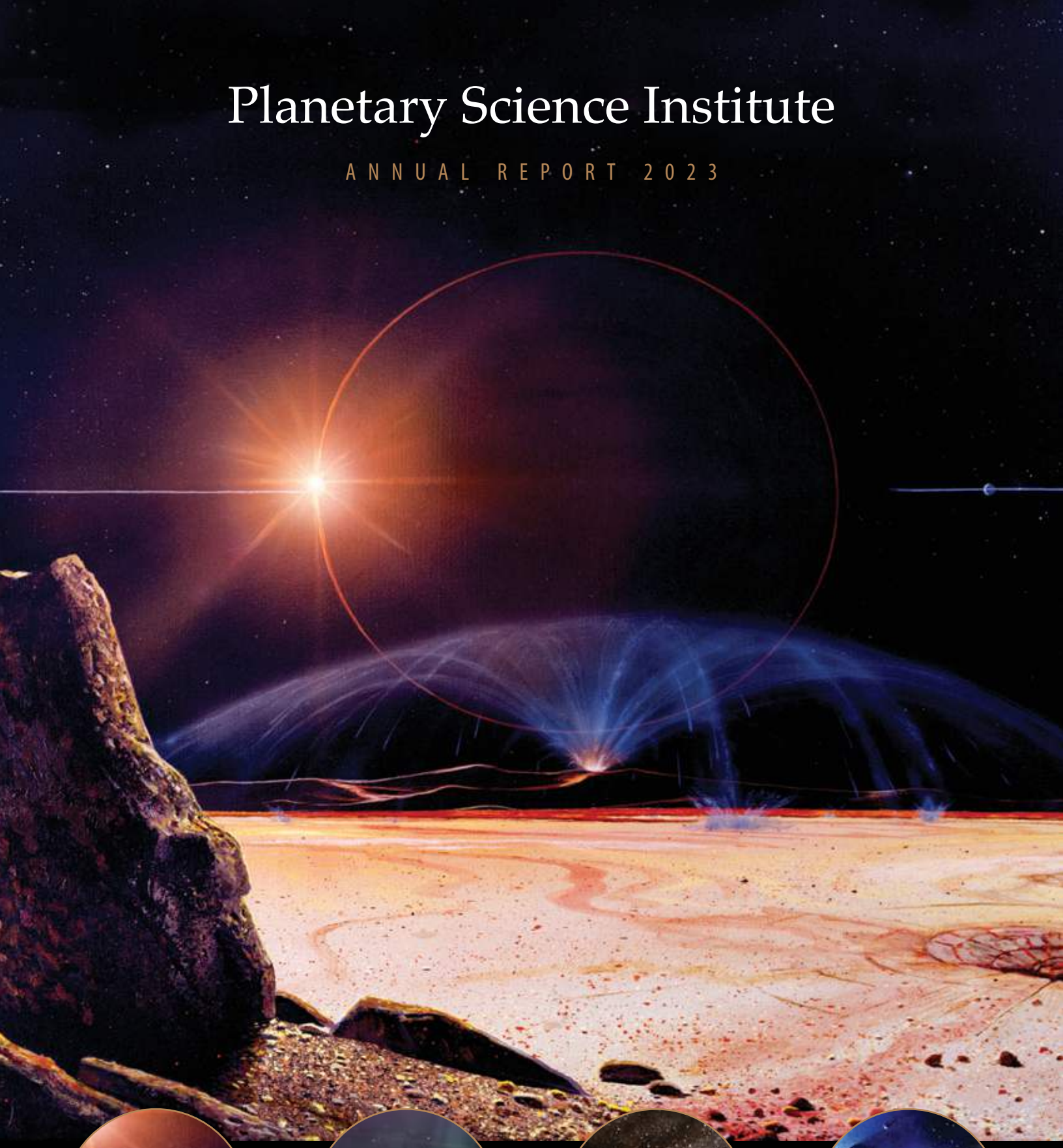
# Planetary Science Institute

ANNUAL REPORT 2023



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

# PLANETARY SCIENCE INSTITUTE

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 35 states and the District of Columbia, and work from various international locations.

## PSI BOARD OF TRUSTEES



*ON THE COVER:*
*"Landscape with an Erupting Volcano on Jupiter's Satellite, Io."*

*Painting Collaboration by PSI Cofounder and Senior Scientist Emeritus William K. Hartmann and Astronomical Artist Ron Miller*

*The Sun is just passing behind Jupiter. Jupiter's very thin ring is visible when seen nearly edge-on. Umbrella-shaped clouds of debris formed by eruptions from active volcanoes have been photographed from space probes near Io. This painting collaboration between Hartmann and Miller was created for one of their joint books about the Solar System.*

# MESSAGE FROM THE DIRECTOR

*This year started off with a bang when we reported the detection by Jeff Morgenthaler of a large volcanic explosion on Jupiter's moon Io, using PSI's IoIO telescope facility.*

The Solar System is always revealing inspiring processes to be understood, but this year we have been also focusing on an ongoing revolution in planetary science as a profession. Decades of increasingly granular discoveries made on other worlds and the explosion of thousands of planets discovered around other stars are breaking down the traditional NASA stovepipes of planetary science, earth science, heliophysics and astrophysics.

Earth is a planet, of course, and since 2022, we have been bringing on "traditional" earth scientists including physical oceanographers and geologists. These areas are of real value as we work to understand other "ocean worlds" in the Solar System and increasingly detailed geological processes beyond Earth. Many planets being discovered around other stars orbit very close to their stellar companion, making the heliophysics of these other stars important to understanding the planetary environment both nearby and at greater distances (how do flares potentially affect astrobiology?). It is good to have heliophysicists on board to inform our understanding of what might be going on in these other solar systems. Finally, given thousands of new solar systems with different architectures and types of planets, traditional topics of star formation are directly relevant to understanding the circumstances under which different solar systems might arise and to understand their potential differences in chemistry and makeup. So now we are welcoming astrophysicists as well! Can NASA keep up, though?

Exciting events of this year included a sample of the asteroid Bennu, captured by the OSIRIS-REx spacecraft and returned to Earth! PSI scientists participated in the characterization of Bennu and even the navigation of the spacecraft. Everyone is looking forward to analyzing the returned material from this “primitive” asteroid – except we already know that it will be at some level a mixture of both primitive and non-primitive material with a complex collisional history and inter-taxonomic contamination (OK, this is just me speaking!).

This year also marked the launch of NASA’s Psyche mission to – you guessed it – the asteroid Psyche. This is the putative metallic core of a differentiated asteroid (think Vesta) that subsequently had its rocky mantle removed through collisional processes. PSI scientists will be interpreting nuclear spectroscopy of the surface to tease out geochemistry from elemental signatures and provide insights into the nature and history of this object. It will be interesting to see what craters look like if the surface has a significant metallic composition!

## PSI IS ALWAYS RICH IN NEW AND EXCITING SCIENCE

- Jianqing Feng, Matt Siegler and Mackenzie White discovered evidence of a volcanic process on the Moon that had only been seen on Earth – an actual volcano.
- Norbert Schörghofer determined that the permanently shadowed regions in the south polar region of the Moon are much younger than previously thought, dramatically changing how much water ice could be there.
- Alexis Rodriguez, Bryan Travis, Dan Berman and Jeff Kargel found remnances of a mud lake charged by mud-volcanoes at a time when the surface of Mars was likely habitable, targetting this area as a good place to search for evidence of ancient life.
- Alexis Rodriguez, Deborah Domingue, Bryan Travis, Jeff Kargel, Oleg Abramov, John Weirich, Nick Castle and Frank Chuang uncovered evidence of potential salt glaciers on Mercury, raising questions about a volatile environment that was potentially habitable on the innermost planet.
- Amanda Hendrix, using Hubble and Cassini data, determined that fresh organics emplaced on the surface of Enceladus by active plumes would be preserved in pristine condition very near the surface, easily accessible by a landing spacecraft.
- Amanda Sickafoose, using occultation data, determined that the rings of the Centaur Chiron are actually a quickly evolving orbiting debris field, possibly due to erupting jets or a shell of surrounding debris.

**SCIENCE IS ADVANCED EVERY DAY AT PSI.**

***— Mark V. Sykes***

# PSI Scientists Honored With Prestigious Awards in 2023

## Rebecca M.E. Williams Named Geological Society of America Fellow

Senior Scientist Rebecca M.E. Williams was elected to be a Fellow of the Geological Society of America by the GSA Council for her work as a planetary geomorphologist who studies the signature of aqueous processes and environments as recorded in sedimentary deposits and landforms.

