At 10:30 p.m, Pacific time, August 5, 2012, the Mars Science Laboratory’s (MSL) rover Curiosity sent back signals confirming its safe landing on Mars. At that moment, carried live from Jet Propulsion Laboratory (JPL) on NASA television, wild cheers and spontaneous hugging erupted in mission control. Unbeknownst to the general public, another celebration of the teams of scientists and engineers associated with the various scientific instruments onboard MSL was occurring at the same moment. This astounding technological achievement for NASA was also a historic moment for planetary science.

The landing meant that after years of designing, building, testing, and re-testing the science instruments, they would now be put to use studying the geology of Gale Crater on Mars. Soon MSL scientists will be studying the stacked layers of material making up the 5.5 kilometer high Aeolis Mons (Mount Sharp) within Gale Crater, yet on the way to the mountain, the sophisticated instruments on Curiosity are already making exciting discoveries (see picture below).

Several members of Planetary Science Institute (PSI) play major roles in the day-to-day science operations of instruments on MSL.

(Continued on page 7)
Welcome Back to PSI, Amara Graps

Amara Graps is a returned PSI scientist who recently moved to Riga, Latvia, the city where her father was born and, consequently, where she has dual citizenship (USA/Latvia-EU). There she expects better time for science and her young daughter, while learning the language and all about the Latvian culture.

Amara's love of cultures mirrors her love of astronomy; in fact, the common thread throughout her 32-year career is everything astronomy. She chose her career in high school, in Orange County, California, where she realized that she could make a better living in science than in photography (although many years later her experience working in Italy questioned that decision). At age 19, she had her first job in the field as an assistant to an observational astronomy instructor at Saddleback Community College. Not long afterwards, via a follow-up to a guest lecturer at her amateur astronomy group, Elenor Helin, she started at JPL, collecting asteroid data at the small Schmidt telescope at Palomar Observatory.

At Palomar, she met members of the Voyager mission team, who were collecting auxiliary data on Jupiter's moon, Io. With Voyager's recent flyby of Saturn, they needed help! Amara applied for a position studying Saturn photopolarimeter data from the recent Voyager 2 flyby and got the job; that marked her professional entry into the planetary science field. She was a sophomore at the University of California, Irvine, studying physics at the time.

Working at JPL weekends and holidays and going to school full-time meant that something had to give a little; turned out to be her school work. Working at JPL was exciting, fun, and fulfilling: her school work was hard and tedious. She did graduate with a B.S. in physics; however, not with stellar grades, which was a deciding factor for not getting into graduate school. But she remedied those early poor grades with math and physics courses wherever she was living, while continuing her planetary science data analysis. Amara found that being a scientific programmer to planetary science teams was, in fact, a fine career, one that lasted 18 years before she pursued a Ph.D.

In July 2001, she completed her Ph.D. in Physics from Universität Heidelberg (Germany) and the Max Planck Institut für Kernphysik, researching the charged dust dynamics of the jovian dust streams. Her previous formal education occurred in conjunction with her jobs: her B.S. in Physics in 1984 from the University of California, Irvine while working at JPL, and her M.S. in Physics (w/Computational Physics option) in 1991 from San Jose State University while she was associated with NASA Ames.

Now academic training and career job converged. After her Ph.D. and postdoctoral research in Germany, she worked in Italy as a long-distance, offsite Associate Research Scientist with PSI, her first stint, and as a researcher at the Institute of Interplanetary Space Physics (INAF-IFSI) in Rome. There she supported the space missions (Cassini, Rosetta, Dawn) that carry INAF's infrared spectrometers, and also worked as an astronomy instructor at the American University of Rome.

However, writing grant proposals and supporting oneself with grant funding has a very steep learning curve, and her first try at being fully supported by research grants did not work. So she jumped to Southwest Research Institute in Boulder, CO, for a two-year contract supporting New Horizons, and continued the grant proposal route to self-funding at the same time. Also in this period, Amara officially started her family; her daughter Vija, now 3 years old, might be the most planned baby on Earth.

