PLANETARY SCIENCE INSTITUTE

NEWSLETTER

Spring 2007 Vol. 8 , No. 1

Est. 1972 www.psi.edu

# Enceladus Encore

*by William K. Hartmann*

Our 2005 Summer Newsletter described Saturn's fascinating moon, Enceladus, as having a brilliant, white surface of frozen water and displaying varied terrains from heavily cratered old uplands to young, fractured plains. The latter must be very young, geologically speaking, since they have few impact craters — meaning the present surfaces cannot have been exposed to cosmic impacts for very long. As that article forecast, "Enceladus seems to have been partly resurfaced, probably when deep fractures broke up old surface regions and allowed eruptions of interior water that froze into new plains." Spectacular examples of such fractures were shown in images taken from the Euro-American Cassini-Huygens spacecraft orbiting around Saturn since 2004.

Sure enough, as described in our 2005 Fall issue, the Cassini-Huygens spacecraft discovered water erupting geyser-like from fractures that stripe the young-looking south polar plains. This surprised those who felt Enceladus, only 500 km (312 miles) across, was too small to have enough geothermal heat to drive eruptions.

Details of the Enceladus geyser eruptions were then reported in a spectacular issue of the journal *Science*, March 10, 2006. Recently published images show the erupting gas plume (see below). Onboard spectrometers determined that the erupting plume is made from water

*See next page*

***Imaginary view along an ice fracture near the south pole of Enceladus, with an eruptive vent in the distance. Organics along the fracture slightly discolor the ice in this region; bright white icy plains can be seen in the distance. Saturn's rings would be seen edge-on, and would lie nearly parallel to the horizon as seen from the venting region near the south pole. (Painting by W. K. Hartmann).***

***A view of Enceladus, back lit by the sun, showing the glow of an erupted plume of water vapor near the south pole (top) on Nov. 27, 2005. Image from Cassini-Huygens project, NASA.***

**Inside this issue:**

## Enceladus Encore *(continued from front page)*

vapor and coming from geothermal warm spots at the south pole. In the *Science* articles, a Cassini imaging team (Porco and 24 others, including PSI affiliate scientist Elizabeth Turtle), inferred that the plume must come from liquid water exposed in the fractures. When exposed to the vacuum of space, the water boils, venting through the fractures as gas jets.

The discovery confirms another oddity of Enceladus — Saturn's faint "E-ring," a ring of ice crystals lying along Enceladus's orbit, far outside the more famous Saturn ring system. These ice particles condensed from the erupting jets of water vapor. Under the weak gravity of 500-km Enceladus, ice crystals from the jets are easily blasted into space and around Saturn, spreading along the orbit of Enceladus itself.

An ice-dominated composition for Enceladus's interior is indicated by Cassini's measurements of this moon's mass and size, which give a mean density of only 1.61 grams per cubic centimeter. (This is barely above the 1.0 value for water ice, and well below the values of 2.5 to 3 grams per cubic centimeter typical of rock.) What process heats and melts Enceladus's icy insides to produce liquid water? Theoretical heating models suggest that tidal heating — the extraordinary heating process that creates active volcanoes on Jupiter's moon Io — is *not* adequate to explain Enceladus's geysers. The Cassini team suggests more complex "spin-orbit" resonances, which dissipate heat in Enceladus's interior. This heats and melts the ice. According to Cassini team models of the observed jetting, the resulting liquid water may exist at depths only 7 meters below the solid-ice surface.

Why the excitement about this? It relates to the grandest of planetary science questions: are we alone in the universe? Do chemical processes producing living material exist on other worlds? In the case of researching whether life ever started on Mars, NASA's mantra has been "follow the water." Now that trail of water has unexpectedly led to Enceladus!

As reported in a companion article in *Science* (Brown and others), Cassini found not only erupting water, but also deposits of organic molecules along the fractures associated with the venting. It implies the water spraying out of the Enceladus fractures contains organic molecules. The term "organic molecules" refers not to biology, but to molecules built around carbon and hydrogen atoms. These molecules, however, are building blocks of living cells, and their presence in liquid water on an icy moon of Saturn dramatically expands the possibilities for understanding the origins of organic materials and possible simple life elsewhere in the solar system.