The citation said Williams received the award "…because of her keen ability to find interesting questions, her capacity for critical thinking, her knack for conducting field campaigns at sites on Earth that are directly applicable to Mars, and to develop coherent, robust hypotheses that stand the test of time. Becky's field studies integrate sedimentological, topographic, and climatic datasets to investigate sediment transport, deposition, and landscape evolution. Becky has a record of publications and sustained participation in GSA meetings, including a GSA field guide for exhumed fluvial landforms in east-central Utah which is widely used in college/university field trips."

## Catherine Johnson Garners Two Honors

Senior Scientist Catherine L. Johnson received two honors: she was elected to the National Academy of Sciences and elected to the Royal Society of Canada.

Johnson is a global leader in studies of terrestrial and planetary magnetism. Her work addresses fundamental questions related to how terrestrial planets and moons form and how their interiors function. Through key roles on science teams for NASA missions, she has pioneered studies of interactions among planetary magnetic fields, deep interior processes and the solar wind. Johnson is a Fellow of the American Geophysical Union and a member of the American Academy of Arts and Sciences.

## Candice Hansen Honored with GSA G.K. Gilbert Award

Senior Scientist Candice J. Hansen was named the 2023 G.K. Gilbert Award winner by the Geological Society of America's Planetary Geology Division.

The Gilbert award recognizes outstanding contributions to the solution of a fundamental problem(s) of planetary geology in its broadest sense, including planetary geology, geochemistry, mineralogy, petrology, and tectonics, geophysics, and the field of meteoritics. Such contributions may consist either of a single outstanding publication, or a series of publications that have had great influence on the field.

Hansen's research focuses on seasonal processes on Mars, plumes across the Solar System, and science and art from Juno's JunoCam visible imager.


***GEOLOGICAL SOCIETY OF AMERICA FELLOW***

*Geological Society of America President Christopher (Chuck) Bailey presents Rebecca M.E. Williams with her Fellow of the Geological Society certificate. Credit: GSA/Jennifer Stalcup*

*Catherine Johnson*

*Candice Hansen*

GSA's citation said Hansen was honored for "being an excellent mentor, scientist, and human. Community consensus has lauded Candy as a straight-talker who puts exceptional effort into encouragement and development of the next generation of scientists and is a terrific leader in public outreach. For all of her scientific achievements, leadership in exploration, advocacy, friendship and mentorship, Candy has been selected as this year's G.K. Gilbert awardee."

Earlier Gilbert award recipients from PSI are M. Darby Dyar, Carle Pieters, and William K. Hartmann.

***NASA SILVER GROUP ACHIEVEMENT AWARD TEAM***

*PSI's Planetary Data System Asteroid/Dust Subnode team, from left, Conor Kingston, Carol Neese, Mike Drum, Beatrice Mueller, Jesse Stone, Kristina Lopez and Eric Palmer. Not pictured: Kelly Yoder*

## NASA Silver Group Achievement Award

PSI's Planetary Data System Asteroid/Dust Subnode team members were honored with the NASA Silver Group Achievement Award.

The team is made up of Mike Drum, Conor Kingston, Kristina Lopez, Beatrice Mueller, Carol Neese, Eric Palmer, Jesse Stone and Kelly Yoder.

"The development of the PDS4 archiving standard has been a vast project. While difficult, this archiving standard ensures that we can operate for many decades to come with a design that can be used by Artificial Intelligence, automated processing and cloud-base systems," said PSI Senior Scientist Eric Palmer, who is the Principal Investigator for the PDS Asteroid/Dust Subnode. "We are honored to receive this award and we look forward to continuing to provide this valuable resource to this community."

NASA's citation said: "This achievement was awarded to the PDS for the creation and ongoing development of the PDS4 data model and standard. The PDS4 model has become the standard for all internationally sponsored planetary archives. This decades-long effort ensures that planetary scientists and many others will efficiently find, access, and use the high quality planetary observations that will reside in the PDS and the world's planetary archives for generations to come."

## Fritz Foss Receives Innovation Award in Geophysics

Senior Research Associate Fritz Foss won first prize for the Innovation Award in Geophysics at the Seventh International Conference on Engineering Geophysics at the United Arab Emirates University in Al Ain City, Abu Dhabi.

As part of the award competition, Foss gave a presentation to the Conference's Technical Committee that included a comprehensive question and answer session. He also spoke with the Committee about ongoing 3D projects, working with both MRO SHARAD and MEX MARSIS data. The award, which includes a $10,000 prize, recognizes significant contributions to applied near-surface geophysics, focusing on innovative contributions that substantially advance the application of geophysics to near-surface problems.

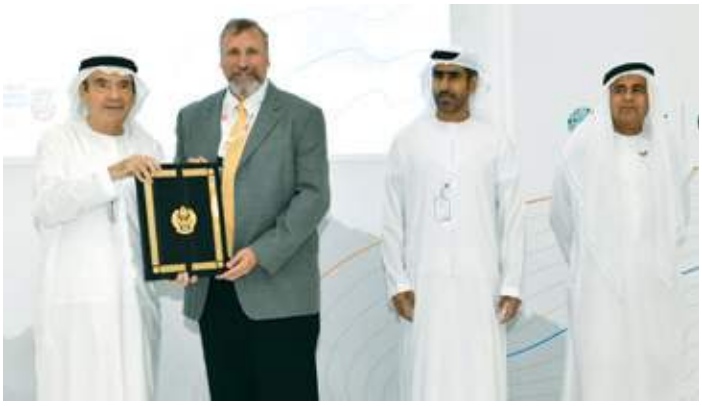
*Ashley Murphy*

*R. Aileen Yingst*

## Murphy, Yingst Receive NASA Team Awards

Ashley Murphy and R. Aileen Yingst received the Mars 2020 Science SHERLOC Operations Team award. The award is for "exceptional efforts on the SHERLOC investigation displaying operations and science expertise that advance Mars exploration and support future sample return.

The SHERLOC (Scanning Habitable Environments with Raman & Luminescence for Organics and Chemicals) instrument is located at the end of the robotic arm on NASA's Mars 2020 rover. SHERLOC is a spectrometer that provides provide fine-scale imaging and uses an ultraviolet laser to determine fine-scale mineralogy and detect organic compounds on Mars.



***INNOVATION AWARD IN GEOPHYSICS***

*From left: Zaki Anwar Nusseibeh, Chancellor of the UAE University, Fritz Foss, Ahmed AlKowaiti, CEO of Lands and Real Estate Sector, Municipality of Al Ain City, and Ghaleb AlBreiki, Acting Vice Chancellor of UAE University.*

Foss's research has focused on radar data analysis and processing, in particular applying/adapting terrestrial seismic methods for use with Mars' orbital sounding radar data to produce 3D orbital radar images of Mars' polar and mid-latitudes regions. The instruments providing the data are the Mars Reconnaissance Orbiter (MRO) Shallow Radar (SHARAD) and Mars Express (MEX) Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS).

# PSI Scientists Honored With Prestigious Awards in 2023

## Jamie Molaro Honored with NASA Planetary Science Early Career Award

Senior Scientist Jamie Molaro received the NASA Planetary Science Early Career Award. The Early Career Award (ECA) program is intended to help promising young scientists play an increased and meaningful role in the planetary science community and pursue professional development in areas relevant to the Planetary Science Division (PSD).

Molaro was cited for her study of the efficacy of thermally driven regolith creep on lunar, Martian, and asteroid surfaces. Molaro's research focuses on geomorphology, rock weathering, ice sintering, and landscape evolution on airless bodies. She has extensive experience in thermal and mechanical numerical modeling and is an expert on the properties of rocks, ice, and regolith. She is best known as the field's foremost expert on thermal fatigue, a mechanical weathering process that drives rock breakdown and regolith production.

## Fred Whipple Award 2023 Given to Thomas Prettyman

Senior Scientist Thomas Prettyman has been named the 2023 recipient of the Fred Whipple Award, the highest honor given by the Planetary Sciences section of the American Geophysical Union (AGU).

The Fred Whipple Award and Lecture are presented annually and recognize significant contributions to the field of planetary science from a mid-career or senior scientist. Established in 1989, this award, and accompanying lecture, are named in honor of Fred Whipple, an AGU Fellow and astronomer whose most notable work focused on comets. AGU's citation said Prettyman was honored for major contributions to our understanding of planetary surface composition using the tools of neutron and gamma-ray spectroscopy on spacecraft.

Prettyman's research focuses on chemical remote sensing of planetary bodies using nuclear spectroscopy. Gamma rays are made by the decay of natural radioelements found in rocks. Neutrons and gamma rays are made by cosmic ray interactions with the outermost surface layers. Particles escaping into space provide a fingerprint of surface elemental composition that can be detected from orbit. Elemental mapping data are used to study geologic and atmospheric processes. Prettyman has had the good fortune to work on several planetary missions, including Lunar Prospector, 2001 Mars Odyssey, and Dawn.

