
- Newspaper (enough to cover work surface)
- 2.5 cups dry ice (about 10 lbs. needed for a class of 30 students)

Preparation & Procedures

1. Purchase dry ice (frozen carbon dioxide; CO2) from an ice company or an ice cream parlor the day of or evening prior to conducting this activity. If possible, get the pellet form of dry ice (rather than the block form); it is easier to crush. However, be aware that the pellet form will sublimate and disappear more quickly than the block form. Be sure to purchase at least ten pounds of dry ice; more will be needed if purchased the evening before. (Ten pounds of dry ice will sublimate in 24 hours unless kept in an insulated bin. Depending on the level of insulation, dry ice storage bins will lose 2%—10% of the dry ice per day.) You may also want to get extra for a test run the night before.

2. Store the dry ice in an ice chest. Place an inch or so of newspaper between the dry ice and the container to prevent the container from cracking. Remember to wear rubber gloves when handling dry ice.

3. Put on rubber gloves. Using a hammer, crush the dry ice pellets or blocks in a large metal tub to the consistency of snow. You should wear protective eye goggles. You can do this before the students arrive to class to save class time.

DO NOT HANDLE DRY ICE WITHOUT PROTECTIVE GLOVES!!

4. Set up the classroom so that there are enough stations for each group of three to have their own space. The groups will need a large table or a few desks pushed together. To protect the desks, each station should be covered with newspapers.

5. Discuss with students why comets are thought to be remnants of Solar System formation. You can use the following facilitation: Ask the students how we keep things from spoiling or melting. (*Desired answer: we put them in a refrigerator*) What if we want to keep them even longer? (*Desired answer: we put them in a freezer*) The colder something is, the longer it keeps things from spoiling. Ask students where comets originate. (*Desired answer: in the outer part of the Solar System*) What is the temperature like there? (*Desired answer: it is very cold so far from the Sun*) Now that you have drawn the parallel between keeping things from spoiling and a comet's environment, ask the students why they think comets are considered to be leftovers from the formation of the Solar System. (*Desired answer: comets were able to be preserved in their cold environment*) Explain that by studying comets, we can study the conditions of the early Solar System.

6. Review with the students the structure of a comet: nucleus, coma, and tail. Discuss the composition of a comet nucleus (dirt, dust, water ice, carbon dioxide ice, methane ice, ammonia ice, and organic molecules). One way comets can be studied in the classroom is by making a model.

7. Divide students into groups of three, and designate the following jobs: Chef, Ingredients Expert, and Recorder.

8. Have students make a model of the comet following the procedures on a piece of paper.

9. When the model comets have been made, cover an overhead projector with plastic wrap. Put a volunteer group's comet on the plastic wrap and turn on the overhead projector. The whole class can look at the projection on the wall or screen and see gas appearing to come from the comet. Ask the students what is happening when dry ice is giving off gas. (*Desired answer: dry ice is sublimating*) Ask them why this is happening. (*Desired answer: surrounding air is much warmer than the dry ice, and the dry ice turns right from solid to gas*) Point out that what they are actually seeing is not the sublimated carbon dioxide gas, but water vapor that is condensing as the cold carbon dioxide cools the surrounding air. Now turn on a hair dryer, set on low, and blow warm air on the comet nucleus. Ask the students what they see, and what part of a real comet it represents. (*Desired answer: gas blows away from the model; a tail*) Ask them what they think the hair dryer represents. (*Desired answer: the Sun*) Ask the students if the hair dryer represents the Sun, which way is the comet moving? (*Desired answer: You cannot tell. The tail is caused by solar wind and radiation pressure from the Sun, and will look the same no matter which direction the comet is traveling*) Point out to the students that this is not an exact model for how a comet's tail forms—it is actually physically different because there is no blowing air coming from the Sun. This is, however, a good way for students to remember that comets' tails always points away from the Sun.