What would the eruptions look like if seen from the surface of Enceladus? I attempted an answer during my 2005 summer teaching stint at the University of Hawaii, Hilo. I set up my painting easel along one of the lava fracture zones on the floor of Kilauea volcano in Hawaii Volcanoes National Park. There, shattered lava plates resemble ice along fracture zones in the Arctic Ocean ice pack (which I've painted in Barrow, Alaska!). Enceladus's fracture zones may have a similar appearance, as plate-like crustal ice masses shift and splinter. I also designed the picture as an homage to a famous painting by a favorite artist, German painter Caspar David Friedrich — his 1824 view "Polar Sea" showed similar shattered ice masses in the arctic. Sunlight passing through ice often has a bluish-green glow, depending on the microstructure of the ice, as seen in polar ice and glaciers, and I tried to utilize this effect to give a color contrast with the warm tones of the organics and of Saturn itself.

Thus, for me, it's interesting not only to apply planetary science knowledge to a painting, but to all possible experiences and sources of information. To take another example, from geometry, the rings of Saturn would not only appear edge-on from Enceladus, but when seen from the south pole of that moon would lie parallel to the horizon. The painting (front page) shows the result, and utilizes actual upended and tumbled fractured lava masses on a Kilauea fracture as a stand-in for shattered ice masses on Enceladus.

An interesting place, Enceladus! As probes send back more and more data, PSI's diverse scientists may find themselves more involved in planetary geology, dynamics, and primitive biochemical evolution related to the intriguingly active features of this little moon.

For more information about the Cassini-Huygens mission visit http://saturn.jpl.nasa.gov

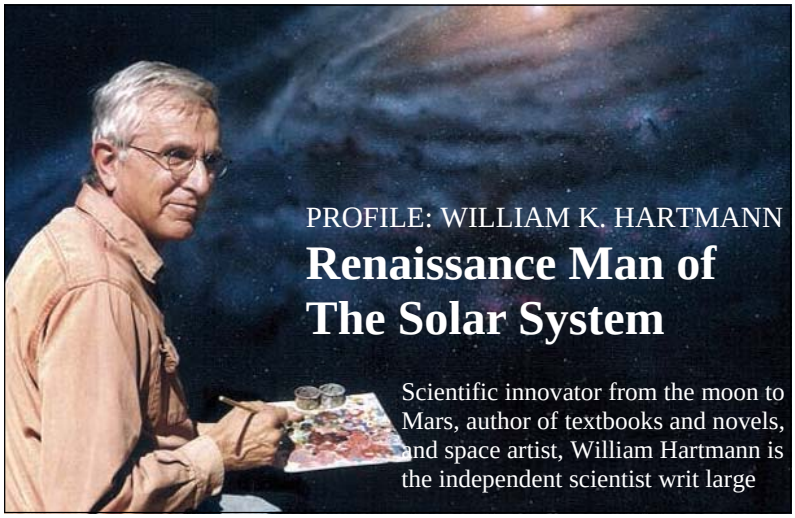
## Director's Notes

Congress took steps to protect NASA science funding for 2007 when it passed appropriations for 2007 in February. There were no additional funds, and research programs are still reeling from the 25% reduction implemented by NASA Administrator Griffin in an effort to shore up funding for shuttle replacement vehicles, but at least Congress put a stop to the hemorrhaging. These research programs and the small, frequent mission programs, such as Discovery, are the core of the US solar system exploration program and their maintenance should be the highest science program priority of NASA, according to a poll conducted by PSI last April (to which an estimated 50% of US planetary scientists responded). Now we need to work to restore these programs and to expand them to accommodate, at least partially, the torrent of data being returned from ongoing missions — there is no point in flying them if the data just sits on a shelf!