## Kathryn Volk's Dynamics Research Earns Vera Rubin Early Career Prize

Senior Scientist Kathryn "Kat" Volk was awarded the American Astronomical Society Division of Dynamical Astronomy's Vera Rubin Early Career Prize for her work on both the dynamics of small bodies beyond Neptune, and the long-term dynamics and stability of tightly packed exoplanetary systems.

Volk gave a presentation and received the award at the 54th annual Division of Dynamical Astronomy meeting in Lansing, Michigan. The Vera Rubin Early Career Prize is named after Vera Rubin and recognizes excellence in Dynamical Astronomy. Recipients must have received their doctorate no more than 10 years prior.

*Thomas Prettyman*
*Credit: Sandra C. Lapham*

*Kathryn "Kat" Volk*
*Credit: Emily Joseph*

The award citation said: "Her numerous contributions span both Solar System and exoplanetary science, powerfully bringing together theory, numerics and observation. Orbital migration of the giant planets early in the Solar System's history can explain various small-body populations in the outer Solar System. In particular, groups of trans-Neptunian objects (TNOs) captured into different mean motion resonances with Neptune are natural consequences of the latter migrating outward, and close encounters with Neptune are thought to be responsible for the dynamically excited scattered disk."

## Faith Vilas Receives Alumnae Achievement Award from Wellesley

Senior Scientist Faith Vilas, Class of 1973, received the Alumnae Achievement Award from Wellesley College.

The award citation said: "Vilas spent 20 years at NASA, where she worked on quantifying orbital debris from spacecraft as well as her planetary science research. While at the Johnson Space Center, she also traveled on an expedition to Antarctica to search for meteorites. She went on to direct the MMT Observatory in Arizona, a joint venture of the Smithsonian Institution and the University of Arizona, and she is now a Senior Scientist at the Planetary Science Institute and editor of the Planetary Science Journal.

"Vilas' pioneering work has been foundational to our understanding of Mercury, asteroids, and moons. Her observations from the ground helped prove the existence of Neptune's rings in 1984. She developed a technique to more easily locate the presence of water on airless bodies. Studying the presence of water has helped explain the history of the Solar System and the potential for development of life. Her instrument design and observational techniques have also helped us explore the full diversity of the Solar System."

# NEW DISCOVERIES IN 2023

## UNVEILING MERCURY'S GEOLOGICAL MYSTERIES

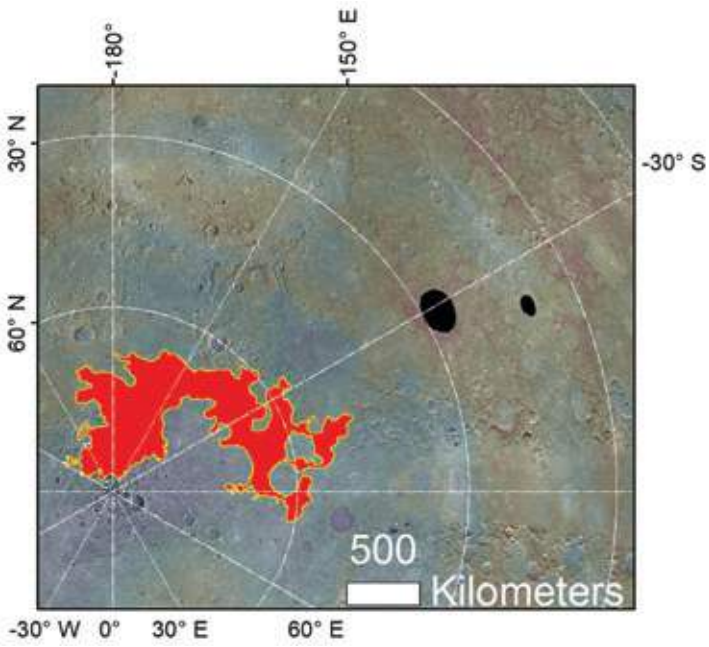
PSI scientists have uncovered evidence of potential salt glaciers on Mercury, opening a new frontier in astrobiology by revealing a volatile environment that might echo the conditions needed to habitability found in Earth's extreme locales.

"Our finding complements other recent research showing that Pluto has nitrogen glaciers, implying that the glaciation phenomenon extends from the hottest to the coldest confines within our Solar System. These locations are of pivotal importance because they identify volatile-rich exposures throughout the vastness of multiple planetary landscapes," said Alexis Rodriguez, lead author of the paper "Mercury's Hidden Past: Revealing a Volatile-Dominated Layer through Glacier-like Features and Chaotic Terrains" that appears in the Planetary Science Journal.

PSI scientists Deborah Domingue, Bryan Travis, Jeffrey S. Kargel, Oleg Abramov, John Weirich, Nicholas Castle and Frank Chuang are co-authors of the paper.

"These Mercurian glaciers, distinct from Earth's, originate from deeply buried Volatile Rich Layers (VRLs) exposed by asteroid impacts. Our models strongly affirm that salt flow likely produced these glaciers and that after their emplacement they retained volatiles for over 1 billion years," said co-author Travis.

"Specific salt compounds on Earth create habitable niches even in some of the harshest environments where they occur, such as the arid Atacama Desert in Chile. This line of thinking leads us to ponder the possibility of subsurface areas on Mercury that might be more hospitable than its harsh surface. These areas could potentially act as depth-dependent 'Goldilocks zones,' analogous to the region around a star where the existence of liquid water on a planet might enable life as we know it, but in this case, the focus is on the right depth below the planet's surface rather than the right distance from a star," Rodriguez said. "This groundbreaking discovery of Mercurian glaciers extends our comprehension of the environmental parameters that could sustain life, adding a vital dimension to our exploration of astrobiology also relevant to the potential habitability of Mercury-like exoplanets."




***MERCURY'S NORTH POLE, SITE OF POTENTIAL SALT GLACIERS***
*A view of Mercury's north polar chaotic terrain (Borealis Chaos) and the Raditladi and Eminescu craters where evidence of possible glaciers has been identified. Credit: NASA*

This work was partly supported by an unsolicited grant from to PSI by NASA (80NSSC20K1839).

## SEARCHING FOR CONCENTRATED BIOSIGNATURES IN AN ANCIENT MARTIAN MUD LAKE

A landmark discovery by a collaborative team led by the Planetary Science Institute's Alexis Rodriguez has unveiled evidence of sedimentary plains created by aquifer drainage within Martian collapse formations termed chaotic terrains.

"Our research focuses on a sedimentary unit within Hydraotes Chaos, which we interpret to be the remnants of a mud lake formed by discharges from gas-charged mudstone stratigraphy dating back to nearly 4 billion years ago, a time when the surface of Mars was likely habitable. These sediments might harbor evidence of life from that or subsequent periods. It is important to remember that the subsurface of Mars might have included habitability lasting the duration of life's history on Earth," said Rodriguez, lead author of the paper "Exploring the evidence of middle Amazonian aquifer sedimentary outburst residues in a Martian chaotic terrain" that appears in Nature Scientific Reports.

PSI scientists Bryan Travis, Jeffrey S. Kargel and Daniel C. Berman are co-authors on the paper. Scientists from NASA Ames Research Center, the University of Arizona, Autonomous University of Barcelona, Blue Marble Space Institute of Science, and the University of Florida are also co-authors on the project.

The extensive study of Martian aquifer drainage has revealed enormous flood channels that stretch thousands of kilometers into the planet's northern lowlands. The prodigious erosion caused by these channels, combined with the subsurface sediments released from

*(Continued on page 8)*

# NEW DISCOVERIES IN 2023

*(Continued from page 7)*

the aquifers, blankets extensive portions of the northern lowlands. This complex landscape presents a formidable challenge for the investigation of the nature of the Martian aquifers.

"Unlike vast flood channels with their complex erosion patterns, this finding simplifies the examination of Martian aquifers, reducing the risk of overland sedimentary acquisition, and opens a new window into Mars' geological past," Rodriguez said.

