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PSI Director Signs Cooperation Agreement in China

by Alan Fischer and Chris Holmberg



PSI CEO and Director Mark V. Sykes (at right) signed the agreement along with Chen Hong, Director of Qian Xuesen Lab (QXS).



Above, Mark Sykes on the Great Wall with Yuanjie Du of QXS Lab.



From left, Jian-Yang Li (PSI), Mark Sykes and Yuanjie Du at Tiananmen Square in Beijing.

On Dec. 15, 2015, in Beijing, PSI CEO and Director Mark Sykes signed a cooperation agreement with Qian Xuesen Laboratory of Space Technology (Qian Xuesen Lab). The mutual aim of this agreement is to advance the open-ended expansion of the exploration of the Solar System and to use the knowledge thus gained in supporting the expansion of human activity beyond Earth. Both institutions also wish to advance their common interest in communicating to the public the knowledge and benefits gained through robotic and human exploration of the Solar System.

“China is the first country since 1976 to successfully land a spacecraft on the Moon. They have mapped the surface of the Moon and executed a brilliant flyby of the near-Earth asteroid Toutatis,” said Mark. “We look forward to working with them.”

While in Beijing, Mark and PSI Senior Scientist Jian-Yang Li gave presentations at a special workshop about PSI, its current involvement in both NASA and ESA missions, PSI’s education and public outreach activities, and the frontier of the science and utilization of near-Earth objects.

PSI CEO and Director Mark V. Sykes signed the agreement along with Chen Hong, Director of Qian Xuesen Lab.

Qian Xuesen Lab is part of the China Aerospace Science and Technology Corporation (CASC), which has been involved in China’s Chang’E missions to the Moon and China’s human space program. The Lab is named after Qian Xuesen (or Hsue-Shen Tsien, as he was known in the U.S.), who is considered the father of the Chinese space program.

Qian Xuesen (1911-2009) was born and educated in China, and then in the U.S. received two advanced degrees: a Master of Science from MIT and a Ph.D. from Cal Tech, where he co-founded the Jet Propulsion Laboratory. At the end of WWII while still at Cal Tech, he interviewed Wernher von Braun and Rudolf Hermann and investigated research facilities in Germany for the U.S. Army Air Forces.

In compliance with federal law, no NASA funds were used in support of this effort.



Mark Sykes and Jian-Yang Li (both from PSI) in front of a copper and aluminum mural celebrating Chinese space missions at the Qian Xuesen Lab.

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Paul Weissman Joins PSI

In August 2015, Paul Weissman joined PSI as a Senior Scientist. From 1974 until last August, he was with the California Institute of Technology's Jet Propulsion Laboratory, having been promoted to Senior Research Scientist in 1995.



Paul's science is all about small bodies in the Solar System, in particular comets. His initial work was in the dynamics of cometary orbits, in particular studies of the Oort cloud and its origin, and the subsequent evolution of long-period comet orbits in the planetary region. He has also worked on thermal modeling of cometary nuclei, studies of the internal structure of cometary nuclei, and telescopic observations of short-period comets in order to determine their size distribution and rotational periods. He has worked on observing programs on asteroids to search for the YORP effect (a phenomenon that affects the rotation rate and pole orientation of an asteroid) in near-Earth objects (NEO's) led by Stephen Lowry at the University of Kent, and in physically characterizing asteroids that are targets of spacecraft missions.

Paul received his Bachelor of Arts in Physics from Cornell University in 1969. He earned two Masters of Science degrees, one in Astronomy from the University of Massachusetts in 1971 and his second in Planetary and Space Physics from the University of California, Los Angeles in 1973. He was awarded his Ph.D. in 1978 from the University of California, Los Angeles, for his work on the Physical and Dynamical Evolution of Long-Period Comets.

Paul worked at the Jet Propulsion Laboratory in many capacities, including as a Research Scientist in the Earth and Space Sciences Division (1979), Mission Scientist for the Mariner Mark II Project (1981–82), Co-Investigator on the Visual Infrared Mapping Spectrometer Science Development Team (1984–88), Deputy Project Scientist on the Comet Rendezvous/Asteroid Flyby Project (1987–92), Co-Investigator on the Near Infrared Mapping Spectrometer (NIMS) experiment on the Galileo spacecraft (1988–2003), Deputy Project Scientist for the Champollion Lander on the International Rosetta Mission (1995–96), Project Scientist for the Champollion/DS4 Comet Lander (1996–99), and the Astronomy Science Lead/Director at Table Mountain Observatory (2003–15).

