Dedicated to Solar System exploration, PSI scientists are involved in NASA and international missions, fieldwork around the world, education, and public outreach.

The Planetary Science Institute is a private, nonprofit 501(c)(3) corporation dedicated to Solar System exploration. It is headquartered in Tucson, Arizona, where it was founded in 1972.

PSI scientists are involved in NASA and international missions, the study of Mars and other planets, the Moon, asteroids, comets, interplanetary dust, impact physics, the origin of the Solar System, extra-solar planet formation, dynamic evolution of planetary systems, the rise of life, and other areas of research. They conduct fieldwork on all continents around the world. They are also actively involved in science education and public outreach through school programs, children’s books, popular science books and art.

PSI scientists and educators are based in 30 states and the District of Columbia, and work from various international locations.

ON THE COVER:
“Discovering a crater with an ice deposit near the south pole of the Moon”

Painting by PSI Cofounder and Senior Scientist Emeritus William K. Hartmann

Since the Sun is always near or below the horizon at lunar poles, there are permanently shadowed crater floors near lunar poles. Water vapor from impacts of comets could condense into ice in such cold surfaces, and the ice could provide water for future lunar research bases. This led to current interest in finding ice deposits that may collect in those craters. However, such ice would be in finite deposits, so the duration of the supply may be a problem. A non-finite supply of water on the moon, consisting of H\textsubscript{2}O created from solar wind H atoms hitting lunar rocks, builds up in the lunar soil each “lunar afternoon,” but it’s not clear whether the total would be adequate to be of interest as a lunar base.
IN 2022 THE COVID-19 PANDEMIC SUBSIDED TO THE POINT WHERE WE COULD HAVE OUR FIRST FACE-TO-FACE IN THREE YEARS AND CELEBRATE PSI’S 50TH ANNIVERSARY!

We enjoyed being regaled by the stories of three of our founders, Don Davis, Bill Hartmann and Clark Chapman, and an early hire, Stu Weidenschilling, who formed the core of PSI for decades. They established an organization that was very collaborative and became well known in the planetary community as NASA was engaged in its growing exploration of the Solar System. The first mission in which PSI was involved, one year after it was founded, was Mariner 10, which launched in 1973 and flew past Venus to enter into orbit about Mercury. Today PSI is involved in almost all of NASA’s planetary missions from the inner to the outermost reaches of the Solar System.

For decades, PSI was a small organization, until about 20 years ago when it started to grow. Our founders (and I lump in Stu here!), created a culture of mutual support and engagement that we have striven to maintain despite our being almost 10 times larger and highly distributed nature today, covering 30 states, the District of Columbia, and 10 countries. This could not have happened without the internet, and its increasingly better and better communication tools! I think this is best manifested by the fact that well more than half of our scientists volunteer to do Red Team reviews of their colleagues’ grant proposals.

When we had our first virtual Retreat during Covid, I promised that when we were back face to face for a Retreat, that I would host a scotch tasting — and so I did! Twenty people signed up and 25 people showed up. I wore my Maclean kilt (my mother’s clan) and featured an array of scotches including an experimental Glenfiddich that I brought back from Edinburgh. Unbeknownst to me, among the participants was Jenny Kroik, an artist who has done covers for The New Yorker magazine, and she captured the event, part of which is shown here. All in all, with the history, new science, new collaborations, and just plain fun, it was a memorable Retreat!

IT WAS ALSO A MEMORABLE YEAR FOR SCIENCE AT THE INSTITUTE!

