PLANETARY SCIENCE INSTITUTE

# NEWSLETTER

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***In 1985, Donald R. Davis (left) and William K. Hartmann demonstrated the Moon's likely origin: A Mars-sized body collided with Earth causing rocky debris to orbit Earth and accumulate to form the Moon.***

# A Blast from the Past

In 1974, the "Giant Impact" hypothesis for the origin of the Moon was first proposed by PSI founding members Bill Hartmann and Don Davis at a conference on satellites at Cornell. A year later, they published the first paper on this idea in *Icarus*. Hartmann came at the idea from the point of view of accretion theory, the moon's lack of iron and dense metals, and his earlier work on giant, multi-ring lunar impact basins. Davis provided modeling showing that a second body, with a diameter as large as Mars, could have formed at Earth's distance from the sun, with the result that Earth could plausibly have suffered a huge collision, blowing mantle material into orbit.

The photo is from a 1985 article in *Discover* magazine, following general acceptance of the theory during a 1984 conference on lunar origin. The theory is still currently accepted as the leading explanation of lunar origin.

Still at PSI 25 years later, Hartmann and Davis continue to be very active in science. Hartmann is working primarily on the cratering history of Mars and other planets. Davis is improving collisional models to reflect the prevalence of "rubble pile" structures in the solar system and is the principal investigator of a project to establish a global network of light pollution monitors. □

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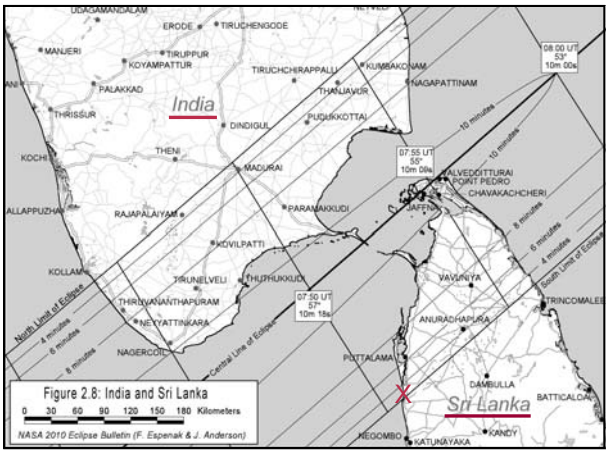
*Tucson AZ Chandler AZ Flagstaff, AZ Phoenix AZ Alhambra CA Angwin CA Cupertino CA Pasadena CA Sierra Madre CA Washington DC Honolulu HI Lexington, KY Columbia MD Pasadena MD Ft Kent ME Albuquerque NM Los Alamos NM Reno NV Houston TX San Antonio TX Arlington VA Reston VA Chester VT Medina WA Seattle WA Appleton WI Evansville WI Sobieski WI Waunakee WI Wheeling WV*

# A Solar Eclipse Viewed from Sri Lanka

*by Nalin Samarasinha*

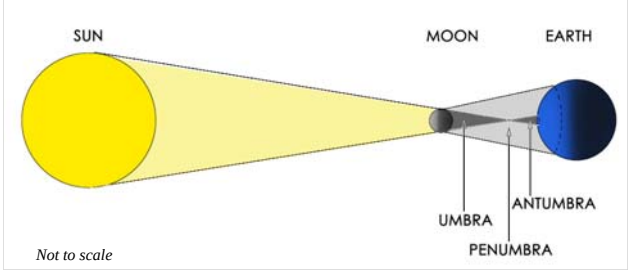
It is always a privilege to see a total or an annular solar eclipse. I had an opportunity to observe the annular solar eclipse of January 15, 2010, from Sri Lanka, my country of origin. An annular (ring-shaped) eclipse occurs when the moon does not completely block out the sun, leaving only a ring of sunlight. The above photograph, taken shortly after the annular phase of the eclipse, at 1:23 p.m. Sri Lanka time on that day, shows the sun as a partial ring.

Unlike lunar eclipses, total or annular solar eclipses can be viewed only from a narrow stretch of land on Earth, which differs with each eclipse. Therefore, one must travel to specific geographic locations on Earth from which that solar eclipse is visible. This January eclipse was visible as only a partial eclipse in much of Africa, Eastern Europe, the Middle East and Asia. It was seen as an annular eclipse within a narrow stretch — about 200 miles wide — across Central and East Africa, Maldives, South Kerala (India), South Tamil Nadu (India), Sri Lanka and parts of Bangladesh, Burma and China.