When asked who inspires him, Paul said it's his science colleagues whom he claims are often much smarter than he is. He calls it a privilege and tremendous fun to watch his peers perform their scientific magic; knowing and working with people at the cutting edge of planetary science is both exciting and exhilarating.

His interest in space began in 1957 when the Soviet Union launched Sputnik just days after his 10th birthday. Sputnik was the first satellite sent into space; it entered Earth's orbit and essentially began the space age. Everyone, including Paul, was very excited about the first ventures into space.

Currently he is working on the European Space Agency's Rosetta mission as an Interdisciplinary Scientist and a Co-Investigator on the dust counter experiment. Rosetta has been orbiting comet 67P/Churyumov-Gerasimenko for 20 months now and has six more months of operations, followed by many years of data analysis. It is rewriting the textbooks on comets with many fascinating discoveries.

Paul has received many awards and honors throughout his illustrious career: Asteroid 3197 named "Weissman" in 1986. In 2005, he was elected a Fellow of the American Association for the Advancement of Science. Also in 2005, he received a NASA Group Achievement Award: Stardust Mission. In 1997, Paul was given a Letter of Excellence in Reviewing: Icarus. In 1996, he received a NASA Group Achievement Award: Galileo Probe Relay and Jupiter Orbit Insertion. In 1995, he received a NASA Group Achievement Award: Galileo Ida Encounter / Dactyl Discovery Team. And in 1991, he received NASA Group Achievement Awards: Galileo Orbiter Instrument Design, Development and Test; NIMS Instrument, Science Calibration Subsystem, Instrument Coordinators.

When he is not working, he enjoys traveling with his wife, Maureen. In February, they made their second trip to Africa, visiting Rwanda to see mountain gorillas and Tanzania to see the whole menagerie of African animals. There, during an early-morning game drive, they were rewarded with 18 lions, five cheetah, huge herds of cape buffalo, wildebeest, gazelles, smaller herds of elephants plus hyenas, jackals, three safely distant rhinos, a wide variety of birds, and one sleeping leopard.

We are very proud to welcome Paul to PSI!



Paul and his wife Maureen on the rim of Ngorongoro Crater, Tanzania, in February 2016.



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Chris Holmberg, Editor and Writer
Alan Fischer, Writer and Photographer

Special thanks to Gil Esquerdo, Dianne Janis,
Emily Joseph, Carol Neese, and Elaine Owens

Introducing Ryan Clegg-Watkins

Ryan Clegg-Watkins joined PSI in June 2015 as an Associate Research Scientist. She received her Ph.D. in May 2015, so she came to PSI fresh out of graduate school. She also currently serves as the McDonnell Center for the Space Sciences Postdoctoral Research Associate at Washington University in St. Louis. She likes to tell people that every little kid wants to be an astronaut, she just never outgrew it. Her interest in space exploration started in a middle school science class, and grew after attending Space Camp twice!



Ryan received her undergraduate degrees in physics and space science at the Florida Institute of Technology. While at FIT, she participated in a NASA internship program and spent two summers working at Kennedy Space Center. There, under the mentorship of Phil Metzger, she studied the effects of rocket exhaust on lunar soil and was exposed to planetary science for the first time. She liked lunar science very much and enjoyed contributing knowledge to future missions so she chose planetary science for her graduate studies. She was also selected for the first cohort of NASA Student Ambassadors and has been actively involved in educating the public about NASA activities ever since.

The summer before starting graduate school, Ryan interned at the Jet Propulsion Laboratory, where she was a member of the proposed MoonRise mission's Student Collaboration Project. She participated in designing an imager that would fly on the communication satellite and assisted MoonRise engineers with dust mitigation strategies for landing on the surface of the Moon. This internship sparked her passion for participating in ongoing and future missions.

Ryan spent her graduate career at Washington University in St. Louis, where she completed her Ph.D. under Dr. Bradley Jolliff.

Crater in India Stands in for Martian Crater

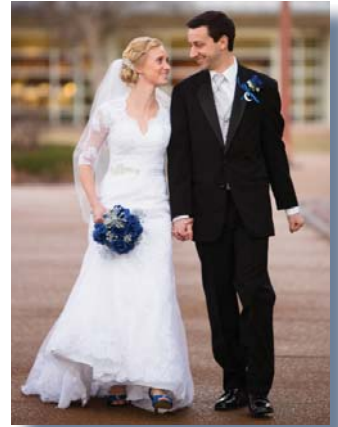
In January 2016, PSI Research Scientist Shawn Wright visited India's Lonar Crater, formed by a hypervelocity asteroid impact



PSI Scientists Shawn Wright (R), Henry Throop (center), and local guide Anand (L) on the rim of India's Lonar crater. The 1.5-km diameter crater is filled with spring-fed water, and more than a dozen Hindu temples from the 11th century are still preserved around the lake's edge.