• Alexis Rodriguez along with Jeff Kargel and Dan Berman determined that in 1976, Viking 1 may have landed on the site of a megatsunami on Mars.
• Roger Clark is co-investigator of the EMIT instrument which was placed on the International Space Station to learn how dust storms on Earth warm or cool the planet, using software he developed called Tetracorder.
• Deborah Domingue led a team of PSI scientists that found that enigmatic dusty features on the surface of the Moon called lunar swirls were related to subtle variations in topography.
• Matt Chojnacki led an effort that determined that “megaripples” in bedforms near northern sand dunes on Mars, thought to be inactive relics of past climates, actually migrated with dunes and ripples — albeit at the rate of about 13 centimeters per year!
• Faith Vilas, Amanda Hendrix and Deborah Domingue did laboratory analysis that contributed to the determination that samples returned from the asteroid Ryugu by a Japanese spacecraft formed in the outer solar system.

SCIENCE IS ADVANCED EVERY DAY AT PSI.

— Mark V. Sykes

SCOTCH TASTING EVENT ILLUSTRATION
Credit: Jenny Kroik
PSI Spent 2022 Celebrating the Institute’s 50th Anniversary of Solar System Exploration

A group of young planetary scientists, including Bill Hartmann, Don Davis, Stu Weidenschilling, Clark Chapman, Mike Price and Al Binder, came together to form the early nucleus of the new PSI. The first PSI headquarters was Hartmann’s living room. After outgrowing a number of sites, the Institute, a private, nonprofit 501(c)(3) corporation, is now headquartered at a suite of offices in central Tucson with a second office near Denver, Colorado, and scientists distributed in 30 states, the District of Columbia, and 10 countries.

“We are a community of scientists, educators, and staff dedicated to excellence in our work as individuals and as an Institution. We help each other be successful in our professional and even personal endeavors,” said Mark Sykes, who has been PSI’s CEO and director since 2004. “This reflects the collegial environment established by our founders and maintained over the decades by generations of employees.”

And PSI’s 50th anniversary was a focus of the Institute’s annual retreat, where about 100 scientists, educators and staff members gathered at the Hacienda Del Sol Guest Ranch Resort in Tucson Aug. 17-19 for the first in-person gathering in two years due to Covid.

A highlight of the event was a discussion of the early days of PSI by Stu Weidenschilling, Clark Chapman, Bill Hartmann and Don Davis at the event’s celebration dinner.

On February 2, 2022, the Arizona Daily Star newspaper ran this front-page story by reporter Henry Brean titled “PSI Celebrates 50 Years of Cosmic Discovery”:

When a handful of Tucson scientists joined together in 1972 to explore the Solar System, they had no idea their efforts would result in the present-day Planetary Science Institute.

PSI, celebrating its 50th anniversary Feb. 2, has grown to be one of the largest planetary science organizations, with more than 160 employees – including 115 Ph.D. scientists – more than 300 current NASA space exploration contracts and more than $15 million in annual revenue, with 95% of funding coming from NASA.

“In the early days of PSI, we did not want to grow to be a large group. Our aim was quality, not quantity,” said Don Davis, PSI founder and Senior Scientist Emeritus. “We sought, and I think achieved, our aim of having a high-quality staff of planetary scientists with overlapping scientific interests who could work both independently and collaboratively on challenging problems in planetary science.”

“The founders of PSI were a group of like-minded University of Arizona graduates who were hired to form a Tucson division of Science Applications International Corporation, devoted to the then-emerging field of space exploration, and who named themselves ‘Planetary Science Institute’ in early February of 1972, with Groundhog Day being the official date for formation,” said Bill Hartmann, PSI founder and Senior Scientist Emeritus.

PSI has been a pioneer in using the Internet to create a distributed workforce, while at the same time building a supportive, collaborative community. “Our scientists bring experience covering almost all of the Solar System missions of the United States, as well as those of other countries. Their shared experiences energize an expansive vision of future exploration in our own Solar System and beyond,” said Mark
Tucson Mayor Proclaimed Aug. 18, 2022, as Planetary Science Institute Day

Citing PSI’s 50th anniversary and the many accomplishments and highlights the Institute has enjoyed, Tucson Mayor Regina Romero presented PSI Director Mark Sykes with a proclamation that said Aug. 18, 2022 is Planetary Science Institute Day in this community and encouraged all our residents to celebrate this special day.

