PLANETARY SCIENCE INSTITUTE

NEWSLETTER

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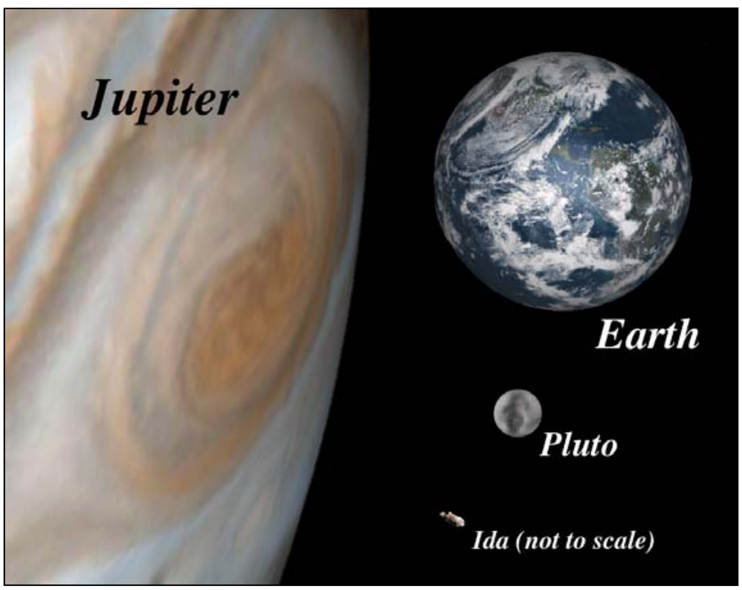
The Great Planet Debate *by Mark V. Sykes*

There has been a brouhaha over the International Astronomical Union's decision at its General Assembly in Prague to exclude Pluto from its pantheon of planets, followed by its unilateral decision after the meeting to go further and classify it as an asteroid, such as Ida (see image). Rather than putting an end to the debate about how the term "planet" should be defined, the IAU has sparked a reaction that is leading to a more considered and open discussion of the issue by the broader community of planetary scientists and astronomers. PSI will be playing a lead role in creating and participating in this discussion.

What we understand to be "planetary" largely relates to our experiences of Earth. Across the solar system we study the chemistry and circulation of atmospheres, non-impact surface features about processes below the surface, and magnetic fields that reveal processes even deeper beneath the surface. We study erosion due to winds and the flow of liquids. We study geysers and volcanism. On some worlds we search for signs of past and even present life.



According to the IAU definition, a planet essentially orbits the sun and "has cleared the neighborhood of its orbit." This tells us about the effect a planet has on the orbits of objects near its own, but nothing about the intrinsic nature of planets that sets them apart from other categories of objects. For an object to be a planet under this definition, it must have larger and larger mass as its distance from the sun increases in order to have either accreted or gravitationally scattered other bodies in its orbit over the age of the solar system. Consequently, the IAU would not call an Earth-sized object a planet if it was discovered in the Kuiper Belt region of the solar system.

Another interesting example to contemplate is Titan. When the Cassini Huygens probe entered the atmosphere of this moon of Saturn, it returned spectacular images of a nearly craterless surface with what appeared to be rivers and lakes, and features that looked like they were formed by familiar tectonic processes. This distant object was described as "Earth-like" by members of the science team studying it. Yet, were it in orbit about the Sun at Saturn's distance, it would not be a planet according to the IAU. This bothers many scientists.

I set up an online petition that was signed by more than 300 planetary scientists and astronomers; they find the IAU definition difficult, stating they will not use it, and that a better definition is needed. Signers included world-class experts in many areas of planetary science, and scientists engaged in solar system exploration from the Mariner missions (1960s) to today.

Under its own rules, the IAU cannot reconsider its action until 2009. Fortunately, scientists and educators are neither bound by IAU decisions, nor constrained by its rules. The internet gives the science community the means to have an open international discussion of planetary characteristics and a definition of "planet" and "planetary bodies" that more broadly captures those objects that share these characteristics. This will be a wonderful opportunity to explain to the public what we have learned about our own solar system, the more than 200 planets around other stars, and what we expect may be discovered in the future.