She joined the Lunar Reconnaissance Orbiter Camera (LROC) team and has had the privilege of working with a great group of scientists who have a passion for lunar science and exploration.

A few months before defending her dissertation, Ryan married an aerospace engineer (in a space-themed wedding, of course) and decided to seek a position that would allow them both to stay in St. Louis, a city she fell in love with during graduate school. Ryan immediately contacted PSI because of the flexibility and the diverse array of research opportunities. WashU has allowed her to continue as a postdoc working with LRO data, and Ryan is quickly learning the ropes of proposal writing so she can transition to PSI full-time.



Ryan currently uses LROC images to photometrically analyze lunar landing sites, silicic volcanic regions, and potential landing sites in the South Pole-Aitken Basin. She is pleased that her daily work involves using mission data and that her research has applications for future robotic and human missions. She is also actively involved in local STEM outreach projects.



Ryan studying limestone at a roadcut in Missouri.

Outside of work, she enjoys being a newlywed, exploring St. Louis with her husband, running, reading, hiking, and brainstorming ways to decorate her new house.

PSI is delighted to welcome Ryan into the fold!

into basalt some 500,000 years ago. Due to its formation in basalt, this impact is believed to be one of the best analogues on Earth for craters on Mars.

Shawn is one of the world's leading experts studying this crater. PSI Senior Scientist Henry Throop, of Mumbai, accompanied him on the trip, as did retired USGS geologist Dan Milton, who was responsible for some of the earliest studies of the crater in the 1970's. Dan's visit was the first time he had returned to the crater since his work 40 years ago.

This trip was Shawn's fourth visit to the crater as he continues to do field work to study its origin and current state, and its suitability as an analogue for Martian craters.

Front page banner: This image shows the northern half of the continental United States at night. The data that formed this composite picture was gathered by the Suomi NPP satellite in April and October 2012, using the satellite's "day-night band" of the Visible Infrared Imaging Radiometer Suite (VIIRS), which detects light in a range of wavelengths from green to near-infrared and uses filtering techniques to observe dim signals such as city lights, gas flares, auroras, wildfires and reflected moonlight. Image: NASA Earth Observatory/NOAA NGDC

PSI Receives \$4M for Data Archiving Services

by Alan Fischer

In December 2015, Planetary Science Institute received a \$4 million, five-year cooperative agreement from NASA to manage the Planetary Data System's Asteroid and Dust Subnode. The Subnode is part of the Small Bodies Node, managed by the University of Maryland.

PSI has provided PDS archiving services for more than 20 years, PSI Research Scientist Eric Palmer said. "We maintain an archive of all NASA flight mission data that relates to asteroids and interplanetary dust." Eric will be the new manager of the Asteroid and Dust Subnode, assuming the reins from PSI Senior Scientist Don Davis who established the subnode in 1994.

PSI's archiving team is lead support on the NASA Dawn, OSIRIS-REx and Japanese Hayabusa 2 missions. They also support the dust detection instrument on Cassini and asteroid flybys of the European Space Agency's Rosetta mission. Past missions include the Infrared Astronomical Satellite (IRAS), Galileo, Near Earth Asteroid Rendezvous mission, the Lunar Atmosphere and Dust Environment Explorer (LADEE) mission, and others. Ground based observations of asteroids are also included. The amount of data stored in the archive approaches 10 terabytes.

"We work with mission teams to ensure that data products are well-documented and in formats that are usable," Eric said. The most important part of the archive process, however, is to subject all data to peer review by outside scientists. This is to ensure

that the data will continue to be usable for the next 50 years."

Seven PSI staffers work on PDS: Eric Palmer, Don Davis, Beatrice Mueller, Carol Neese, Rose Early, Jesse Stone and Michael Wendell.



Members of PSI's NASA Planetary Data System Asteroid and Dust Subnode are, from left, Donald R. Davis, Rose Early, Eric E. Palmer, Beatrice Mueller, Jesse V. Stone, Carol Neese, and Michael Wendell. Photo: Alan Fischer

"The PDS plays an essential role in the public getting continuing benefit from their investment in NASA missions during and beyond the lifetime of those missions," said PSI Director Mark Sykes. "Under the leadership of Eric Palmer, a new generation is taking up the reins of this program, bringing new vision and perspective which will help the PDS continue its open-ended role."