Romero’s proclamation said PSI is the largest private employer of planetary scientists in the world, providing high-paid, high-technology jobs that boost the local economy; and scientists and staff at the Planetary Science Institute are involved in all NASA Solar System exploration missions, as well as missions of other nations, and are engaged in cutting edge research from the Sun to Earth to Pluto and to the thousands of planets around other stars; and scientists and staff at the Planetary Science Institute are exploring the origins of life on Earth, where it may arise elsewhere in our Solar System and beyond, and the detectability of other technological civilizations in our galaxy.

Also, the Planetary Science Institute is dedicated to conveying to the regional and general public what it is learning about the universe in which we live, through science education and public outreach including school programs, children's books, popular science books and art, to advance science literacy and inspire individuals to pursue careers in science and related fields. It has been a pioneer in creating a geographically distributed workforce and achieving gender parity in its demographics, science leadership, salary, and success in a substantial scientific organization. The Planetary Science Institute is celebrating its 50th anniversary as a local business, placing Tucson at the forefront of planetary exploration.

Sykes, PSI CEO and Senior Scientist. “I also deeply appreciate the unmatched experience and dedication of our staff in supporting our scientists and educators.”

PSI scientists have defined the modern theory of the origin of the Moon, proposed the rubble pile structure for many asteroids, developed a method for determining the ages of planetary surfaces from craters that have stood up over time, identified evidence for tsunamis over the shores of Mars’ early polar ocean, identified potential locations of Mars life today, determined the locations of potential caches of water ice in the daylit regions of the Moon of value to future human activity, constrained the magnetic fields of planets around other stars, and explored the environments associated with the earliest stages of planet formation around other stars, among many other accomplishments. PSI scientists and educators have also been pioneers in engaging the public in citizen science and integrating real science experiences with the programs of faith communities.
Alexis Rodriguez, along with Jeff Kargel and Dan Berman, determined that when NASA's Viking 1 lander touched down on the surface of Mars on July 20, 1976 it may have landed on the margins of a megatsunami deposit, formed when a 3-kilometer asteroid impacted a northern Martian ocean about 3.4 billion years ago.

The spacecraft became NASA's (and the world's) first lander to successfully operate on the red planet's surface, offering the first views of Mars from the ground.

Early hypotheses suggested the landing site was on a thick blanket of debris ejected by nearby impacts or broken-up lavas. However, it was also recognized that nearby craters were too few and that lava fragments were rare. The lack of consensus persisted during the six years of operation, leading to an enduring mystery in planetary exploration.

“Our investigation provides a new solution – that a megatsunami washed ashore, emplacing sediments on which, about 3.4 billion years later, the Viking 1 lander touched down,” Rodriguez said.

An earlier paper by Rodriguez suggests that 3.4 billion years ago, there were two Martian megatsunamis. During the time that separated them, the ocean experienced significant regression, and the climate became much colder. The paper shows a newly identified possible marine impact crater – Pohl crater – which likely generated the first of these two megatsunamis.

“Pohl is outstanding in several respects; it is atop immense fluvial landscapes formed by ocean-generating floods, and it is partly covered by the second megatsunami. It must have formed after the ocean’s generation and before its disappearance,” Rodriguez said.

The research was funded by a grant to PSI from NASA's Mars Data Analysis program.

Matt Chojnacki led an effort that determined that megaripples, intermediate-scale bedforms caused by the action of the wind that have been studied extensively and thought to be largely inactive relics of past climates, save for a few exceptions, actually migrated with dunes and ripples – albeit at the rate of about 13 centimeters per year.

Chojnacki identified abundant megaripple populations across the north polar region of Mars which were found to be migrating with dunes and ripples.