On a different note, previous PSI Newsletters have illustrated our interest and commitment, as an institution, to engage in education and public outreach. Now, six of our science staff and an affiliate have signed up for the Speaker's Bureau of the Tucson Chamber of Commerce as a part of their Business and Education Partnership program (we make up more than 10% of the list!). We will be speaking to schools and business groups about topics in solar system exploration, national space policy and environmental conditions, such as dark skies, that promote astronomy and local area growth. We look forward to making more connections with the Tucson community.

Mark V. Sykes
March, 2007

## *PSI in the News...*




***Headline of the* Science *magazine article profiling Bill Hartmann, who is shown in front of one of his own paintings.***

**T**he January 19, 2007, issue of ***Science*** (vol. 315), featured a two-page article by science writer Richard Kerr about PSI Senior Scientist **Bill Hartmann's** illustrious career as a scientist and an artist. The article covers Bill from his first homemade telescope at age 14, through his graduate school years at the "dawn of the space age", the currently accepted Origin-of-the-Moon theory Bill co-authored with PSI's Donald Davis, and his long career as a noted space artist and writer. The article also discusses the history of PSI — Bill, Alan Binder, Donald Davis and Clark Chapman founded PSI in 1972 — and accurately captures the flavor of our institute as a wonderful and unusual scientific workplace. Further, Bill is hailed by Ross Irwin of the National Air and Space Museum, DC, as "one of the most productive, innovative scientists in the field."

It is a marvelous article about PSI and our own Bill Hartmann! Hip, hip, hooray!

## Article in *Nature* Helps Explain Titan Lakes

**A** new report coauthored by PSI Senior Scientist **Chuck Wood**, and published in the prestigious journal ***Nature,*** confirms a long-held belief that there are lakes on Saturn's largest moon, Titan. But not lakes as we know them.

Chuck Wood is a member of the radar team on the Cassini-Huygens mission, a NASA endeavor to explore Saturn and its moons. As a planetary geologist and volcanologist, Wood and his team analyze the data sent back from Saturn and its moons.

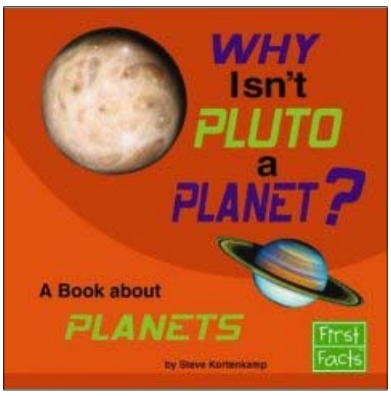
In the cover story of the January 4, 2007, issue of *Nature*, Wood joins lead researcher Ellen Stofan and several other authors from the radar team to disclose that lakes of methane and probably ethane have been discovered in the northern hemisphere of Titan. Titan is the only moon in the solar system to have a dense atmosphere — similar to that of the primordial Earth — with thin layers of methane and nitrogen clouds. It has long been believed that lakes or even seas of methane might exist on the surface, but until now definitive evidence has been lacking.

On July 22, 2006, the Cassini spacecraft's radar imaged the northern latitudes of Titan during the moon's long winter and revealed a number of large, dark patches around the surface of the pole, ranging in diameter from 3 to 70 km. The combined radiometric evidence and morphological features of the patches and their location in these topographic depressions led Wood's team to conclude that they are bodies of liquid hydrocarbons — methane lakes — existing on the surface of Titan today. Wood said: "This is critical evidence that Titan has a hydrological cycle, with methane rather than water being transported through clouds, rainstorms, rivers, and finally lakes."

## The Pluto Debate Rages On


**P**SI Director **Mark Sykes** was interviewed on ***The News Hour with Jim Lehrer*** in October, 2006, about Pluto and planetary definitions. The show aired on January 31, 2007, on PBS.


***Why Isn't Pluto a Planet? A Book About Planets*** (First Facts) (Capstone Press, 2007) This newly published hardback book by PSI Senior Scientist **Stephen Kortenkamp**, is aimed at stimulating scientific curiosity in elementary school students. It is available through Amazon.com.