***The diagonal lines depict the region of Sri Lanka and India from which this annular eclipse was visible. The bold diagonal central line shows where the annular eclipse was of the longest duration; the further we move from the center, the shorter the duration of the annular eclipse. The red X shows the location of our Eclipse Expedition Team.*** ***Eclipse Predictions by Fred Espenak, NASA's GSFC.***

A solar eclipse occurs when the moon passes between the Earth and the sun, and the moon and Earth align just right to cast the shadow of the moon onto the Earth. If an observer on Earth happens to be in a place where the shadow — umbra, antumbra or penumbra — falls, then, respectively, a total, an annular, or a partial solar eclipse can be seen (see below). If the angular size of the moon is smaller than that of the sun (depending on the exact Earth-moon and Earth-sun distances at that time), the moon will not completely cover the sun, resulting in an annular rather than a total eclipse — such as the one I observed on January 15.




If the observer is located inside the penumbra, a partial eclipse of the sun can be seen. As the penumbra falls on a much larger area on Earth than the umbra or antumbra, more people see only the partial phase of the eclipse. This annular eclipse appeared as a partial eclipse over a region many thousands of miles wide.

In addition, this January eclipse of the sun had an annular phase lasting more than 10 minutes, making it one of the longest annular eclipses; in fact, the longest in this millennium.

The eclipse expedition involved a scientific experiment. I teamed up with colleagues Saraj Gunasekera and Janaka Adassuriya of the Arthur C. Clarke Institute for Modern Technologies, in Sri Lanka, to video record the eclipse with the goal of accurately timing the occurrences of Baily's Beads. Baily's Beads (right) occur when the rugged topography of the moon's border allows the sunlight to pass through some places but not others, creating a beaded effect.

***Baily's Beads (in center) as seen during the solar eclipse in Sri Lanka. It bears the name of Francis Baily, who described the effect he observed at an annular eclipse in 1836.*** ***Image credit: Eclipse Expedition Team***

To maximize the chances of seeing Baily's Beads, the team settled on a location just north of the southern limit of the eclipse path (rather than the central line where one would be able to see a nice symmetrical annular sun). The sky was clear during the eclipse, and the expedition was a success. Such observations of Baily's Beads, carried out by multiple observers located along the northern and southern limits of the eclipse path, can be used to determine an accurate diameter of the sun. This will help scientists monitor variations of the sun's diameter over time, and has implications in many fields, including solar physics and climate modeling. Currently, an international team of professional and amateur astronomers is analyzing the data.

The eclipse expedition also provided an opportunity to reach out to school children in rural Sri Lanka where our team members set up the equipment. Everyone was very excited to learn about and experience this annular solar eclipse, since the last solar eclipse (annular or total phase) seen in Sri Lanka was in 1955.

***Nalin Samarasinha explaining the solar eclipse to a group of school children.*** ***Image credit: Janaka Adassuriya***

Finally, if you are not in a hurry, you don't have to travel to a faraway place to see a solar eclipse, in midday. On August 21, 2017, a total solar eclipse will be viewable from the U.S.* You will only need to travel to a location on a narrow strip of land extending from Oregon to South Carolina. Meanwhile, for observers elsewhere in the U.S., it will only be a partial solar eclipse. ▫

** Note: there will be an annular eclipse visible from the western U.S. shortly before sunset on May 20, 2012, a partial eclipse, visible from most of the continental U.S., will occur on Oct. 23, 2014.*

## NASA Awards Millions to PSI to Archive Asteroid and Dust Data *by Ed Stiles*

**P**SI has received a NASA grant of nearly $2.5 million to continue archiving data relating to asteroids and space dust. PSI has been part of NASA's Planetary Data System (PDS) effort to preserve, organize, and make mission data available to the scientific community since the PDS was formed in the early 1990s.

The five-year grant will fund PSI work on the Asteroid/Dust Subnode of the PDS Small Bodies Node. PSI Senior Scientist Donald R. Davis is the principal investigator on the project.

"NASA established PDS as a long-term archive for data collected on planetary missions," Davis explained. "NASA's Planetary Science Division spends more than a billion dollars each year to acquire data, and the PDS is the primary way in which this data is made available to the scientific community, both for immediate analysis and for future use."