“Using repeat HiRISE images acquired over long durations – six Mars years or 13 Earth years – we examined the dynamic activity of polar bedforms. We found the thin Martian atmosphere can mobilize some coarse-grained megaripples, overturning prior notions that these were static relic landforms from a past climate. We mapped megaripples and adjacent bedforms across the north polar sand seas, the most expansive collection of dune fields on Mars,” Chojnacki said.

“Megaripples were found to be widespread across the region and migrating at relatively high rates relative to other sites on Mars that are at lower latitudes. This enhanced activity is likely related to the greater sand fluxes found for neighboring dunes which are driven by summertime seasonal winds when polar ice is sublimating. This supports the idea that much of the Martian surface is actively being modified and not just ancient or static,” Chojnacki said. “In contrast, other megaripples appear to be stabilized, a likely result of intergranular ice within low wind areas.”

The project was funded by NASA Mars Data Analysis program grant 80NSSC20K1066.
Roger Clark is co-investigator of NASA’s Earth Surface Mineral Dust Source Investigation (EMIT) instrument which was placed on the International Space Station to learn how dust storms on Earth warm or cool the planet, using software he developed called Tetracorder.

Blown by wind across continents and oceans, dust does more than make skies hazy, congest lungs, and leave a film on windshields. Also known as mineral dust or desert dust, it can influence weather, hasten snowmelt, and fertilize plants on land and in the ocean. Particles from North Africa can travel thousands of miles around the globe, sparking phytoplankton blooms, seeding Amazonian rainforests with nutrients, and blanketing some American cities in a veil of grit also absorbing and scattering sunlight.

“Understanding the dust composition is key to understanding the warming versus cooling and by how much, both on regional and global scales. Depending on the composition of the dust, it can cool or warm the planet. Dark dust, including dust with iron oxides, may cause warming, whereas light dust may result in cooling,” Clark said.

EMIT uses a software system called Tetracorder, developed by Clark and colleagues at the U.S. Geological Survey, that continues to be developed at PSI. Tetracorder is a public-domain analysis program that is used to identify and map specific materials using spectroscopic data. It also may be used to assist in the identification of materials measured using laboratory spectrometers. An important feature of this program is the identification of materials.

“Tetracorder is an identification and mapping system that will play a crucial role in EMIT’s success,” Clark said. “In some ways, Tetracorder is like the tricorder on the science fiction series Star Trek, in that it identifies materials remotely. But the tricorder only pointed the direction to the detected compounds. With imaging spectroscopy and Tetracorder analysis we’ve surpassed the Star Trek tricorder in that we produce maps of compounds.”

Clark’s work on the EMIT project was funded by awards to PSI from NASA’s EMIT mission, JPL Subcontract No. 1616046. Tetracorder development is funded by awards to PSI from the EMIT project, NASA’s TREX node of the Solar System Exploration Research Virtual Institute, NSF and a contract from Centro Nacional de Supercomputación (Spain).
Deborah Domingue led a team of PSI scientists that found that bright and dark swirling patterns on the Moon's surface called lunar swirls were related to subtle variations in topography.

“This is the first time there has been a demonstrated correlation between the swirl albedo patterns and topography,” said Domingue, lead author of “Topographic Correlations within Lunar Swirls in Mare Ingenii” that appears in Geophysical Research Letters. Albedo is the measure of brightness or the proportion of light reflected from a surface, with a dark object having a low albedo. PSI scientists John Weirich, Frank Chuang, Amanda Sickafoose and Eric Palmer are co-authors.

“Until now the swirls were thought to overlay the topography, which has been cited as part of the evidence that they are created through shielding of the surface from the solar wind by the magnetic fields present at swirls. This correlation argues that there is more than just shielding from space weathering that goes into their creation,” Domingue said.

Two swirl regions in Mare Ingenii, a large, dark basaltic plain formed by ancient volcanic eruptions on the Moon’s far side, display a correlation between albedo and topography, where the bulk elevation in the bright regions is lower than the bulk elevation in the dark regions. These differences are apparent in the meter-scale-resolution topographical data.