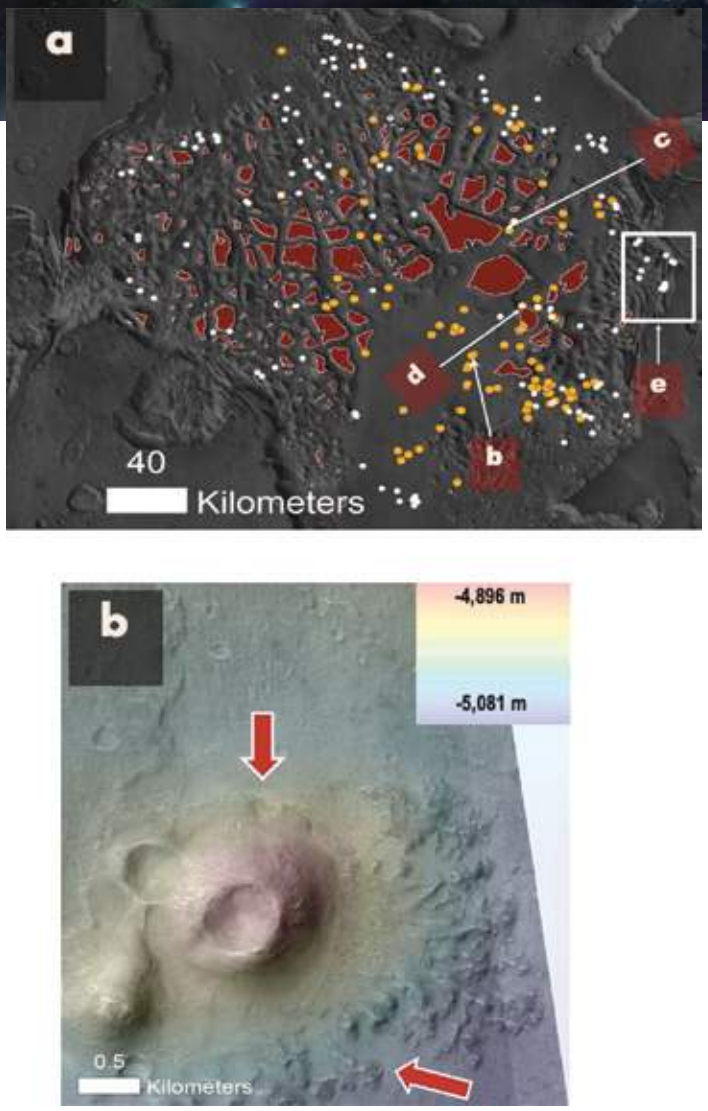
"Our numerical models reveal a fascinating story. The lake's source aquifer likely originated from phase segregation within the mudstone, forming vast water-filled chambers, several kilometers wide and hundreds of meters deep. This process was likely triggered by intrusive igneous activity. Moreover, the observed segmented subsidence across the chaotic terrain suggests an interconnected network of chambers, depicting stable water-filled giant caverns, some reaching kilometers in widths and lengths, way larger than any known Earth counterparts," co-author Travis said.

"Initially biomolecules could have been dispersed throughout the volume of large groundwater filled cavities. As the water was released to the surface and ponded, the water went away leaving behind lags of sediments and potentially high concentrations of biomolecules," Rodriguez said.

Therefore, the residue of this ancient mud lake could provide unprecedented access to aquifer materials enriched in biomolecules that have remained hidden within Mars' subsurface for most of its existence.

"Our crater counts indicate that the plains are relatively recent, returning an age of 1 billion years. This age is good news for our search for life. This age is way younger than the ages of most aquifer releases on Mars, dating back to approximately 3.4 billion years ago. So, the materials spent a huge amount of time in the subsurface," co-author Berman said.

Funding for the project was from a grant to PSI from Mars Data Analysis Program (80NSSC19K1490) and a 2020 NASA Ames Research Innovation Award.




***MUD VOLCANOES ON MARS***

*Figure(a) Map of Hydraotes Chaos showing how the interpreted mud volcanoes (orange dots)and diapirs (white dots) are widespread. Both feature types result from sedimentary volcanism – instead of magma upwells and eruptions, wet sediments, and salts reach and breach the surface, forming mounds and flows. Figure (b) shows a possible mud volcano. Notice that its surrounding lobate deposits are highly eroded and removed (red arrows), consistent with the flows that emplaced them as fine-grained, volatile-rich materials. Credit: NASA*

# LARGE VOLCANIC OUTBURST ON JUPITER'S MOON IO

A large volcanic outburst was discovered on Jupiter's moon Io by Senior Scientist Jeff Morgenthaler using PSI's Io Input/Output observatory (IoIO).

Morgenthaler has been using IoIO, located near Benson, Arizona, to monitor volcanic activity on Io, since 2017. The observations show some sort of outburst nearly every year, but the largest yet was seen in the fall of 2022.

Io is the innermost of Jupiter's four large moons and is the most volcanic body in the Solar System thanks to the tidal stresses it feels from Jupiter and two of its other large satellites, Europa and Ganymede.

"This could be telling us something about the composition of the volcanic activity that produced the outburst or it could be telling us that the torus is more efficient at ridding itself of material when more material is thrown into it," Morgenthaler said.

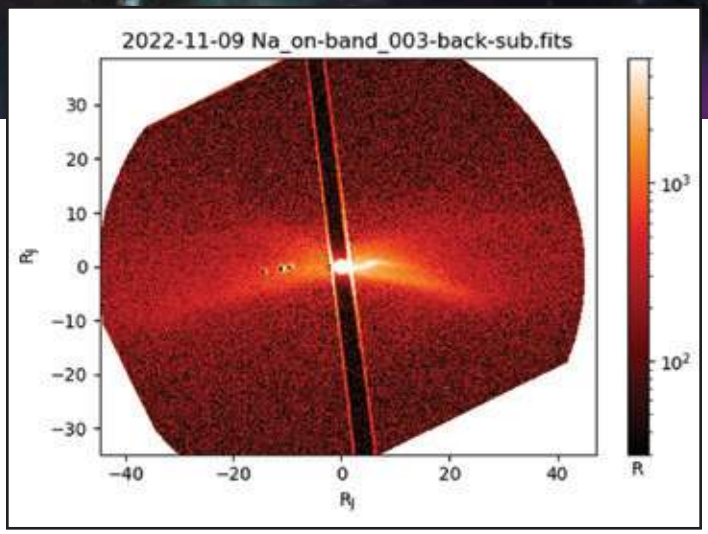
The observations have profound implications for NASA's Juno mission, which has been orbiting Jupiter since 2016. Juno flew past

Europa during the outburst and is gradually approaching Io for a close flyby in December 2023. Several of Juno's instruments are sensitive to changes in the plasma environment around Jupiter and Io that can be traced directly to the type of volcanic activity observed by IoIO. "Juno measurements may be able to tell us if this volcanic outburst had a different composition than previous ones," Morgenthaler said.

In addition to observing the Jovian sodium nebula, IoIO also observes Mercury's sodium tail, bright comets and transiting extra-solar planets.

Visit https://www.psi.edu/sites/default/files/ftp/Na_SII_best_0.mp4 to see a short video of IoIO images.

IoIO is supported by NSF and NASA funding.



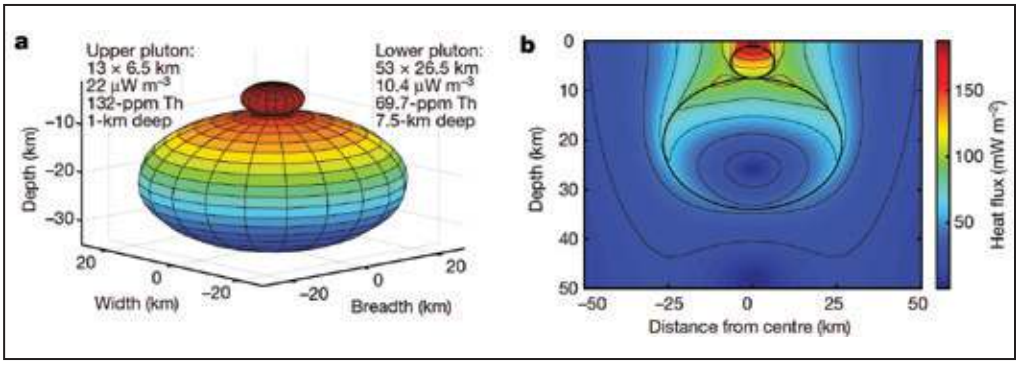

***VOLCANIC ACTIVITY ON IO***

*IoIO image of Jovian sodium nebula in outburst. Credit: Jeff Morgenthaler, PSI*

# EVIDENCE OF NEW VOLCANIC PROCESS ON MOON DISCOVERED

A new instrument type has discovered evidence of a volcanic process on the Moon that had only been seen on Earth.

"Before the 1950's, most scientists thought the craters on the Moon were from volcanoes, then, studies associated with the Apollo missions showed that they were nearly all from impacts," said Matthew Siegler, Senior Scientist at the Planetary Science Institute and author of "Remote Detection of a Lunar Granitic Batholith at Compton-Belkovich" that appears in Nature. PSI'S Jianqing Feng is a co-lead author, and PSI funded students Katelyn Lehman and Mackenzie White are co-authors.




***VOLCANIC PROCESS ON THE MOON***

*The favored Compton-Belkovich pluton model based on (a) fitting of the surface heat flux enhancement, (b) the resulting heat flux. Credit: Matthew Siegler, PSI*

"There was plentiful volcanism, with flood basalts, thin flowing lavas, covering about 16% of the Moon, but not much in the way of thicker, silicic lavas that could form something that we would call a volcano," Siegler said.