## Notes on my PSI Internship

*by Thomas Taccone, Presidio High School Senior*

On November 28, 2006, my two-week science-writing internship at PSI began with a bang. Don Davis, Director Emeritus of PSI, arranged for me to meet with Richard Kerr, the esteemed senior writer at *Science*. My conversation with Mr. Kerr was enlightening. He mentioned different programs available at the University of Arizona for potential science writers, offered me a list of interesting books and websites to sift through, and explained the requirements for becoming a science writer. I was dizzy with good information at the end of day one.

The next day, I started writing an article for the PSI newsletter with Chris Holmberg, the newsletter editor, about PSI's visit to my school the day of the Mercury transit (see Winter 2006 issue). Throughout the week I had many interesting meetings. PSI Director, Mark Sykes, had a lengthy discussion with me about my role as an intern and suggested articles I might write while at PSI. I interviewed Don Davis and Mark Everett about the Mercury transit for quotes and information for that article. And Don Davis arranged for me to meet Thomas Stauffer, a reporter for the Arizona Daily Star who formerly wrote science articles. Mr. Stauffer explained his route to becoming a science writer for the newspaper and writing careers in general, along with tips for interviewing people and maintaining community relationships. He offered many useful insights about scientists, one being their eagerness to share their enthusiasm with the public.

In week two, I helped fold and seal over 600 newsletters. I kept motivated thinking that once they were mailed out my article would be read worldwide. The newsletter was finally complete and I had been able to take part in the entire process from writing to layout and editing and finally the mailing preparation.

My last exciting meeting was with Bill Hartmann. After reading about him online, I was very eager to meet with the internationally-revered scientist. When we finally did meet, we had a very long and interesting discussion covering a broad array of topics.

PSI improved my life. Through this internship, I was able to meet an abundance of incredibly intelligent and interesting people who I am very thankful towards. Chatting with them helped me realize that I am going to have to work my hardest to do well in the writing career I hope to have in the future.

***During his internship at PSI, student Thomas Taccone (right) met with Arizona Daily Star reporter Thomas Stauffer.***

**P**SI is very pleased to acknowledge two recent donations to the California Science Education Field Trip Program from organizations that share our goals for the community.

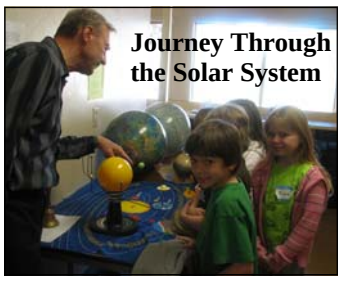
**Beckman Coulter, Inc.** has awarded $5,000 to PSI in support of the Journey through the Solar System program. Beckman Coulter, a leading manufacturer of biomedical testing instrument systems, has a long history of philanthropy. Their goal, as a corporate citizen, is to provide funding for non profits and academia, specifically targeting the sciences.

The **Wells Fargo Foundation** donated $3,000 to our Journey through the Solar System program. Wells Fargo Foundation has been supporting communities in the western US for over 150 years, from their early days in stagecoaches, delivering people and mail in the old west, to their current goal of supporting K-12 math and science education (among others).

We offer our sincerest thanks to Beckman Coulter, Inc. and the Wells Fargo Foundation for their generous financial assistance to this community program for Orange and Los Angeles County elementary school students.

## Science Education Field Trip Program

**J**ourney through the Solar System is a unique and highly successful program created and run by our Science Education Field Trip office in Laguna Niguel, California. It is a $2^1/_2$ hour program for $3^{rd}$ to $6^{th}$ grade students that incorporates hands-on science activities performed in small groups to foster curiosity about learning science. Below are some snapshots from a recent field trip.