Inside this issue:

A Visit to an Asteroid and a PSI Model Confirmed? *by William K. Hartmann*

A Japanese mission in 2005 has provided compelling evidence for an asteroid theory pioneered by PSI scientists Don Davis and Clark Chapman in the late 1970s. The evidence comes in startling closeup pictures of the tiny asteroid 25143 Itokawa, photographed by the Japanese Hayabusa spacecraft during a two-month encounter late last year.

One of the early questions about asteroids, as the first spacecraft missions began to fly close to them, was whether they would all look more or less the same. This might be expected from the idea that collisions at all scales are ongoing for asteroid fragments in the asteroid belt. Thus, just as the moon's surface has been sandblasted by micrometeorites into relatively smooth dust, one might expect that even when a "fresh" asteroid is produced during an asteroid collision, it is rapidly sandblasted and reduced to a relatively smooth surface, similar to older asteroids. According to this argument, all asteroids might look structurally similar. In keeping with this, see the images (right) of a typical asteroid, Eros, and a small satellite of Mars, Phobos, each showing typical, cratered surfaces with smoothed, rounded contours.

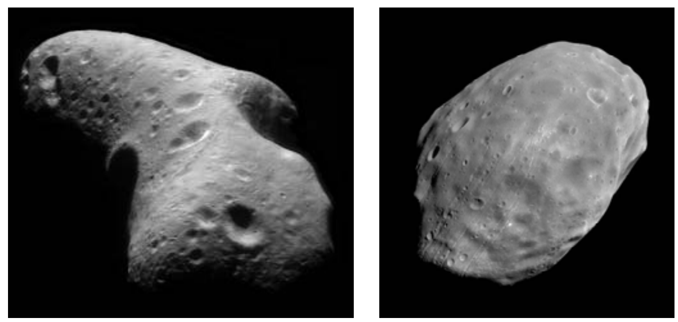
A different argument might be made that as rare, large impacts smash asteroids, different size fragments undergo different histories, depending on the nature of these collisions. Working along these lines in the late 70s, a PSI team of myself, Don Davis, and then-PSI scientists Rick Greenberg and Clark Chapman recognized that asteroid collisions might not have enough energy to blow fragments apart. Instead, the fragments might fall back together under gravity, and reaggregate into clusters of fragments. Adjacent fragments, launched during chaotic breakups, might even end up orbiting each other, explaining some of the now commonly observed cases of asteroid satellites.

As a result of this work, Davis, Chapman, Greenberg and Weidenschilling first coined the term "rubble pile" to describe the structure of a shattered, reassembled asteroid in a 1979 article titled: *Collisional evolution of asteroids: Populations, rotations, and velocities* in *Asteroids* (T. Gehrels, Ed), pp. 528-557, UA Press. The term is now widely used. Low densities observed during spacecraft flybys of some asteroids indicated large porosities, hinting at possible rubble pile structure, but many of these didn't *look* like the chunky, rubbly objects that one might expect of a rubble pile.

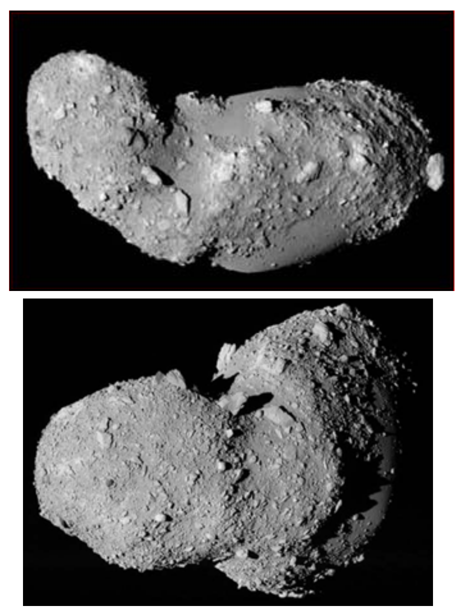
That was before the Hayabusa spacecraft flew past Itokawa. The scientific results, recently highlighted in the June 2, 2006 issue of the journal *Science*, are amazing, and the images are unlike the images of other asteroids, which were mostly rounded and potato-like, dotted by craters, and with a few scattered boulders on the surface. In contrast, Itokawa (lower right) appears to be composed of massive splinter-like boulders protruding from a larger matrix of smaller fragments and dust. The largest boulders sticking out of the body appear to be some tens of meters across. This asteroid looks the way a rubble pile should! The title of the lead article from the Hayabusa team, by Fujiwara and 21 other authors, including PSI Associate Research Scientist Paul Abell and Senior Scientist Bob Gaskell, and PSI Affiliate Scientists Hirdy Miyamoto and Faith Vilas, refers to "The Rubble-Pile Asteroid Itokawa."