This work was supported by NASA's Lunar Data Analysis Program (80NSSC17K0278) and the Solar System Exploration Research Virtual Institute 2016 (SSERVI16) Cooperative Agreement (NNH16ZDA001N) SSERVI-TREX.

Laboratory analysis by Faith Vilas, Amanda Hendrix and Deborah Domingue contributed to the determination that samples returned from the asteroid Ryugu by the Japanese spacecraft Hayabusa2 had formed in the outer Solar System.

Laboratory analysis of 17 individual grains from the samples collected by Hayabusa2 found CO$_2$-bearing water in an iron-nickel sulfide crystal, indicating the parent body formed in the outer Solar System.

“The Hayabusa2 spacecraft sampled the surface twice: once on Feb. 21, 2019, and again on July 11, 2019. The first sampled the undisturbed surface, the second sampled the regolith excavated by the artificial impact created earlier during the mission. This study examined grains from both sample sites, providing samples that can really provide insight into Ryugu’s evolution,” Domingue said.

“The goal of these initial studies is to understand and characterize Ryugu’s formation history. While the orbital data identified the presence of phyllosilicates, it was analysis of the samples that gave us information on the detailed mineral composition and the physical properties of the regolith grains,” Domingue said. Numerical simulations based on these results show that Ryugu’s parent body formed approximately 2 million years after the birth of our Solar System, in the outer Solar System.

The PSI scientists’ work was funded by a grant to PSI from NASA’s TREX Solar System Exploration Research Virtual Institute.
Senior Scientist Catherine Johnson Elected to American Academy of Arts and Sciences

Catherine Johnson was elected as a member of the American Academy of Arts and Sciences. With this election, Johnson joins the company of notable members, including Benjamin Franklin, Alexander Hamilton, George Washington, Margaret Mead, John F. Kennedy, Martin Luther King, Jr., Martha Graham, Georgia O’Keeffe, and Madeleine Albright.

Johnson was elected in Class I - Mathematical and Physical Sciences (Astronomy, Astrophysics and Earth Sciences). She researches geophysical investigations of terrestrial planets, moons and small bodies in our Solar System, and has worked on several NASA planetary missions, including the Mars InSight mission and the Mercury MESSENGER mission. By using sample, observatory and satellite data, Johnson and her group probe the interior structure and history of these bodies to understand how internal and external processes interact to shape a planet or moon’s evolution.

“Data are like puzzle pieces,” Johnson said. “If we collect them, look after them, and query them carefully from many viewpoints, we can find and tell the stories of planets and moons.”

Founded in 1780, the Academy honors excellence and convenes leaders from every field of human endeavor to examine new ideas, address issues of importance to the nation and the world, and work together, “to cultivate every art and science which may tend to advance the interest, honor, dignity, and happiness of a free, independent, and virtuous people.” The Academy’s work is wide-ranging and multidisciplinary, and its areas of focus include Arts & Humanities, Democracy & Justice, Education, Energy & Environment, Global Affairs, and Science & Technology.

Research Scientist Peter Buhler Honored as AGU Outstanding Reviewer

Peter Buhler was named an Outstanding Reviewer of 2022 by the American Geophysical Union (AGU).

“Peer review is central to communicating and advancing science. While there have never been more ways to distribute ideas and research outputs, a robust peer review ensures that we maintain the highest integrity in our scientific discourse. The peer review process is organized by our journal editors, but every article decision relies on dedicated individuals who take time away from their own research to volunteer their time and expertise. The work of these reviewers ensures proper evaluation of thousands of articles each year. We are truly thankful for their efforts,” AGU said in its citation.

“Peer review is an essential part of the scientific process. I see reviewing as an opportunity to help the author publish their best work possible, which is both good for the author and good for the community. It is gratifying to be trusted to provide this service,” Buhler said.