PSI Funded for Expanded Education Outreach

by Alan Fischer

In March, PSI learned it will receive \$2.6 million as a team member on a five-year, NASA-funded effort to invite the world to join in exploring our universe by enabling everyday people to help NASA scientists make new discoveries.

PSI will provide professional development to formal and informal educators to help students engage with current NASA data. Additionally, PSI will lead an effort to increase the number of astronomy related science fair projects, locally in Arizona and across the nation. PSI scientists will recruit and support NASA scientists to include their data in CosmoQuest (CosmoQuest.org), a virtual research facility, to ensure public participation in up to date space science research. CosmoQuest is led by Pamela Gay at Southern Illinois University Edwardsville, and brings together scientists, educators, and software developers from eight collaborating institutions and numerous additional partners.

PSI participants are Education Specialist and Research Scientist Sanlyn Buxner, Senior Scientist and Education Specialist Jennifer Grier, Education Specialist Andrea Jones and Senior Education Specialist Larry Lebofsky.

"This project offers fun and exciting ways for the public to directly engage with the process of science. They become a critical piece of the process, collecting the data that eventually leads

to a better understanding of our cosmos and the world around us," Jennifer said. "It's about much more than just having fun. Working with CosmoQuest develops critical thinking skills, and enhances overall science literacy."

PSI also hopes to increase planetary-related science fair projects. In Tucson, with all its astronomy activity, less than one percent of the projects seen at the annual Southern Arizona Research, Science, and Engineering Fair are space science related. This is typical across the nation.

"Through one component of CosmoQuest, we will provide teachers and scientists nationally with the tools to help engage students with background science content, activities, and ideas for space-science related research projects that could lead to good science fair projects," Larry said.

"I am delighted to be a part of CosmoQuest, inviting teachers, students, the country, and the world to engage in the excitement of NASA science and exploration, and to make meaningful contributions to our quest for knowledge about the Solar System, and beyond," Andrea, based in Arlington, Va., said.

This cooperative agreement also funds team members at the Astronomical Society of the Pacific, InsightSTEM, Interface Guru, Lawrence Hall of Science, Johnson Space Center, McREL International, McDonald Observatory, and Youngstown State University.

Director's Note

Over its 44 years, PSI has supported almost exclusively NASA missions and programs, including NASA programs to support foreign missions. PSI has been involved with the European Space Agency's Mars Express, India's Chandrayan 1 to the Moon, Japan's Hayabusa 1 to the near-Earth asteroid Itokawa, and others. Other nations are ramping up their Solar System exploration activities, in particular China with its impressive series of Chang'e missions. It is an exciting time.

We are reaching out directly to these other countries now and look forward to closer ties as we move forward. My trip to China with PSI Senior Scientist Jian-Yang Li (see front page) was a great experience. There is much energy and a great amount of deserved pride in the nascent Chinese Solar System exploration program. We met and had discussions with a number of their scientists and engineers at the Qian Xuesen Lab. It is hard not to be inspired by their enthusiasm. It will be a real pleasure to work with them.

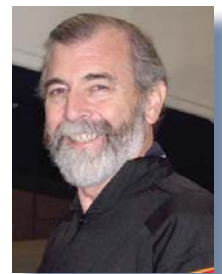
This activity is reflected in PSI's newly adopted strategic plan. The plan was developed over the past year to make a clear statement about the mission of the Institute, our vision for the future, and the principles that guide what we do. Our priorities in the plan arose from individual conversations I had with more than 90 of our employees. These include increasing funding opportunities (which would include diversifying our funding

sources) and expanding institutional infrastructure (e.g., laboratories). With regards to infrastructure, we have been given notice that U.S. Geological Survey will be transferring to our Tucson offices a spectroscopy lab created and built up over years by PSI Senior Scientist Roger Clark when he was still a USGS employee. This will be a great capability for use by our scientists.

One of our most important principles, included in the plan, which I feel sets us apart from most organizations, is our explicit commitment to create "an environment within which the ambitions of scientists and educators can be pursued and realized." Our staff is our greatest asset. It is their initiative that will advance our goals. I see no reason to limit what will be pursued consistent with our strategic plan. One day there will be a PSI-run mission in addition to spacecraft instruments and major research programs. Some of our scientists are also pursuing human exploration by the Institute.

A final note about China. During our week-long trip, the sky was crystal clear and there was none of the air pollution for which Beijing is noted. After a few days, people were talking about how unusual it was. I expressed my feeling that it was a positive portent of the future!