"Using an instrument looking at microwave wavelengths – longer than infrared – sent to the Moon on both the Chinese Chang'E 1 and 2 orbiters, we have been able to map temperatures below the surface. What we found was that one of these suspected volcanoes, known as Compton-Belkovich, was absolutely glowing at microwave wavelengths," Siegler said. "What this means is that it is hot, not necessarily at the surface, as you would see in infrared, but under the surface. The only way to explain this is from extra heat coming from somewhere below the feature within the deeper lunar crust. So Compton-Belkovich, thought to be a volcano, is also hiding a large heat source below it."

Surface evidence shows this volcano likely last erupted 3.5 billion years ago so the heat is not from molten lava or anything of that sort, but instead comes from the radioactive elements in the now solid rock. The only type of rock that really contains enough of those radioactive elements is granite. So the data collected with a fundamentally new type of microwave instrument shows that a large volcano on the Moon was once fed by a much larger granite magma chamber below it – the most Earth-like volcanism on the Moon.

A granitic batholith is a huge body larger than 20 kilometers of what was once subsurface lava that never erupted. Batholiths lie below volcanic chains, like the Andes or the Cascade mountain ranges, and are basically the plumbing system that feeds them. When these plumbing systems cool, they form granite. Granites, nearly absent in the Solar System outside of Earth, are a type of rock that is basically cooled-off lava that never made it to the surface.

Siegler's and Feng's work on the project was funded by a grant to PSI from NASA's Lunar Data Analysis program and Lunar Reconnaissance Orbiter mission.

# PIERAZZO INTERNATIONAL STUDENT AWARD WINNERS

PSI has announed that Kiersten Boley, Salvatore Buoninfante and Pa Chia Thao have been named winners of the 2024 Pierazzo International Student Travel Award. The Pierazzo International Student Travel Award was established by the Planetary Science Institute 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.

## Kiersten Boley

Kiersten Boley (Ohio State University) will receive the award as U.S.-based graduate students going to a planetary-related conference outside of the U.S. Boley will be attending Extreme Solar Systems V in Christchurch, New Zealand, March 16-21, 2024. Her research title is "The First Evidence of a Metallicity Cliff in the Formation of Super-Earths."

## Salvatore Buoninfante

Salvatore Buoninfante (Università degli Studi di Napoli "Federico II") will receive the award as a non-U.S.-based graduate student going to a planetary-related conference within the U.S. Buoninfante will be attending the 55th Lunar and Planetary Science Conference in The Woodlands, Texas, March 11-15, 2024. His research title is "Relationship between tectonic and crustal structures of Mercury."

***PIERAZZO STUDENT AWARD WINNERS (CLOCKWISE FROM TOP LEFT )***
*Kiersten Boley*
*Salvatore Buoninfante*
*Pa Chia Thao*

## Pa Chia Thao

Pa Chia Thao (University of North Carolina) will receive the award as U.S.-based graduate students going to a planetary-related conference outside of the U.S. Thao will be attending Exoplanets V in Leiden, The Netherlands, June 16-21, 2024. Her research title is "Probing the Atmosphere of the 17 Myr, Gas Giant, HIP 67522b with JWST."

# THANK YOU TO OUR 2023 BENEFACTORS

With deep appreciation the Planetary Science Institute acknowledges the following individual and organizational benefactors who made contributions between January 1, 2023 and December 31, 2023.

**$5,000 and up**
Dr. Mark V. Sykes and
Ms. Marilyn Guengerich

**$2,000-$5,000**
Ms. Anna Don

**$500-$1,999**
Mr. Richard Hendricks
Ms. Alison Nordt
Dr. Dorothy Oehler
Mr. Jeri Seyk

**$100-$499**
Dr. Thomas H. Prettyman
Col. Pamela Melroy, Retired
Dr. Christopher Chyba
Mr. and Mrs. John and
Kathleen O'Brien
Dr. Vicki Hansen
Mr. Charles Katzenmeyer

**$1-$99**
Dr. Andrew Wheeler

# PSI FINANCIAL REPORT

***Maurizio Balistreri, CPA*** Chief Financial Officer

PSI's revenues totaled $18M for the fiscal year ended September 30, 2023. During the fiscal year, PSI was actively involved in 128 prime awards issued directly from federal agencies and 154 subawards / contracts issued through other institutions. 92% of PSI's Grants and Contracts revenues were derived from awards with NASA.

## REVENUES

| | |
|---|---|
| Grants and Contracts | $ 17,741,199 |
| Contributions | 121,858 |
| Other | 93,597 |
| **Total Revenues** | **$ 17,956,654** |

## ACTIVE PROJECTS BY PRIME AWARDING AGENCY

| | |
|---|---|
| NASA | 116 |
| NSF/Other | 12 |
| Subawards/Contracts | 154 |
| **Total Projects** | **282** |

Salaries and related fringe benefits represented 74% of PSI's total expenses. Operating expenses included $2.1M from subawards issued to other institutions for collaborative efforts on PSI prime awards. Program Service expenses amounted to 89% of total expenses.

## EXPENSES

| | |
|---|---|
| Salaries and Benefits | $ 13,003,277 |
| Operating | 4,324,037 |
| Depreciation | 250,655 |
| Interest | 42,432 |
| **Total Expenses** | **$ 17,620,401** |

## EXPENSES BY FUNCTION

| | |
|---|---|
| Program Services | $ 15,748,076 |
| Management & General | 1,871,605 |
| Fundraising | 720 |
| **Total Expenses** | **$ 17,620,401** |

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, 2023 is reflected below.

| | |
|---|---|
| Current Assets | $ 4,817,482 |
| Property & Equipment, Net | 1,513,667 |
| **Total Assets** | **$ 6,331,149** |

| | |
|---|---|
| Current Liabilities | $ 2,819,000 |
| Long-term Liabilities | 226,591 |
| Net Assets with Donor Restrictions | 110,040 |
| Net Assets without Donor Restrictions | 3,175,518 |
| **Total Liabilities & Net Assets** | **$ 6,331,149** |

# PSI EDUCATION AND PUBLIC OUTREACH

***PSI scientists and education and communication specialists continue to support many science education and public engagement projects across the globe.***

Currently, our scientists, education specialists, and staff are based in 35 states, the District of Columbia, and several international locations. In 2023, PSI members hosted dozens of in-person and virtual events with many preparing for and celebrating the October 14, 2023, annular eclipse visible across the U.S. Those engaged in this work included: Bea Mueller, Kat Volk, Sanlyn Buxner, Larry Lebofsky, Kristina Lopez, Thomas Prettyman, Jianqing Feng, Grace Wolf-Chase, Deborah Domingue, David Vaniman, Candice Hansen, Nader Haghighipour, Henry Hsieh, Jules Goldspiel, Jamie Molaro, Amanda Sickafoose, JA Grier, Pamela Gay, Annie Wilson, and Amanda Hendrix.

## Workshops

The PSI EPO Tucson-based team, led by Lebofsky and Buxner, conducted five in person and two virtual workshops for formal and informal educators, including Girl Scout leaders, to prepare for the annular eclipse. Grier and Buxner also organized and implemented a seven-week virtual Disabled Science Writers Retreat which engaged disabled science writers and scientists from across the U.S. Researchers Molaro, Hendrix, Prettyman and Lebofsky all presented at this event. Additionally, Prettyman presented hands-on workshops at the Native American STEAM conference.

## Media Appearances

Our researchers both create content for media outlets and serve as subject matter experts. For instance, Hsieh wrote an article on active asteroids for Sky & Telescope magazine and Gay's team produces Escape Velocity Space News, which airs on NowMedia.tv stations. We've also seen the following researchers appear as subject matter experts: Prettyman on AZPM and in Forbes regarding the Psyche launch; Feng appeared on Live Science and Al Majalla and was interviewed by BBC to discuss internal lunar structures; and Sickafoose appeared on Cape Talk Radio and was interviewed for Sky & Telescope and Astronomy Magazines regarding her research.