Data from the spacecraft, as reported in *Science*, support the rubble pile model. Spectra show a composition similar to chondrite-type meteoritic rock, which should have a density around 3.2 grams per cubic centimeter. However, the mean density measured by the spacecraft is only 1.9 g/cc! The team researchers estimate that the fragments fit together poorly, leaving open space in the interior. They derive a porosity of about 41% in the internal body of the asteroid.

The biggest problem with the confirmation of the rubble pile structure is the size of the asteroid. Most researchers had estimated that rubble piles would be found among asteroids larger than a kilometer or so across, and that smaller bodies would have too little gravity to hold a rubble pile together during collisions, rotation, etc. Itokawa, however, is only 209 m x 535 m in size! Its escape velocity is only about 10 cm/sec, so that even a modest collision or vibration might dislodge many pieces or cause it to fly apart. Itokawa is bound to inspire new research on a whole range of asteroid structures — following in the footsteps of PSI researchers three decades ago.



The asteroid Eros (left) and Mars's moon, Phobos, both showing typical cratered and "sandblasted" appearance, in which contours are smoothed by microcratering. Asteroid Eros, 33 x 13 km in size, and moon, Phobos, 27 x 19 km.



Views of 535-meter long asteroid Itokawa, showing the same side under slightly different rotational perspective. Full view (top) showing areas of rubbly blocks and other areas of smooth dust. Close-up view (above) showing details of rocky rubble. (Courtesy ISAS/JAXA Japanese space agency.)

2006 PSI Retreat

PSI members at the retreat, front row (l-r): Kim Kuhlman, Tamara Kemnitz-Michotte, Mary Bourke, Bea Mueller, Betty Pierazzo, Andy Nelson, Gil Esquerdo, Sumita Jayaraman, Les Bleamaster. Second row: Elaine Owens, Becky Williams, Cathy Weitz, Jennifer Grier, Dan Berman, Chris Holmberg, Carolyn Shoemaker, Eldar Noe Dobrea, Nic Richmond, Melissa Lane, Bill Feldman. Back row: Carol Neese, David Crown, Frank Chuang, Steve Anderson, David Tarico, Dave O'Brien, Paul Abell, Nader Haghighipour, Pasquale Tricarico, Bruce Barnett, Nalin Samarasinha, Kelly Yoder, Steve Kortenkamp, Rose Early, Matt Chamberlain, Mark Sykes, John Mason, Stu Weidenschilling, Tim Hunter, David Levy, Asmin Pathare, Robert Gaskell, Brad Fobar. Attendee not pictured: Ben Smith.

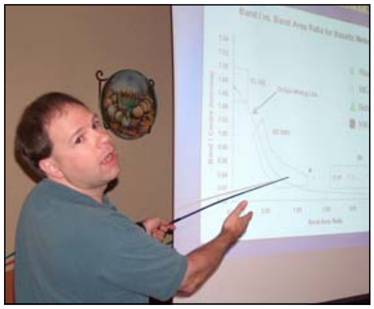
The lush desert landscape at the Hacienda del Sol Guest Ranch Resort, in the Catalina Mountain foothills, just minutes north of PSI's Tucson headquarters.

The historic Hacienda del Sol Guest Ranch Resort was the scene of our second annual PSI retreat in August. Our members gathered in Tucson from all over the country — California, Hawaii, Maryland, New Mexico, South Dakota, Texas, Washington, D.C., and Wisconsin — for two days of getting to know each other through science talks, group discussions and shared meals. Laughter accompanied learning throughout the retreat!