Mark V. Sykes
March 2016



PSI Staff News

In January 2016, PSI Senior Scientist **Joe Michalski** was interviewed on *CBS This Morning*. Joe, working at the Natural History Museum in London, is on camera describing an exhibition of Michael Benson's photographic space art called "Otherworlds."

The artist uses original photos taken by NASA spacecraft over the last 60 years and creates a jigsaw puzzle of images, adding scientifically correct color to the black and white originals to make the stunning artworks.



CBS NEWS January 23, 2016, 1:58 PM
"Otherworlds" exhibit casts new light on space using raw data

"In a technical sense this is very clearly an art exhibition," said Joe. "We hope that the people who appreciate art will come here for that. We hope that people who come here for science will be pleasantly surprised by the art."

Congratulations to our new scientist-parents!

PSI Senior Scientist **Susan Benecchi** and her husband R.J. welcomed their second child on March 5, 2016, in Virginia. Their newborn daughter, Sarah Elizabeth, weighed 5 lb, 8.8 oz and measured 19.5 inches long.



Big brother Joshua (age two) is very excited and gentle with her.

PSI Senior Scientist **Pasquale Tricarico** and his wife Caroline Corrier had their second son on March 2, 2016, in Angers, France.

His name is Arthur, and he weighed 5 lb, 9.5 oz, and measured 18.11 inches.



Mother and newborn are doing well; older brother Louis (five in May) is busy with his drawings.

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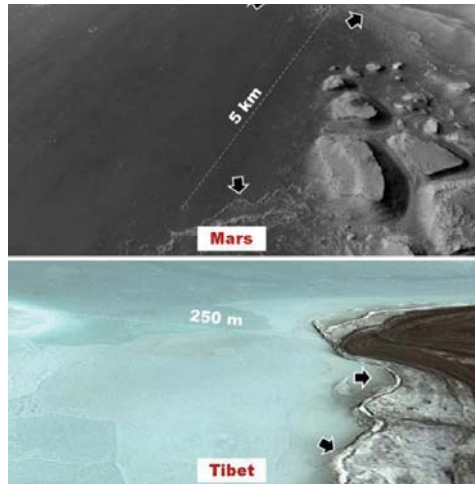
Martian Lakes Might Have Been Linked to Ancient Habitable Environment *by Alan Fischer*

Over 3 billion years ago groundwater circulating beneath a massive tectonic rift zone along the flanks of some of the Solar System’s largest volcanic plateaus carved a few of the deepest basins on Mars, according to a new paper by PSI Senior Scientist J. Alexis P. Rodriguez.

These basins could have been episodically covered, perhaps for hundreds of millions of years, by lava and water lakes that were discharged from subsurface pressurized sources, Alexis writes in “Groundwater flow induced collapse and flooding in Noctis Labyrinthus, Mars” that appears in *Planetary and Space Science*.

This shows an area on Mars that could possibly have harbored life. “The temperature ranges, presence of liquid water, and nutrient availability, which characterize known habitable environments on Earth, have higher chances of forming on Mars in areas of long-lived water and volcanic processes,” Alexis said.

“Existing salt deposits and sedimentary structures possible within ancient Martian lakes are of particular astrobiological



Close-up views of a lava-covered basin on Mars (top), and the proposed study area on Earth, a high mountain lake in Tibet (below). The arrows in both panels identify similar ridges. In the Tibetan lake case, the ridges are thought to form when sediments are pushed outwards by freezing waters. These types of ridges might be diagnostic shoreline features of lakes that formed under extremely cold, dry Martian conditions. A key objective of the planned field expedition is to investigate these bizarre shoreline features and characterize their astrobiological potential. Images: Google Earth

importance when looking for past habitable areas on Mars. Especially if the discharge of early Mars groundwater (perhaps hydrothermal systems that were active for billions of years) contributed to the formation of the ancient lakes, as it is proposed in this investigation.”

The detection of ancient lake sites on Mars is particular challenging because under the planet’s frigidly cold and thin atmosphere their ponded water would have behaved differently than on Earth, he said. “In this research we propose a Tibetan region where high mountain lakes show unique sets of landforms that might explain some basin interior features in the studied region of Mars.”

In collaboration with the Chinese government, Alexis will visit the Tibetan region this summer to investigate their in-situ potential for being astrobiologically analogous to Mars. These activities will not be funded by NASA.

PSI Senior Scientist Cathy Weitz and Associate Research Scientist Thomas Platz are co-authors on the paper.