There's a lot more to archiving than simply tossing data into a computer file and noting where it is. Data must be archived in a way that makes it easy to retrieve and scientifically useful. "We make sure the data is well described so that scientists 10, 15, or even 50 years from now can understand how it was taken, the instrument used, the spacecraft and the mission objectives," Davis said. "All of this has to be adequately described and documented. Without this background, a bunch of tables, numbers or images is much less useful. We also include published papers that are based on a particular dataset."

PSI has developed an On-Line Archiving Facility (OLAF) that guides mission scientists in preparing their datasets for inclusion in the Asteroid/Dust Subnode. The data and its accompanying support material are then peer reviewed and any weaknesses in the dataset are referred back to the researcher or researchers for further clarification before the data is added to the archive.

PSI also is developing a Data Ferret that will make it much easier for a scientist to sift through the increasingly voluminous holdings in the Asteroid/Dust Subnode to find what they need. This tool, which should be operational sometime in 2010, will allow a scientist to query the archive using standard scientific terms, rather than computer-specific terminology. The Data Ferret will then search through the holdings and return a list of datasets, which the scientist can ask the Data Ferret to further sift and refine.

The Small Bodies Group also includes ground-based observations in the archive to make it even more useful. "A mission can tell you an awful lot about a single body, but you really want to be able to extrapolate that to the entire population of thousands of comets, millions of asteroids, and endless amounts of space dust," Davis said. "We're really interested in populations, not just individuals visited by missions, and the larger datasets in small bodies are taken primarily by ground-based observations."

The group is also including data gathered by amateur astronomers, who have the knowledge and sophisticated equipment — CCDs and half-meter class telescopes, for instance — to do professional-quality work. Nearly all the data on asteroid light curves, for instance, are now collected by amateur astronomers, Davis noted.

All of this effort to preserve data in a scientifically useful archive will be as important in the future as it is now. "After all, there is no use-by date on scientific data, and researchers frequently want to re-examine old data as new theories and data analysis techniques are developed," Davis explained.

Fifty years from now this data will still form a priceless archive to help future generations in their quest to understand the solar system and their place in it. □

## Inflatable Tumbleweed on Mars

*by Ed Stiles*

**P**SI Senior Scientist Kim Kuhlman is the principal investigator of the Tumbleweed project. She has put together a team of scientists and engineers, including two NASA centers and several academic and private institutions, to design a fleet of instrumented Tumbleweeds for missions of opportunity.


***The Tumbleweed vehicles, some of which resemble beach balls on steroids, are based on well-developed and tested technology.***

Tumbleweeds are lightweight, inexpensive vehicles that can carry a variety of instruments and cover large swaths of terrain as Martian winds cause them to roll like tumbleweeds across the surface of Mars. They are designed to bridge the gap between large-scale surveys done by spacecraft in Mars orbit and intensive, small-scale research conducted by Mars rovers.

Fleets of Tumbleweed vehicles could conduct long-range, randomized surveys with simple, low-cost instrumentation that is functionally equivalent to conventional coordinate grid sampling. These vehicles can be suitably instrumented for surface and near-surface sensing and analysis and released to roam for the duration of a season or longer. It is anticipated that within just a few years, instruments such as gas chromatograph mass spectrometers (GC-MS) and ground-penetrating radar (GPR) will be deployable on Tumbleweed vehicles. Different Tumbleweed configurations can provide the capability to operate in varying terrains and accommodate a wide range of instrument packages making them suitable for autonomous surveys for in situ natural resources. Tumbleweeds are lightweight and relatively inexpensive, making them very attractive for multiple deployments or piggybacking on larger missions. □

*In addition to Kim Kuhlman, the Tumbleweed team includes: Alberto Behar (NASA JPL), Jack Jones (NASA JPL), Max Coleman (NASA JPL), Daniel Wilson (JPL), Penelope Boston (New Mexico Tech), Jeffery Antol (NASA LaRC), Greg Hajos (NASA LaRC), Warren Kelliher (NASA LaRC), Ronald Crawford (U-Idaho), Lynn Rothschild (NASA Ames), Martin Buehler (Decagon Devices), and G. Bearman (Snapshot Spectra).*

# Mary Chapman Joins PSI

**M**ary Chapman recently joined our staff as a Senior Scientist. This came after her 2009 retirement from the U.S. Geological Survey, having served as a Research Geologist for 24 years with the Astrogeology Team, at the Flagstaff, AZ, field office.