Amara's life as a new single mother on the heels of the self-funded research path demonstrated what worked and what did not. A flexible work life is key for a new parent, so that worked. Conversely, high cost of living, child care, and working every weekend half of every night for two years on grant proposals, while losing precious time with her daughter, did not work. Hence the return to PSI, to make it possible for her to live where she wants and to have more time for her daughter and for science.

She is continuing to support the New Horizons Pluto mission and her old Ph.D. studies of circum/interplanetary dust charging and dynamics, with a new focus on how dust charges and moves on asteroids. She has brought into her professional realm an old hobby interest of the question of the origin of water on the terrestrial planets via geochemistry and geochronology tools. But two-year contracts for 20 of the last 30 years with 12 different astronomy teams shows the variety of her work.

In her ESA and NASA projects, she has analyzed data from the New Horizons space mission, Rosetta spacecraft, Ulysses spacecraft, GORID/Express spacecraft, Cassini spacecraft, Galileo spacecraft, SOHO spacecraft, NASA's Kuiper Airborne Observatory, NASA's ER-2 aircraft, the Voyager 2 spacecraft, the Pioneer Venus Orbiter spacecraft, the Infrared Astronomical Satellite (IRAS), the Space Shuttle's SpaceLab 2, and ground-based telescopes in Hawaii, California, and Arizona. The data include calibration star cluster fields, dust from Saturn's and Jupiter's magnetosphere and Earth's geostationary orbit, the Sun, Comet Shoemaker-Levy 9, Comet Halley, Supernova 1987a, Venus, Mars, Io, Mercury, the Moon, Saturn's and Uranus' rings, asteroids, Earth's atmosphere, protostars, molecular clouds, galaxies, novas, main-sequence stars, and the exhaust-cloud around the Space Shuttle.

Amara's hobbies include bicycle touring, volcanoes, Cremona violins, photography, writing, watercolor painting, studying philosophy, and learning new languages. She is very interested in helping people learn about the cultural interdependent nature of people on our planet. She also adores her daughter, who has superseded her hobbies during the last 3 years, but is now at the age where she can begin participating in them with her mom.

We are delighted to welcome Amara back to PSI and wish her well in Latvia!
In late August, 70 local and offsite PSI members from 12 U.S. states, Canada, and the United Kingdom assembled at the historic Westward Look Resort in Tucson for our eighth annual retreat. This year, three days were devoted to science talks, a memorable banquet, and interesting field trips to the University of Arizona’s Steward Observatory Mirror Lab and Biosphere 2.

The retreat banquet was held at another historic hotel, the Arizona Inn, where over 100 PSI staff and guests filled the elegant dining room. After dinner, surprise tributes were made to Carol Neese and ten other PSI employees acknowledging their decade-plus years at PSI with a handsome, engraved cherrywood chair for each and a special 20th anniversary plaque for Carol.

PSI’s 40th anniversary was commemorated with a symposium of our scientists and illustrious colleagues celebrating the work of PSI’s co-founders Donald R. Davis and William K. Hartmann. See the complete retreat program at: www.psi.edu/retreat/2012

More retreat photos on pages 4-5

At the banquet, Director Mark Sykes, left, gathered these longtime employees on stage for a surprise presentation of captain’s chairs engraved with their names and year of arrival at PSI, L-r: co-founder Bill Hartmann (1972) co-founder Don Davis (1972), Stu Weidenschilling (1978), Elaine Owens (1990), Carol Neese (1992), Kelly Yoder (1996), Dan Berman (1998), David Crown (2001), Melissa Lane (2001) whose chair was not a surprise as it was shipped to her home in PA, Steve Kortenkamp (2001), and Chris Holmberg (2002). Congratulations all!

Carol Neese received a plaque from Director Mark Sykes in recognition of her 20 years at PSI as a Senior Research Associate.

Bravo, Carol!
Sarah Andre came from DC and discussed large impact basins on Mercury.

Robert Nelson (CA) explained his research on the surface of Titan.

Naoyuki Yamashita (NM) talked about the results of gamma-ray spectroscopy from the Moon and Vesta.

Terrill Yuhas gave an update on the Institute’s IT support.