“Receiving this recognition provides encouragement that my review efforts have been helpful to my colleagues, which makes me glad and renews my excitement to continue to do my best work to aid the scientific community. It also causes me to reflect with gratitude on the helpful reviews that I have received, which have improved my own work and provided a model for providing good reviews to others.”
BAHARIER, HENDERSON NAMED 2023 PIERAZZO INTERNATIONAL STUDENT TRAVEL AWARD WINNERS

Bea Baharier and Sarah Henderson were named winners of the 2023 Pierazzo International Student Travel Award. The Pierazzo International Student Travel Award was established by PSI in memory of Senior Scientist Betty Pierazzo to support and encourage graduate students to build international collaborations and relationships in planetary science.

A PSI representative will present each awardee with a certificate and check for $2,000 at their respective conferences.

Bea Baharier

Baharier will receive the award for a non-U.S.-based graduate student going to a planetary-related conference within the U.S., and Henderson will receive the award as a U.S.-based graduate student going to a planetary-related conference outside of the U.S.

Baharier of Open University (Milton Keynes, United Kingdom) will attend the 54th Lunar and Planetary Science Conference in The Woodlands, Texas, March 13-17, 2023. Her research title is "Terrestrial Aqueously Altered Magmatic Dike Forming Sulfate-Rich Hydrothermal Fluids to Constrain Martian Habitability." Baharier's work contemplates putative past Martian hydrothermal environments' habitability as Mars evolved to the drier, colder environment of today, and lays constraints for identifying these changing Martian environments. Her work can be used as a comparison to future returned sample properties from Jezero Crater.

Sarah Henderson

Henderson, of the University of Iowa (Iowa City, Iowa), will attend the European Geophysical Union in Vienna, Austria, April 23-28, 2023. Her research title is "Influence of Magnetic Fields on Precipitating Solar Wind Hydrogen at Mars." Henderson's work explores the consequences of charge exchange collisions in the outer reaches of the Martian atmosphere, which were first detected by the Mars Atmosphere and Volatile Evolution mission, representing a source of energy to the Martian upper atmosphere with potentially significant chemical consequences, and producing a unique ultraviolet auroral emission during the earliest stages of formation.

THANK YOU TO OUR 2022 BENEFactors

With deep appreciation the Planetary Science Institute acknowledges the following individual and organizational benefactors who made contributions between January 1, 2022, and December 31, 2022.

$2,000 and up
Anna Don
Dr. William K. Hartmann

$1,000-$1,999
David Rossetter
Dr. Dorothy Oehler

$500-$999
Richard Hendricks
Crest Insurance Group

$250-$499
Alison Nordt
Robert Reedy

$100-$249
Larry East
Charles Katzenmeyer
Dr. Christopher Chyba
Melroy and Hollett Technology Partners
Otto Rueger
Thomas Prettyman
Dr. Vicki Hansen

$1-$100
Dr. Brent Archinal
David Kouchnerkavich
Jeri Seyk
Jonathan Lilly
Elaine Noel
Sara Hammond
Dr. Andrew Wheeler
Victor Baker
Vidya Rama
Shad Sterling
Scott Seramur
PSI's revenues grew to over $18.4M for the fiscal year ended September 30, 2022. During the fiscal year, PSI was actively involved in 135 prime awards issued directly from federal agencies and 144 subawards / contracts issued through other institutions. 93% of PSI's Grants and Contracts revenue was derived from awards with NASA.

**REVENUES**

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<td>Contributions</td>
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<td>Other</td>
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**EXPENSES**

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**ACTIVE PROJECTS BY PRIME AWARDING AGENCY**

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<th>Agency</th>
<th>Projects</th>
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<td>NSF/Other</td>
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<tr>
<td>Subawards/Contracts</td>
<td>144</td>
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<td><strong>Total Projects</strong></td>
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</table>

Salaries and related fringe benefits represented 71% of PSI's total expenses. Operating expenses included $3.3M from subawards issued to other institutions for collaborative efforts on PSI prime awards. Program Service expenses amounted to 90% of total expenses.