## Presentations

Our researchers gave presentations at local, national, and international events. Highlights from 2023 include: Prettyman presented to the Southwest Florida Astronomical Society and Gay presented to the St. Louis and Ottawa astronomical societies;

***TUCSON FESTIVAL OF BOOKS** (TOP)*
*PSI's Bea Mueller chats with a Tucson Festival of Books attendee about meteorites and impact rocks. Credit: Sanlyn Buxner*

***SAFE SOLAR VIEWER***
*Kat Volk (center with white hat) is shown demonstrating a safe solar viewer to a group at the Grand Canyon South Rim Visitor center.*

## Public Events

PSI researchers support numerous public outreach events around the nation through booths, lectures and workshops. This year's events included:

- A PSI booth (staffed by Muller, Prettyman, Lebofsky and Buxner) featuring hands-on activities at the two-day Tucson Festival of Books, with 1,300 people visiting PSI's display;
- A PSI booth at the 11th Annual Family SciFest event held at the Children's Museum Tucson, staffed by Buxner and Lopez, offering kids of all ages a chance to learn about meteorites, have their image taken with an infrared camera, build strings of UV beads, and color planetary science related images;
- Lebofsky supported the SARSEF Community STEM Expo with Meteor kit demonstrations;

*FAMILY SCIFEST*

*A steady stream of attendees visited PSI's exhibit at Family SCIFest at the Children's Museum Tucson. Credit: Sanlyn Buxner*

- Volk assisted in public solar observing and gave a public lecture at the Grand Canyon's South Rim visitor center as part of the Astronomer in Residence Program;
- Gay and Wilson supported a booth with demos at First Friday events at the St Louis Science Center; and
- Gay appeared at the Arisia Science Fiction and Fantasy conference as a speaker.

## Major Project and Mission-related Outreach

Many major research programs and missions rely on PSI researchers to support their educational and public engagement activities. For example, Hansen continued her work with the Planet Four citizen science project regarding Mars, which returned to operations and published its second paper. Hansen also continued her work with the JunoCam, a public camera on the Juno mission that engages the public in image analysis. Fellow researcher Hsieh also supported the Active Asteroids citizen science project. Buxner supported International Observe the Moon Night on October 21, 2023, a key public engagement program of the Lunar Reconnaissance Orbiter.

## Other Online Outreach

Gay and her team produced the Astronomy Cast and 365 Days of Astronomy podcasts and supported the CosmoQuest project through their website and related tools, including livestreams on Twitch, and events in their community Discord server. Additional activities included Haghighipour presenting an episode of Ideas in Science on YouTube.

## Mentoring

Researchers stepped in as student mentors in many different situations. For instance, Domingue mentored a student on a research project as part of NASA's Neurodiversity Network SciAct program.

## Outreach and Classroom Events

Multiple PSI scientists served as judges for various science fairs including Lebofsky and Mueller in Arizona, Prettyman in New Mexico, and Goldspiel in Virginia.

Other outreach events included direct presentations by Sickafoose presented on comparative geology at Summerdale High School in South Africa, and she also gave a talk to a summer science program at Purdue University; Wolfe-Chase gave an online talk as part of the Epic of Creation course at Lutheran School of Theology at Chicago that was also made public on YouTube; Vaniman gave a series of presentations to Independent Elementary School in California; and Buxner participated in numerous events preparing for the annular eclipse and facilitated safe viewing for visitors at Chaco Culture National Historical Park in Nageezi, New Mexico, on October 14 and 15, 2023.

# PSI CONTINUES TO EXPAND IN 2023

As it has been for more than 50 years, PSI's strength and advantage continues to be in its people. Our culture of openness and high level of mutual support distinguishes us as an organization. In 2023 PSI continued to grow, adding 17 new research and administrative staff members.

**Eddie Baron**
*Senior Scientist*

**Ben Boatwright**
*Associate Research Scientist*

**Liz Carey**
*Senior Research Associate*

**Rita Economos**
*Senior Research Associate*

**Tyler Linder**
*Research Scientist*

**Max Marconi**
*Senior Research Associate*

**Marc Mensing**
*Systems Administrator*

**Dennis Metzger**
*Lead Software Developer*

**Jed Mosenfelder**
*Senior Scientist*

**Randall Perry**
*Senior Scientist*

**Brian Ramirez**
*IT Support Specialist*

**Micki Recchuiti**
*Research Associate*

**Bo Reipurth**
*Senior Scientist*

**Lior Rubanenko**
*Associate Research Scientist*

**Alex Shelton**
*Junior Web Developer*

**Marshall Tabetah**
*Associate Research Scientist*

**Marissa Vogt**
*Senior Scientist*

*As it has been for more than 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.*

# ASTEROIDS NAMED AFTER PSI SCIENTISTS

The International Astronomical Union in 2023 announced the designation of four asteroids in honor of people who have made significant contributions to PSI and our community: Elisabeth Jensen, Elisabeth Adams, Delmar Barker and Eva Lilly.

## 12997 Lizjensen

*Discovered 1981—Mar-02 by Bus, S. J. at Siding Spring*

Elizabeth A. Jensen (b. 1975) is an American space scientist who developed a method of studying solar corona structure using the Faraday effect. She measures the solar magnetic field and studies the dynamics of coronal mass ejections and magnetohydrodynamic waves by analyzing radio signals from interplanetary spacecraft.

## 28769 Elisabethadams

*Discovered 2000—Apr-24 by LONEOS at Anderson Mesa*

Elisabeth R. Adams (b. 1981) is an American Senior Scientist at the Planetary Science Institute (based in Somerville, MA). Her work includes studying a range of planetary dynamics, from the Kuiper Belt to exoplanets, as well as writing science fiction.

## 249823 Delmarbarker

*Discovered 2001—Mar-21 by SKADS at Kitt Peak*

Delmar Barker (1941–2023) was an American physicist whose work spanned the spectrum from γ rays to radio frequencies. His 42 patents covered fields ranging from geology to antimatter. His final project was developing a nuclear-powered rocket engine, an endeavor cut short prematurely. His smile and engaging manner were an integral part of his legacy.

## 346999 Evalilly

*Discovered 2010—Feb-15 by Pan-STARRS 1 at Haleakala*

Eva Lilly (b. 1982) is a Slovak-American astronomer. She earned her PhD in astronomy at Comenius University in Bratislava. After working at the University of Hawai'i for the PanSTARRS survey she became a Senior Research Scientist at the Planetary Science Institute. Her research includes planetary defense, comets and trans-Neptunian objects.

# NEW PSI RESEARCH GRANTS

**Eddie Baron.** Dust our luck? Measuring molecule and dust formation in M101's hydrogen-rich SN 2023ixf. NASA James Webb Space Telescope Guest Observer Program-Cycle 1.

**Eddie Baron.** MIR spectroscopy of type 1a supernovae: The key to unlocking their explosions and element production. NASA James Webb Space Telescope Guest Observer Program-Cycle 1.

**Eddie Baron.** Near- and mid-IR observations to probe dust formation in the remarkably nearby stripped-envelope supernova 2023dbc. NASA James Webb Space Telescope Guest Observer Program-Cycle 1.

**Peter Buhler.** Historical extent of Mars' south polar massive CO2 ice deposit. NASA Mars Data Analysis program.

**Sanlyn Buxner.** Virtual trips to extreme environments. NASA Teams Engaging Affiliated Museums and Informal Institutions (TEAM II) program, Universities Space Research Association subcontract.

**Sanlyn Buxner.** Western regional Noyce network. National Science Foundation, University of Oregon subaward.

**Matthew Chojnacki.** Archiving and distribution of high-quality context camera (CTX) digital terrain models for the Mars research community. NASA Planetary Data Archiving, Restoration, and Tools program.

**Matthew Chojnacki.** Seasonal slumps in the equatorial regions. NASA Mars Data Analysis program, Rutgers, The State University of New Jersey subaward. Roger Clark. Earth surface mineral dust source investigation. NASA EMIT program, Jet Propulsion Laboratory subcontract.

**Darby Dyar.** Collaborative research: Building and applying a universal plagioclase oxybarometer using X-ray absorption spectroscopy. National Science Foundation Petrology and Geochemistry program.

**Darby Dyar.** Experimental constraints on surface weathering on Venus. NASA Solar System Workings program, University of Tennessee subaward.

**Darby Dyar.** Spectroscopies for assessing redox conditions (SPARC). NASA Apollo Next Generation Sample Analysis program.

**Darby Dyar.** Venus experimental capabilities and calibrations. NASA Topical Workshops, Symposia, and Conferences.

**Darby Dyar.** VERITAS, VesCOOR, and related activities. NASA Discovery program, Jet Propulsion Laboratory subcontract.

**Rebecca Ghent.** A fresh examination of the Moon's young craters: Insights from new datasets and analysis tools. NASA Lunar Data Analysis program.

**Rebecca Ghent.** CoRaLS: Cosmic ray lunar sounder. NASA Directorate Development and Advancement of Lunar Instrumentation program, University of Hawaii subaward.

**Stuart Gilchrist.** Collaborative research: SHINE–Using photospheric imprints of coronal currents to understand coronal magnetic structure. National Science Foundation Solar, Heliospheric, and Interplanetary Environment program.

**Nader Haghighipour.** Detection and characterization of circumbinary planets around TESS eclipsing binaries. NASA Exoplanet Research program.