JP Kirby (CA) presented his idea for an Enceladus remote analysis instrument.

Jian-yang Li came from Virginia to discuss his work on cometary nuclei and asteroids.

Amanda Hendrix (CA) explained the research she is doing on hydrated minerals and weathering on the moon.

Sugata Tan visited from Wyoming to discuss the liquid on the surface of Titan.

Rebecca Ghent (CO), Naoyuki Yamashita (NM), Sarah Andre (DC), and Sugata Tan (WY) enjoy the Sonoran Rooftop after the symposium.

Sunset soireé on the rooftop of the Westward Look Resort.

PSI Trustees Candice Kohl (left) and Tim Hunter with Tim’s wife, Carol Hunter, at the rooftop soireé.

Ewen Whitaker, astronomy legend and inspiration to many, turned 90 this year! At the banquet, he was surprised with a cake and a serenade from over 100 guests. Happy Birthday, Ewen!

PSI tours the Polishing Lab at the University of Arizona Steward Observatory Mirror Lab.

At right, the second Giant Magellan Telescope mirror and the primary/tertiary mirror for the Large Synoptic Survey Telescope (LSST).

At the Mirror Lab (l-r): J.P. Kirby, Melissa Lane, Maui Balistreri, Beatrice Mueller, Candace Kohl, Amy Trueba Knudson, Sugata Tan, and the tour leader. In the back are Terrill Yuhas, Stu Weidenschilling, and Michael Wendell.
PSI’s 40th Anniversary Symposium

Tim Hunter, Chair of PSI’s Board of Trustees, talked about his efforts to reduce light pollution.

Michael Belton, CEO of Belton Space Exploration Initiatives of Tucson, presented on cometary activity.

Bill Bottke, of SWRI, discussed his work on the early bombardment of the solar system.

Ed Tedesco, right, traveled from New Mexico and gave a symposium presentation on the history and future of asteroid photometry.

Clark Chapman, who was with PSI from 1974 to 1995, came from Southwest Research Institute (SWRI) in Colorado and presented 40 years of perspectives on asteroids and cratering.

Tim Swindle (UA-LPL) gave a presentation on the evidence for the late heavy bombardment versus a lunar cataclysm.

David O’Brien talked about Vesta’s contribution to our understanding of the asteroid belt.

Stu Weidenschilling described his work with planetesimal simulations.

Dave Stevenson, of CalTech, described the current challenges to the giant impact hypothesis.

PSI members on a field trip to the famous Biosphere 2, about 20 miles north of Tucson. Above left, PSI members examine the ocean. Above right, Mark Sykes enjoys the rainforest.

Jian-Yang Li, Nalin Samarasinha, and Michael Gibbs at Biosphere 2.

Photographs were taken by Gil Esquerdo, Alan Fischer, Chris Holmberg, and Emily Joseph.
Astrid Ruth Hattenbach slumbers on her father four days after her birth, Jun. 29, 2012, in Washington, D.C. Astrid’s parents, Heidi Hattenbach and PSI Senior Scientist Henry Throop, have two other children, Piper and Finn, and all now reside in South Africa.

Sanlyn Buxner (PSI Education Specialist) and her husband Rob Bovill (PSI Docent) had their first child on August 27, 2012. Annyse Maia Buxner weighed 7 lb. 7 oz. and measured 20 inches.

Anna Hartmann-Gordon (6 lb. 5 oz.) was born to Amy Hartmann-Gordon (former PSI Development Officer and daughter of Bill Hartmann) and Joe Gordon, on Oct. 7, 2012. Here she is, moments after greeting the world, being held by her big sister, Grace (3 yrs.).

At right, Astrid Elara Pitman Crevello was born on Oct. 8, 2012, to first-time parents PSI Research Scientist Karly Pitman and her husband Damian Crevello, in Altadena, CA. Astrid’s vital statistics: 5 lb. 10.3 oz., 21” long.

Above, PSI Senior Scientist Matt Balme and his wife Anne Jay had their second child on Sept. 22, 2012, in Milton Keynes, England. Eliza Balme, who weighed 3.55 kg (7 lb. 13 oz), has an older sister named Isobel (2 yrs).