**EXPENSES BY FUNCTION**

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PSI's financial records are audited annually by independent auditors. A condensed Statement of Financial Position from PSI's audit report as of September 30, 2022 is reflected below.

<table>
<thead>
<tr>
<th>Description</th>
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<tr>
<td><strong>Total Liabilities &amp; Net Assets</strong></td>
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</table>
Tucson Festival of Books

Sanlyn Buxner and Larry Lebofsky, along with students from the University of Arizona, participated in the Tucson Festival of Books on the University of Arizona Mall. There were hundreds of visitors to PSI’s display each day. Our activities included a hands-on display of meteorites and “meteorwrongs” where participants used magnets to determine if samples were meteorites. We also had a place for kids to make bracelets with pony beads and UV beads that change color in sunlight.

In addition to the gifts that the kids got by making the bracelets, we also had Meteorite Cards that we gave out only to those (especially kids) who showed an interest in the meteorites and would appreciate a “rock from space.” The text was provided to us by Brother Bob Macke of the Vatican Observatory and included a small (several gram) ordinary chondrite meteorite donated by Larry Lebofsky. In total, we gave out 125 of these.

CosmoQuest Team Shows LEGO® Spacecraft

PSI’s CosmoQuest team participated in the St. Louis Astronomy Festival, where an exhibit of LEGO® spacecraft attracted lots of attention. Pamela Gay, Tanya Kuzara, Lindsey Odom and Annie Wilson participated. Gay gave a presentation titled “Beautiful Science: Combining the Art of Astrophotography with the Pursuit of Science Data.”

“All of the LEGO® – especially the Orrery – really attracted attention and we were able to chat with quite a few folks,” said PSI’s Annie Wilson.

Other PSI EPO events included a professional development program for educators at the Cooper Center for Environmental Learning, a virtual presentation for Chabot Space and Science Center, a total lunar eclipse viewing event at the University of Arizona Flandrau Science Center that attracted 300 people, a Marvel character themed night at the Arizona-Sonora Desert Museum, five weekly presentations at the Frank and Edith Morton Boys and Girls Club, Space Night at the Children’s Museum Tucson, and a presentation at the Cooper Center to retired educators from Tucson Unified School District who do outreach in classrooms.

Planetary Jeopardy Game

People tested their knowledge of planetary science by answering questions found on Planetary Jeopardy, a game developed by
Space Workshop on Space, SciArt, and Society organized by Research Scientist Jamie Molaro.

The event included talks by experts on recent discoveries in planetary science, discussion of how and why humans explore space, and art-making activities that explore how similar science and art truly are. Artists, educators, and scientists from across the country used a wide variety of materials, including paint, collages, clay, and even poetry and video to create science-related art during the three-day event at the Catalyst Arts & Maker Space at the Tucson Mall.

“This workshop is about using art as a tool to both explore and communicate scientific ideas,” said Molaro, an award-winning space artist. “By teaching art techniques for incorporating scientific information and spacecraft data into art, it gives them the opportunity to actually participate in space exploration on their own terms and to share their discoveries with others.”

A number of artists and planetary scientists, including PSI’s Amanda Sickafoose, gave presentations at the event.

PSI’s Sanlyn Buxner supported the event, which was partially funded by TREX, the Toolbox for Research and Exploration program funded by NASA through PSI.

Kristina Lopez, PSI research assistant.

The game, similar to the televised game show Jeopardy, is part of the Planetary Data Systems exhibit at events like American Geophysical Union and American Astronomical Society Division for Planetary Sciences conferences.

PDS is NASA’s system to archive mission data, to ensure that it can be used – for free, by anybody on the planet – decades down the road. “We wanted a way to engage people to learn about PDS that would be fun. And get people excited about planetary science,” Lopez said. “I was a kid who was really affected by outreach. It really sparked my interest in science.”