Topics of the presentations included: *Is Pluto really a planet?*; *Where on Earth is Mars?*; *Confessions of an evangelical stereophotoclinometer: Finding topography from multiple images; Probing the inner solar system with Mars Odyssey, Messenger, Dawn and Taranis; Investigations of Planetary Volcanism* and much more. Visit our website for the complete program and photos: *www.psi.edu/retreat.*

Additional pictures of the event are on the next three pages.

Retreat Photo Gallery

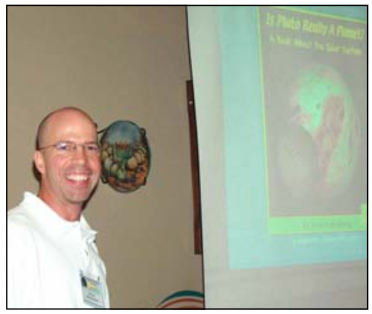


Row 1

Row 1: Presenting science talks: Sumita Jayaraman; Paul Abell; Oz Pathare; Gil Esquerdo.

Row 2: Steve Kortenkamp – "Is Pluto Really a Planet?"; Trustees Carolyn Shoemaker, David Levy and Tim Hunter.

Row 3: PSI women, from left, Betty Pierazzo, Kim Kuhlman, Becky Williams, Carolyn Shoemaker, Cathy Weitz, Chris Holmberg, Kelly Yoder, Melissa Lane, Carol Neese, Tamara Kemnitz-Michotte, Rose Early, Bea Mueller, Jennifer Grier, Mary Bourke and Nic Richmond (Elaine Owens regrettably missing from picture); Melissa Lane.



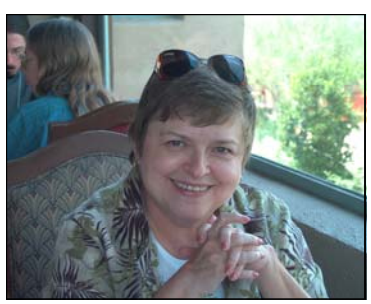
Row 2

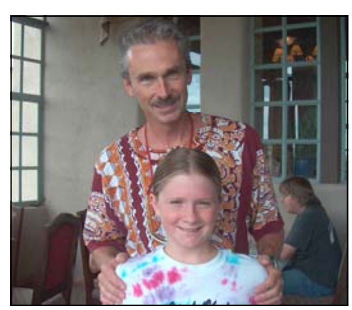
Row 3

Row 4

Row 4: Nic Richmond; Mark Sykes, Dan Berman, Bill Feldman and Oz Pathare discuss Pluto.

Row 5: Frank Chuang, Steve Kortenkamp and Les Bleamaster; Elaine Owens; Steve Anderson and daughter Aspen.





Row 5

Retreat Photo Gallery

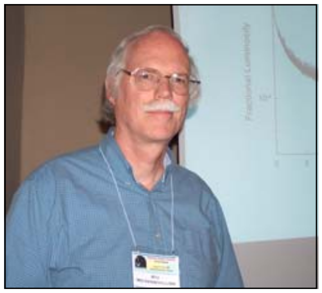



Row 1

Row 1:* *Les Bleamaster; Bob Gaskell; Kim Kuhlman; Becky Williams.

Row2: Stu Weidenschilling; Bea Mueller; Bruce Barnett.

Row 3: Jennifer Grier; Mary Bourke; Nader Haghighipour.



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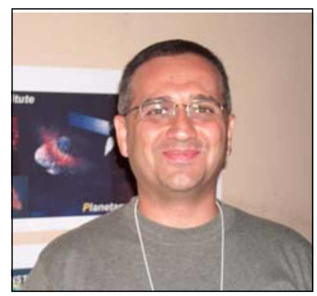


Row 3

The Banquet



Row 4



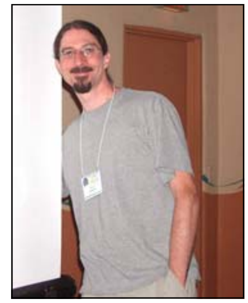
Row 5

Row 4: Enjoying the retreat banquet at the festive J-Bar restaurant: David Crown, Cathy Weitz and Becky Williams; Frank Chuang and his wife, Kang Li; Mark Sykes with his wife, Marilyn Guengerich .