*Mary with her daughter Alana*

Mary is primarily known for her Mars research, which includes the documentation and interpretation of outflow channels, geologic mapping that resulted in numerous published products, the investigation of volcano-ice interactions with a focus on the possibility of sub-ice volcanism, and the editorship of several planetary science texts. From 2004-09, Mary served as support personnel for the Mars Exploration Rover Mission, being one of four Downlink Position Leads (PDLs) on the Micro-Imager Camera instrument. In 2006, Mary was added to the science team for the High Resolution Stereo Camera (HRSC) instrument on board ESA's Mars Express spacecraft and has been working at Freie Universität Berlin, mapping Mars for Dr. Gerhard Neukum.

In addition to Mars research, from 2004-08 Mary was the Director of the USGS Regional Planetary Image Facility in Flagstaff. From 1999-2009, she was also the Site Geologist assisting Johnson Space Center's space suit and rover teams in their annual summer field-testing around Flagstaff.

Mary earned a B.S. in geology at the University of Utah, where as an undergraduate she was a field geologist in coal and uranium exploration with Utah Power & Light Company. After graduation, she became an engineering geologist with U.S. Bureau of Reclamation in charge of a preconstruction geologic program to determine suitability of the first Rollercrete dam for the CUP Project in the Uinta Mountains.

She holds a M.S. in geology from Flagstaff's Northern Arizona University. Her thesis was a study of volcaniclastic rocks on the Colorado Plateau that documents her discovery of welded rhyolitic tuff boulders (9+ meter diameter) embedded in debris flows that traveled a whopping 250 kms, from their Jurassic magmatic arc source in south-central Nevada to the outcrop site in southern Utah. Her Ph.D. is in comparative planetary geomorphology from Keele University, UK. The dissertation "Possible Icelandic analogues for Valles Marineris interior layered deposits and associated outflow channels on Mars" incorporated three seasons of Icelandic field studies on sub-ice volcanoes and catastrophic flood channels in a whole-system approach with her investigations of possible analog features on Mars.

Currently she is funded by NASA's Exobiology and Evolutionary Biology Program on a terrestrial project titled "Upper Triassic Mass Extinction Event: Study of 214 Ma (million years old) and 201 Ma Rocks on the Colorado Plateau." Mary is a 2010 Commission Chair for the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI). She is also part of a 2009-2010 International Space Science Institute (ISSI in Bern, Switzerland) Team funded to study the interior layered deposits on Mars. In addition, she is busy writing a fourth geoscience book.

As the only parent of her 14-year-old daughter, the most challenging and rewarding experience of Mary's life continues to be raising her child, while remaining a well-rounded and contributing member of the science community. At this time she is working offsite from Flagstaff, but dreams of working remotely for PSI from a hobby farm somewhere in sunny California.

We are very pleased to welcome Mary to PSI!


**P**SI scientists attended the Lunar and Planetary Science Conference, March 1-5, 2010, in The Woodlands, Texas. At the conference, 37 of our scientists contributed by participating in 108 abstracts.

PSI conference attendees gathered for the annual LPSC dinner. Front row, from left: Lijie Han, Asmin Pathare, Betty Pierazzo, Mark Sykes, Deborah Domingue Lorin, Paul Abell, Natasha Artemieva. Middle row, from left: Scott Mest, Les Bleamaster, Robert Gaskell, Amy Trueba Knudson, Joe Michalski, Kim Kuhlman, Thea Cañizo, Dan Berman, Eldar Noe Dobrea, Liz Jenson (guest), Karly Pitman, William Feldman, Tom Prettyman, Aileen Yingst, Robert Reedy, Steve Anderson (alumnus), Rebecca Williams, Chuck Wood. Back row, from left: Andrew Wheeler (guest), Marc Fries (guest), Mary Chapman, Stephen Metzger, Patrick Russell (alumnus), Ross Irwin, Steven Croft, Anton Ivanov, Larry Lebofsky, Gary Hansen (alumnus), David Crown, and Faith Vilas (affiliate).