***Future scientists learn about the solar system with PSI Education Specialist Bill Schramm.***

***Science fun: The visible conduction of electricity to fingers is demonstrated through the usage of high voltage and high frequency electrical energy.***

***Students show California mineral samples and an optical illusion box. In the background, PSI program presenter Dick Kenealy demonstrates a Cartesian driver.***

***Learning about microscopes: looking at a small bee at 60x magnification allows individual eye sensors to be seen.***

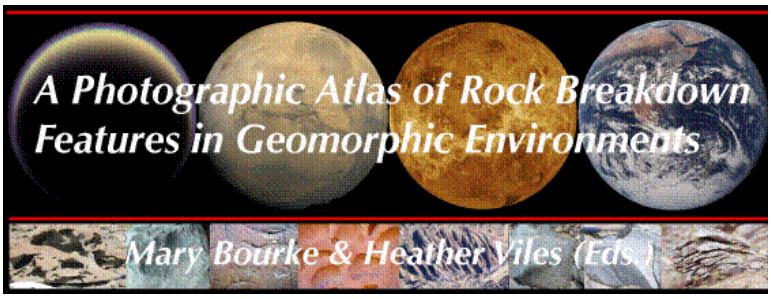
## PSI Board of Trustees

*The 2007 PSI Board of Trustees, at the January 26th Annual Board Meeting. Seated, from left: David Levy (2006 Board Chair), Candace Kohl (new Vice Chair), Donald Davis. Standing, from left: John Mason (Treasurer), Tim Hunter (new Board Chair), Mark Sykes, Bill Hartmann, Ben Smith and Brent Archinal. Thank you, Board members!*

## The Flags of PSI

*Our 63 staff members and affiliates were born in or are citizens of 18 countries! Belgium will be added soon. As an expression of pride in our international makeup, a flag display was added to the East Wing entrance. Can you name all the countries? (Answer on pg. 6)*

## PSIs First Free OnLine Publication




**O**n February 16th, 2007, PSI launched its Scientific Publication Series with *A Photographic Atlas of Rock Breakdown* edited by PSI Research Scientist Mary Bourke and Heather Viles (University of Oxford). Our first online publication contains more than 85 photographs with short descriptions of features found on rocks that have been transported by rivers, blasted by sand, and eaten away by salts and other agents of erosion. The Rock Breakdown Atlas will be a valuable reference for those examining the shape and surface texture of rocks seen on the surface of Mars, Venus, Titan and other places in our solar system and beyond. Please feel free to download it from the PSI web site http://www.psi.edu/bookshop/ .

*Pedestal rock in sandstone, Finke River Gorge, central Australia. From PSIs free online Rock Breakdown Atlas ( pg. 53).*

*Honeycombs developed in sandstone at Finke River Gorge, Australia. Note flaking on back wall. From A Photographic Atlas of Rock Breakdown Features ( pg. 60).* →

**PLANETARY SCIENCE INSTITUTE** Newsletter Published Quarterly

1700 E. Fort Lowell Road, Suite 106
Tucson, AZ 85719-2395
Phone: 520/622-6300
Fax: 520/622-8060
**www.psi.edu**

NON-PROFIT ORG.
U.S. POSTAGE
PAID
TUCSON AZ
PERMIT NO 356

Planetary Science Institute



## Friends of *PSI* Membership

***Yes,*** *I* would like to become a **Friend of PSI**.
Enclosed is my donation of $_____

**PSI** welcomes corporate and business members.
For complete membership benefits, please see page 5.

Name: _____

Address: _____

City, State, Zip: _____

Phone: _____

Email: _____

*Please mail your check to:*
**Planetary Science Institute**
*1700 E. Ft. Lowell, Suite 106*
*Tucson, AZ 85719*
***And, thank you!***

***All donations to PSI, a 501(c)(3)organization, are tax deductible as allowable by law.***

**The Flags of PSI** (page 5): from left to right, top to bottom: *Commonwealth of Australia, United States of America, People's Republic of China, Republic of India, Islamic Republic of Iran, Republic of Ireland, State of Israel, Italian Republic, Japan, Republic of Latvia, Grand Duchy of Luxembourg, New Zealand, Russian Federation, Kingdom of Spain, Democratic Socialist Republic of Sri Lanka, Swiss Confederation, United Kingdom of Great Britain and Northern Ireland, Canada.*