**Amanda Hendrix.** Characterizing primitive asteroids. NASA Hubble Space Telescope Observer Program-Cycle 30.

**Amanda Hendrix.** Europa-UVS: An ultraviolet spectrograph for the Europa mission. NASA Europa Clipper program, Southwest Research Institute subaward.

**Amanda Hendrix.** Nightingale support. NASA Nightingale program, Jet Propulsion Laboratory subcontract.

**Amanda Hendrix.** Support for planetary science program analysis/assessment groups. NASA Topical Workshops, Symposia, and Conferences program, Universities Space Research Association subaward.

**Amanda Hendrix.** UMIS: The Ultraviolet Micromirror Imaging Spectrograph NASA Maturation of Instruments for Solar System Exploration program.

**Carly Howett.** Development of a metamaterial spectral filters for high spectral resolution spectroscopy. NASA Planetary Instrument Concepts for the Advancement of Solar System Observations program, Ball Aerospace & Technologies Corp. subaward.

**Carly Howett.** Enceladus: Is there activity we're missing? NASA Cassini Data Analysis program, Southwest Research Institute subaward.

**Carly Howett.** Investigating energetic electron weathering at Saturn's inner mid-sized moons. NASA Cassini Data Analysis program, Southwest Research Institute subaward.

**Carly Howett.** Science team support and MVIC instrument scientist Lucy phase E. NASA Discovery program, Southwest Research Institute subaward.

**Carly Howett.** Science team & Ralph instrument operations support New Horizons extended mission 2 (KEM2). NASA New Horizons program, Southwest Research Institute subcontract.

**Henry Hsieh.** Characterization of water outgassing in main-belt comets 133P/Elst-Pizarro and 358P/PANSTARRS. NASA James Webb Space Telescope Observer Program-Cycle 2.

**Catherine Johnson.** Geophysical evolution of the Martian crust from magnetic source depth analyses of MAVEN data. NASA Innovative Advanced Concepts program, University of Alabama subaward.

**Catherine Johnson.** Lunar magnetotelluric sounder (LMS). NASA Lunar Surface Instrument and Technology Payload program, Southwest Research Institute subaward.

**Catherine Johnson.** The lunar interior temperature and materials suite (LITMS). NASA Portable Remote Imaging SpectroMeter program, Southwest Research Institute subaward.

**Nathan Kaib.** CAREER: Next generation models of planet formation and evolution. National Science Foundation Faculty Early Career Development program.

**Nathan Kaib.** Deciphering and interpreting the survival of the pristine Uranian moons. NASA Emerging Worlds program, Johns Hopkins University Applied Physics Laboratory subaward.

**Nathan Kaib.** Dynamical harassment of the Kuiper Belt during planet migration and instability. NASA Emerging Worlds program.

**Georgiana Kramer.** Integrated measurements and analysis of geophysics of Schrödinger (IMAGES). NASA Lunar Data Analysis program, University of Texas at Austin subaward.

**Lucille Le Corre.** XGEO space domain awareness from ground based optical telescopes. NASA Spaceflight Technology, Applications and Research program, University of Arizona subaward.

**Jian-Yang Li.** Long-term evolution of Dimorphos's dust tail created by the DART impact. NASA Hubble Space Telescope program, Space Telescope Science Institute Guest Observer Program-Cycle 30.

**Eva Lilly.** Investigating centaur surface colors: Connecting surface transformation to thermal and dynamical history. NASA Science Support Office program.

**Jonathan Lilly.** Evolution and fate of wind-derived internal wave energy. National Science Foundation Physical Oceanography program.

**Jim Lyons.** The isotopic compositions of light elements in the solar wind: Implications for solar composition. NASA Laboratory Analysis of Returned Samples program, University of California, Los Angeles subaward.

**Jamie Molaro.** Efficacy of thermally induced regolith creep on lunar, Martian, and asteroid surfaces. NASA Planetary Science Early Career Award program.

**Gareth Morgan.** Constraining Martian non-polar ice deposition and preservation within impact structures. NASA Mars Data Analysis program.

**Gareth Morgan.** Exploring the volcanic history of the Crisium basin through geologic mapping. NASA Lunar Data Analysis program.

**Jeff Morgenthaler.** Parker solar probe GSFC magnetometer team consultant. Goddard Space Flight Center program, ADNET Systems subcontract.

**Thomas Prettyman.** Lunar-VISE: An investigation of the Moon's non-mare silicic volcanism. NASA Portable Remote Imaging SpectroMeter program, University of Central Florida subaward.

**Nathaniel Putzig.** High-resolution 3D radar mapping, analysis, and modeling of the internal layers within the north polar layered deposits. NASA Mars Data Analysis program.

**Matthew Richardson** and **Amanda Sickafoose.** Understanding asteroids by the distribution of their hydrated minerals. NASA Solar System Observation program, Johns Hopkins Applied Physics Laboratory subaward.

**Alexis Rodriguez.** The chaotic terrains of Mercury: Unveiling the history of planetary volatile retention and loss in the innermost Solar System. NASA Discovery Data Analysis program.

**Kirby Runyon.** Low-gravity assessment of crater ejecta. NASA Solar Systems Workings program, Johns Hopkins University Applied Physics Laboratory subaward.

**Kirby Runyon.** Lunar impact melt deposit stratigraphy. NASA Lunar Data Analysis program, Johns Hopkins University Applied Physics Laboratory subaward.

**Juan Sanchez.** Spectral characterization of artificial objects. Air Force Research Lab Space4, University of Arizona subaward.

**Stephen Schwartz.** Investigating irregular vertical structures at the edges of Saturn's A and B rings. NASA Cassini Data Analysis program, SETI Institute subaward.

**Matthew Siegler.** CSA LEAP lunar rover phase B, C, and D. NASA Lunar Exploration Accelerator Program and Lunar Rover Mission, Canadensys Aerospace Corporation subaward.

**Matthew Siegler.** Lunar-VISE: An investigation of the Moon's non-mare silicic volcanism. NASA Portable Remote Imaging SpectroMeter program, University of Central Florida subaward.

**Robert Skarbek.** Collaborative research: Subduction megathrust rheology: The combined roles on- and off-fault processes in controlling fault slip behavior. National Science Foundation Geophysics program.

**Robert Skarbek.** Landslide kinematics in response to ongoing climate shifts. NASA Earth Surface and Interior program, Jet Propulsion Laboratory subcontract.

**Robert Skarbek.** Understanding firn rheology through laboratory compaction experiments and radar data. National Science Foundation Antarctic Research program, Columbia University subaward .

**Sarah Sonnett.** Exploring key Solar System evolutionary processes by debiasing the main asteroid belt. NASA Solar Systems Workings program.

**Bryan Travis.** Source emission accounting & localization system (SEALS): Developing, demonstrating, and flux inversion algorithm for continuously monitored oil and gas infrastructure environments. NASA Compact Atmospheric Multispecies Spectrometer program, University Corporation for Atmospheric Research subcontract.

**David Vaniman.** Extended mission 4 support for the CheMin mineralogical Instrument onboard Mars Science Laboratory: Experiment planning, data analysis and mission operation. NASA Mars Science Laboratory program.

**Kathryn Volk.** The classical and large-a distant Solar System survey: The importance of outer resonances. NASA Solar System Observations program, Smithsonian Astrophysical Observatory subaward.

**Kathryn Volk.** Tools for advanced dynamical characterization of Solar System small bodies. NASA Planetary Data Archiving, Restoration, and Tools program.

**Catherine Weitz.** A geologic map of Aram Chaos: A community resource to facilitate future scientific investigations on Mars. NASA Planetary Data Archiving and Restoration program.

**Catherine Weitz.** Analog support to maximize science during the human exploration of the Moon. NASA Desert Research and Technology Studies program.

**Catherine Weitz.** Analyses of sulfates in chaos regions on Mars. NASA Mars Data Analysis program.

**Grace Wolf-Chase.** Leveraging a Zooniverse discovery to bridge our understanding of low- and high-mass star formation. National Science Foundation Astronomy and Astrophysics Research Grants program, College of Idaho subaward.

**Bin Yang.** Probing water ice in distant comets: Crystalline or amorphous? NASA James Webb Space Telescope program, Space Telescope Science Institute subaward.

# P S I P U B L I C A T I O N S


Acharya, P., **I.B. Smith**, W. Calvin (2023). Tracking the northern seasonal cap retreat of Mars using computer vision. Icarus 390, id. 115295. https://doi.org/10.1016/ j.icarus.2022.115295.

Adam, C.D., L.K. McCarthy, J.M. Leonard, **R. Gaskell**, P.G. Antreasian, A.J. Liounis, K. Getzandanner, M.C. Moreau, **E.E. Palmer**, **J. Weirich**, O.S. Barnouin, J.L. Geeraert, E.M. Sahr, B. Ashman, D.S. Nelson, J.Y. Pelgrift, E.J. Lessac-Chenen, D. Wibben, B.G. Williams, M.G. Daly, D.S. Lauretta (2023). Stereophotoclinometry for OSIRIS-REx spacecraft navigation. Planet. Sci. J. 4, 167. https://doi.org/10.3847/PSJ/ace31d.