## PSI Scientists Bring the Solar System to the Public *by Ed Stiles*

**P**SI scientists are being featured in several national TV science specials and radio broadcasts in 2010.

On March 2, PSI Director **Mark Sykes** again* joined Neil deGrasse Tyson, host of *Nova scienceNOW* on PBS and director of the New York Hayden Planetarium, on the Nova television program *The Pluto Files*. In that show Tyson investigated the public uproar over Pluto's demotion from planetary status. Sykes has defended full planet status for Pluto and several other dwarf planets and has been a vocal critic of the International Astronomical Union's new classifications for solar system objects that proclaims only eight planets in our solar system — excluding Pluto and several others, and effectively slamming the door on future discoveries of planets beyond Neptune.

***Mark Sykes (right) and Neil deGrasse Tyson discuss planets on the PBS Nova show, The Pluto Files.*** *Image Credit: PBS/Nova*

PSI Senior Scientist **Kim Kuhlman's** research was featured on an NPR *StarDate* radio program series dealing with space weathering which aired February 15-18. The first program provided a general overview and the next three discussed Kuhlman's research on how micrometeorite impacts pulverize the moon's surface. Her research will foster better understanding of the moon's history and provide data that may help future astronauts discover and extract resources from the lunar surface. To hear the programs, go to the "Radio" heading on the StarDate web site (http://stardate.org/radio/) and search for space weathering.

PSI scientists **Stephen Metzger, Matt Balme** and **Asmin Pathare** will be featured on *Storm Worlds - Earth*, a one-hour program in a three-part series slated to air on the National Geographic channel this spring.

***Matt Balme (left) and Stephen Metzger being filmed for a National Geographic TV series.*** *Image credit: PSI Dust Devil Team*

*Storm Worlds* shows how dust becomes airborne in desert regions and is distributed around the globe, where it is found in deposits such as glaciers and associated with long-distance transmission of sometimes dangerous bacteria.

The program emphasizes the role that dust devils play in this process, and includes a section featuring Metzger, Balme and Pathare chasing dust devils in Nevada. They are studying these terrestrial dust devils as analogs for those on Mars that are believed to contribute to the Red Planet's dusty atmosphere.

***PSI Dust Devil Team and National Geographic film crew, covered in Nevada dust, in the middle, from left: Stephen Metzger, Matt Balme and Asmin Pathare.*** *Image credit: Dust Devil Team*

Balme and Metzger were also interviewed for the BBC production, *Seven Wonders of the Solar System*, a multi-part series of hour-long episodes. That interview also related to the Nevada dust devil research. The U.S. air date has not yet been scheduled. □

**PSI Director Mark Sykes previously sparred with Neil DeGrasse Tyson in "The Great Planet Debate" moderated by NPR's Ira Flatow in August, 2008. See the PSI Fall 2008 Newsletter Director's Note for details.*

## Director's Note: *PSI a Growing Asset to its Communities*

**D**espite poor economic times, PSI continues its successful growth, expanding revenues by more than 20% for the second year in a row and bringing more NASA funds into the Tucson area and other communities around the country.

Our projected growth for the current year conservatively exceeds 10%. These gains are rooted in increased productivity of PSI scientists, their continuing success in obtaining highly competitive research grants, their increasing work on NASA missions, and a steady stream of scientists wishing to become a part of our community. From a business standpoint, PSI is very attractive. We provide employment for a highly educated workforce (largely PhDs), and contribute to the positive image of Tucson through the announcement of discoveries and advancements by PSI scientists and their appearances in national media as a consequence of their work.

In addition, we are committed to reaching out to our neighbors and our schools to share the fruits of their tax dollar investments in our work. This is very much the case in Tucson, where PSI was founded in 1972 and where it continues to have its national headquarters. PSI scientists give (and are available to give) lectures to the public and to students around the city and its environs.

Further, we provide workshops for science teachers, putting our work in the context of state and federal educational standards and allowing teachers to earn required continuing education credits when the state has drastically cut back its own such programs. PSI recently received a $750,000 grant from NASA to expand these educational programs. The timing could not have been better.

Solar system exploration is intrinsically exciting and inspirational, and PSI scientists are expanding our knowledge of what is out there, how it works, and how it relates to the Earth. Our success is not contained within the ivory towers of our profession, it is success for Tucson and the other communities where we live and work.

*Mark V. Sykes*
*March 2010*

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