**And, They’re All Girls!!**

Since late June, five new children have been added to our extended PSI family! Congratulations to all the parents! And, hello to all their sweet little girls!

**Director’s Note**

PSI continues to expand in infrastructure as well as in science (and babies!). In the past several months we have hired our first Controller, Maurizio (Maui) Balistreri, who will be responsible for daily accounting activities of the Institute and strengthening our internal controls while helping us implement a new commercial financial management system. Maui is no stranger to PSI. Several years ago he was on the Keegan, Linscott and Kenon team that annually audits PSI’s financial records. Most recently he was the Controller for a health services corporation. PSI has the largest number of contracts and grants from NASA, which is an administrative challenge. With Maui, we will be securing the foundation of our financial operations so we can efficiently sustain our growth.

We have also hired Michael Gibbs as Chief Advancement Officer and Deputy Director. Michael was most recently the Vice President for Advancement at Capital College, outside of Washington DC, and an Associate Professor of Business and Information Technology. Having served on our Board of Trustees, he is also no stranger to PSI. Michael will be bringing his considerable experience to help PSI build its funding base to sponsor programs not supported by NASA. This is particularly important in education, since NASA has slashed or terminated programs in that area. We will also be working to support initiatives beyond the scope of what NASA funds, such as the Atsa Suborbital Observatory.

As always, the times are exciting with PSI scientists making new discoveries on Mars and elsewhere in the solar system, as well as on Earth. For instance, just in the last few months PSI Research Scientist Marc Fries has successfully tracked meteorite falls, allowing for their quick recovery in California, Nevada, Canada and Colorado!

All the while, in Washington the budgetary sword of Damocles hangs over our heads. Nevertheless, we push forward to strengthen our Institute internally, while ever building on our accomplishments.

*Mark V. Sykes*

*October 2012*
Curiosity Lands on Mars! (Continued from front page)

PSI Senior Scientist R. Aileen Yingst is the Deputy Principal Investigator on the Mars Hand Lens Imager (MAHLI) instrument team and a Co-Investigator on the Mast Camera (MastCam) and Mars Descent Imager (MARDI) camera team. As a geologist, she is interested in understanding the size and diversity of rocks and rock fragments, which may yield information on the processes that weather and erode material on the Martian surface.

“Curiosity is the first rover designed to be both field geologist and portable laboratory,” Yingst said. “It has many of the characteristics of other rovers, but it also has instruments that will allow it to look for evidence of carbon compounds in samples. This is something that your typical field geologist could only do in the lab.”

MAHLI, a camera operating on the end of a long robotic arm, will acquire close-up images of rocks and other surface materials with spatial scales as high as 13.9 micrometers/pixel (particles smaller than a grain of sand can be resolved).

“MAHLI will shine a magnifying glass on the Martian surface. It has the highest resolution of any mobile camera that has gone to Mars,” Yingst said. “Curiosity will use MAHLI to look at the physical characteristics of the small surface particles – on Earth we’d call it soil or dirt, on planets without organic activity we call it regolith. The shape and size of those particles, their texture, and how and whether they are sorted, all tell us something about what those little grains are, what type of rock they came from, and how they got there.”

The MasCam is a stereo camera on the vertical mast, which takes monochromatic and color pictures, plus video of the surroundings. MastCam is the major set of “eyes” for Curiosity. MARDI is a camera that captured high-definition video as MSL descended to the Martian surface after its heat shield was jettisoned.

PSI Senior Scientist David Vaniman is the Deputy Principal Investigator of the Chemistry & Mineraology X-Ray Diffraction/X-Ray Fluorescence (CheMin) instrument and a Co-Investigator on the Chemistry & Camera (ChemCam) instrument team. CheMin will help identify and measure the abundance of various minerals in samples of Martian rocks and soil that are delivered to a sample holder on MSL.