Lopez has provided teachers with the files needed to print out the game components. If interested, contact her at klopez@psi.edu.

Workshop Uses Art as a Tool to Explore and Communicate Scientific Ideas

Twenty-five people gathered in Tucson to interpret scientific themes, data, and images and transform them into art at the Making
For 50 years, PSI’s strength and advantage continue to be in its people. Our culture of openness and high level of mutual support distinguishes us as an organization. In 2022 PSI continued to grow, adding 26 new research and administrative staff members.
Elisabeth Adams. Finding the next doomed worlds. NASA Exoplanets Research program.

Susan Benecchi. Outer solar system objects at opposition. NASA Solar System Observations program. The University of Virginia subaward.

Sanlyn Buxner. Collaborative research: Evaluating sources and claims scaffolds to promote students’ socio-scientific thinking and learning. National Science Foundation Discovery Research K-12 program. National Science Foundation grant.


Sanlyn Buxner. System Observations program. The University of Virginia subaward.

Deborah Domingue. Pahoehoe-like flow morphologies in the Tharsis and Elysium volcanic provinces. NASA Mars Data Analysis program.


Deborah Domingue. Continued studies of the impact of solar wind ions on the surface and exosphere of Mercury. NASA Solar System Workings program.


Catherine Johnson. Geophysical characterization of surface and near-surface structure on Venus with VenSAR. European Space Agency and NASA Envision program.


Jamie Molaro. Timescales for boulder evolution from thermal fatigue and impacts on asteroid (101955). NASA New Frontiers Data Analysis program.

Alexander Morgan. Runoff production on early Mars. NASA Mars Data Analysis program. Smithsonian Institution subaward.

Gareth Morgan. 3-D subsurface imaging and analysis of glaciers and lava fields with SHARAD data. NASA Mars Data Analysis program.


Asmin Pathare. The thermophysical properties and rock breakdown rates of craters on the Moon. NASA Lunar Data Analysis program.

Alex Patthoff. Ongoing activity at Enceladus: A search through time. NASA Cassini Data Analysis program.

James Richardson. Interpreting the coupled collisional, dynamical, crater history of Bennu. NASA New Frontiers Data Analysis program. Southwest Research Institute subaward.

Emilie Royer. Composition of the icy satellites of Saturn from an ultraviolet perspective. NASA Discovery Data Analysis program.

Emilie Royer. Harmonic analysis of the martian nitric oxide nightglow. NASA Mars Data Analysis program.


Antonia Savcheva. The stability of magnetic flux ropes: Bridging observations with simulations. NASA Heliophysics Supporting Research program.

Antonia Savcheva. Studying the magnetic field structure and topology of circular ribbon flares. NASA Heliophysics Supporting Research program. New Jersey Institute of Technology.

Norbert Schörghofer. Impact triggered volatile loss on Ceres. NASA Discovery Data Analysis program.

Norbert Schörghofer. Mapping of surface and subsurface cold trap for ice and supervolatiles. NASA Lunar Data Analysis program.

Norbert Schörghofer. Subsurface migration of water vapor on airless bodies. NASA Solar System Workings program.


Stephen Schwartz. Predicting and understanding the long process of crater formation and ejecta production in the microgravity environment of Dimorphos and Didymos. NASA Double Asteroid Redirection Test Participating Scientist program.

Rachel Sheppard. Understanding Mg-sulfate distribution, hydration state, and crystallinity in Mt. Sharp. NASA Mars Science Laboratory Participating Scientist program.
Amanda Sickafoose. Unraveling the mysteries of small-body ring systems through numerical modeling. National Science Foundation Astronomy and Astrophysics program.


Rebecca Williams. Reconstructing the geologic history and assessing habitable environments with WATSON observations. NASA Mars Science Laboratory SHERLOC instrument. Jet Propulsion Laboratory subaward.


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