Row 5: Margrethe Feldman, Suzy and Stu Weidenschilling, Andy Nelson, Dave O'Brien; Melissa Lane's son, Jonathan, and Bea Mueller's daughters, Annika and Sandra; Carl Matter, David Tarico, Will Johnson, Pasquale Tricarico, Jesse Stone and Rose Early.

Retreat Photo Gallery



Row 1

Row 1: Day two science presenters: Cathy Weitz; Bill Feldman; Elaine Owens; Dave O'Brien.

Row 2: Dan Berman; Betty Pierazzo; Matt Chamberlain.

Row 3: Pasquale Tricarico; Nic Richmond and Trustee John Mason; Mark Sykes.



Row 2



Row 3


Row 4

Row 5

Row 4: Nalin Samarasinha; Casa Feliz, our meeting room; Eldar Noe Dobrea.

Row 5: Listening to science talks, from left, Bill Feldman, Oz Pathare, Matt Chamberlain, Nic Richmond, Trustee Ben Smith, Bruce Barnett, Sumita Jayaraman.

At break, right: Dan Berman, Bill Feldman, Nader Haghighipour, Nalin Samasinha, Pasquale Tricarico, Dave O'Brien and Bea Mueller.

Director's Note: A Potpourri

We conducted our second Annual PSI Retreat in August. It is always a great time to get together with our PSI colleagues from around the country, hear about their work and generally catch up. Our open house the Sunday before the retreat was highlighted by a cloud of small children in perpetual motion, running round and round the West Wing. It was a lot of fun!

In planning the retreat this year, the science staff had called for shorter presentations to free up more time for open discussions and work on new collaborations. This was very successful, and we will be doing it again next year. I am struck again by the fortune we have in our people at PSI — they not only do excellent work, but are also personally a great bunch of people.

After the retreat, PSI CFO Bruce Barnett, Grants Administrator Kelly Yoder, and I made our annual tour of NASA financial operations. This allows us to keep up to date on the grants system and the people running it, particularly as it is undergoing yet another series of changes.

While back in Washington, DC, we took some time off to visit the Orbital Sciences Corporation to see the Dawn spacecraft (photo below); PSI Senior Scientist Bill Feldman and I are members of the Dawn science team. Since coming back from its second cancellation last May, the Dawn spacecraft is making great progress. Now it is nearly complete and about to go through environmental testing. We are nine months away from the launch and the start of our journey to asteroids Vesta and Ceres.

From left, Bruce Barnett, Mark Sykes, and Kelly Yoder in their "clean suits," inspecting the Dawn spacecraft at Orbital Sciences Corporation in Virginia.

Our trip also took us to NASA Stennis, near New Orleans, where the final processing of our grants now takes place. We were impressed with the quality of the operation there, especially since its start-up was only four months ago. The areas we saw in New Orleans, and along the Gulf Coast, are still heavily damaged from Hurricane Katrina, and yet the major construction appears to be centered on the I-10 highway, near the city, and the installment of sight-barriers to hide the destruction. It seems such a misallocation of resources.

Speaking of misallocations, NASA continues to put pressure on its basic research programs critical to solar system exploration, implementing cuts that will have reduced support for these programs by 25% over FY2006 and FY2007. These monies are being used to feed the maw of the far larger Space Shuttle and Shuttle-replacement programs. To add insult to injury, NASA Administrator Griffin purged the NASA Advisory Council of its outspoken supporters of basic science programs to better insure he would get the advice he wants to hear. We can only hope that this is not done in other areas. NASA can ill afford another disaster.

Mark V. Sykes
September 2006

Stu Weidenschilling was elected as a Fellow of the Meteoritical Society. This honor is awarded to members of the Society who have distinguished themselves in meteoritics or closely allied fields. Fellows are only elected by the Council in even-numbered years.

Congratulations, Stu!

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