“CheMin uses X-ray diffraction to determine the mineralogy of the sample,” Vaniman said. “This is the first time that this powerful standard laboratory method of determining mineralogy will be used on another planet. Ability to measure fluoresced as well as diffracted X-rays makes CheMin especially versatile because it will determine both crystal structure and chemical composition.”

ChemCam sits at the top of the 2.1-meter-high mast on MSL and will fire a laser to analyze the elemental composition of vaporized materials in areas smaller than 1 millimeter on the surface. Being a geologist and geochemist, Vaniman is interested in understanding what mineral types are in the rock layers, how much of each type are present, and if altered, what alteration minerals are present.

This information will help yield clues to what geologic processes were active on Mars throughout the history of Gale crater.

PSI Senior Scientist and geologist Rebecca Williams is a NASA Participating Scientist for the MSL mission and is working with MastCam images to interpret the geology of the landing site and more specifically, to better understand the relative timing, amount, and duration of past water-related activity in Gale Crater.

At the Sep. 27th NASA mission press briefing, Williams was on the panel that presented exciting new findings from Curiosity: It has discovered geologic evidence that a fast-flowing stream historically coursed across the surface of Mars!

Images by Curiosity’s mast cameras of rocks on two Martian outcrops containing ancient streambed gravels indicate long-distance transport by the vigorous flow of surface water on Mars due to the rounded shape of some of the stones. The materials range in size from a grain of sand to a golf ball.

“The shapes tell you they were transported and the sizes tell you they couldn’t be transported by wind. They were transported by water flow,” said Williams.

“This is wonderful ‘concrete’ evidence of water-transported gravels on Mars. It is very exciting to have ground truth confirmation of the hypotheses developed from analyzing orbital data,” Williams said. “With this finding, we can now better constrain the amount and duration of water flow activity at this site, a critical step in identifying habitable environments on Mars.”

Williams participates in both the geology and mineralogy theme rooms at JPL where planning and discussion on the science occurs on a daily basis. In terms of rover operations, Williams will help serve as “Keeper of the Plan” on certain days where all scientific observations requested from a science group are delivered to her and she plans the day’s activities, making sure that adequate resources are available (principally time and rover power) to execute the plan. The planned activities must also be consistent with certain rules for rover operation.

Other members of PSI involved with the mission include Senior Scientists Bruce Barracough and Robert L. Tokar, Research Scientist Daniel C. Berman and Senior Research Associate Steven C. Bender. We will be hearing more from them as Curiosity’s exploration continues.

The ChemCam Remote Micro-Imager took these before-and-after images showing laser shots (middle, right) in soil target "Beechey" on sol 19 (19th Martian day). Each hole received 50 total shots to investigate the chemical variability of soil at short scales. The holes are about 0.08-0.16 inches (2-4 millimeters) wide. (NASA Planetary Image Atlas #15695)
**Curiosity Lands on Mars!**  (Story on front page)

**NASA's Mars Science Laboratory (MSL) rover “Curiosity” drove about 70 feet (21 meters) on the mission’s 21st Martian day, or sol, Aug. 30, 2012. Its onboard Navigation Camera took the images that were combined to create this scene of the rover looking back at its own fresh tracks on Mars. Six PSI scientists are on MSL instrument teams.**

For more information on the mission and up-to-the-minute results go to: [http://www.nasa.gov/mission_pages/msl/index.html](http://www.nasa.gov/mission_pages/msl/index.html)

Image credit: NASA/JPL-Caltech

**On Aug. 5, PDT, this image of MSL’s descent to the Martian surface, via supersonic parachute, was captured by the High Resolution Imaging Science Experiment (HiRISE) camera onboard NASA’s Mars Reconnaissance Orbiter (MRO), about one minute prior to landing. “Curiosity” and its parachute are in the center of the white box; the inset image is an enlarged picture of the rover. This was the second time a spacecraft was pictured during its final descent to Mars; in 2010 it was the NASA Phoenix Lander. Several PSI scientists are involved with the HiRISE team: Senior Scientist Cathy Weitz, Research Scientists Eldar Noc Dobrea and Dan Ber- man, and Research Associate Frank Chuang.**

Image credit: NASA/JPL-Caltech/Univ. of Arizona