Alemanno, G., J. Helbert, **M.D. Dyar**, T. Hagelschuer, P. Gisbert, M. Pertenais, D. Grießbach, T. Säuberlich, S. Adeli, O. Barraud, A. Van Den Neucker, C. Ytsma, S. Smrekar (2023). Laboratory VNIR emissivity spectra of Venus analogue rocks for the VEM on VERITAS and the VenSpec-M on EnVision verification plan. Proc. SPIE 12686, id. 1268605. https://doi.org/10.1117/12.2678683.

Amano, K., M. Matsuoka, T. Nakamura, E. Kagawa, Y. Fujioka, S.M. Potin, T. Hiroi, E. Tatsumi, R.E. Milliken, E. Quirico, P. Beck, R. Brunetto, M. Uesugi, Y. Takahashi, T. Kawai, S. Yamashita, Y. Enokido, T. Wada, Y. Furukawa, M.E. Zolensky, D. Takir, **D.L. Domingue**, C. Jaramillo-Correa, **F. Vilas**, **A.R. Hendrix**, M. Kifuiri, T. Morita, H. Yurimoto, T. Noguchi, R. Okazaki, H. Yabuta, H. Naraoka, K. Sakamoto, S. Tachibana, T. Yada, M. Nishimura, A. Nakato, A. Miyazai, K. Yogata, M. Abe, T. Okada, T. Usui, M. Yoshikawa, T. Saiki, S. Tanaka, F. Terui, S. Nakazawa, S. Watanabe, Y. Tsuda (2023). Reassigning CI chondrite parent bodies based on reflectance spectroscopy of samples from carbonaceous asteroid Ryugu and meteorites. Sci. Adv. 9, id. adi3789. https://doi.org/10.1126/sciadv.adi3789.

Anderson, R.B., **R.M.E. Williams**, A.G. Gulick, W. Nelson (2023). Inverted relief and morphology of intracrater alluvial fans north of Hellas Basin. Icarus 394, id. 115122. https://doi.org/10.1016/j.icarus.2022.115122.

Battalio, J.M., N. Heavens, A. Pankine, C. Wright, **A. Cowart** (2023). Martian gravity waves observed by the Thermal Emission Imaging System (THEMIS) during northern summer. J. Geophys. Res.: Planets 128, id. e2022JE007653. https://doi.org/10.1029/2022JE007653.

Becker, H.N., J.I. Lunine, P.M. Schenk, M.M. Florence, M.J. Brennan, **C.J. Hansen**, Y.M. Martos, S.J. Bolton, J.W. Alexander (2023). A complex region of Europa's surface with hints of recent activity revealed by Juno's stellar reference unit. J. Geophys. Res.: Planets 128, id. e2023JE008105. https://doi.org/10.1029/2023JE008105.

**Berman, D.C.**, **J.A.P. Rodriguez**, **C.M. Weitz**, **D.A. Crown** (2023). Geologic map of the source region of Shalbatana Vallis, Mars. U.S.G.S. Series Investig. Map 3492. https://doi.org/10.3133/sim3492

Bierhaus, E.B., F. Rossmann, **C.L. Johnson**, R.T. Daly, D. Golish, J. Nolau, A. Allen, H. Campins, M. Pajola, B. Rizk, C. D'Aubigny, D. DellaGiustina, E. Cloutis, D. Trang, D.S. Lauretta (2023). A subsurface layer on asteroid (101955) Bennu and implications for rubble pile asteroid evolution. Icarus 406, id. 115736. https:/doi.org/10.1016/j.icarus.2023.115736.

Bland, M.T., C.B. Beddingfield, T.A. Nordheim, **D.A. Patthoff**, S.D. Vance (2023). Constraints on the composition and thermal structure of Ariel's icy crust as inferred from its largest observed impact crater. Icarus 395, id. 115452. https://doi.org/10.1016/j.icarus.2023.115452.

Bodewits, D., Z. Xing, M. Saki, **J.P. Morgenthaler** (2023). Neil Gehrels — Swift Observatory's ultraviolet/optical telescope observations of small bodies in the Solar System. Universe 9, id. 78. https://doi.org/10.3390/universe9020078.

Bostroem, K.A., L. Dessart, D.J. Hillier, M. Lundquist, J.E. Andrews, D.J. Sand, Y. Dong, S. Valenti, J. Haislip, E.T. Hoang, G. Hosseinzadeh, D. Janzen, J.E. Jencson, S.W. Jha, V. Kouprianov, J. Pearson, N.E. Meza Retamal, D. Reichart, M. Shrestha, C. Ashall, **E. Baron**, P.J. Brown, J.M. DerKacy, J. Farah, L. Galbany, J.I. González Hernández, E. Green, P. Hoeflich, D.A. Howell, L.A. Kwok, C. McCully, T.E. Müller-Bravo, M. Newsome, E.P. Gonzalez, C. Pellegrino, J. Rho, M. Rowe, M. Schwab, M. Shahbandeh, N. Smith, J. Strader, G. Terreran, S.D. Van Dyk, S. Wyatt (2023). SN 2022acko: The first early far-ultraviolet spectra of a Type IIP supernova. Astrophys. J. 953, id. L18. https://doi.org/10.3847/2041-8213/ace31c.

Bowen, B., V. Reddy, M. De Florio, T. Kareta, **N. Pearson**, R. Furfaro, B. Sharkey, A. McGraw, D. Cantillo, **J.A. Sanchez**, A. Battle (2023). Grain size effects on visible and near-infrared (0.35–2.5 μm) laboratory spectra of ordinary chondrite and HED meteorites. Planet. Sci. J. 4, 3. https://doi.org/10.3847/PSJ/acb268.

Braga-Ribas, F., C.L. Pereira, B. Sicardy, J.L. Ortiz, J. Desmars, **A. Sickafoose**, M. Emilio, B. Morgado, G. Ma rgoti, F.L. Rommel, J.I.B. Camargo, M. Assafin, R. Vieira-Martins, A.R. Gomes-Júnior, P. Santos-Sanz, N. Morales, M. Kretlow, J. Lecacheux, F. Colas, R. Boninsegna, O. Schreurs, J.L. Dauvergne, E. Fernandez, P.V. Heerden, H. González, D. Bihel, F. Jankowsky (2023). Constraints on (2060) Chiron's size, shape and surrounding material from November 2018 and September 2019 stellar occultations. Astron. Astrophys. 676, id. A72. https://doi.org/10.1051/0004-6361/202346749.

Broz, P., **D. Oehler**, A. Mazzini, E. Hauber, G. Komatsu, G. Etiope, V. Curin

(2023). An overview of sedimentary volcanism on Mars. Earth Surf. Dynam. 11, 633-661. https://doi.org/10.5194/esurf-11-633-2023.

Bu, C., L.S. Morrissey, B.C. Bostick, M.H. Burger, K.P. Bowen, S.N. Chillrud, **D.L. Domingue**, C.A. Dukes, D.S. Ebel, G.E. Harlow, P.-M. Hillenbrand, D.A. Ivanov, R.M. Killen, J.M. Ross, D. Schury, O.J. Tucker, X. Urbain, R. Zhang, D.W. Savin (2023). Absolute doubly differential angular sputtering yields for 20 keV Kr+ on polycrystalline Cu. J. Appl. Phys. 135, id. 035302. https://doi.org/10.1063/5.0184417.

**Buhler, P.B.** (2023). A 510,000-year record of Mars' climate. Geophys. Res. Lett. 50, id. e2022GL101752. https://doi.org/10.1029/2022GL101752.

**Burbine, T.H.**, P.C. Buchanan, M.J. Jercinovic, R.C. Greenwood (2023). Determining the pyroxene mineralogies of vestoids. Planet. Sci. J. 4, 96. https://doi.org/10.3847/PSJ/accb98.

**Buxner, S.**, N. Gross, M. Opher, J. Wong, J. Richardson. (2023). SHIELD DRIVE Science Center: Efforts in diversification and inclusion in heliophysics. Front. Astron. Space Sci. 10, id. 1155843. https://doi.org/10.3389/fspas.2023.1155843.

Cantillo, D., V. Reddy, A. Battle, B. Sharkey, **N. Pearson**, T. Campbell, A. Satpathy, M. De Florio, R. Furfaro, **J. Sanchez** (2023). Grain size effects on UV-MIR (0.2-14 μm) spectra of carbonaceous chondrite groups. Planet. Sci. J. 4, 177. https://doi.org/10.3847/PSJ/acf298.

Cheng, A.F., H.F. Agrusa, B.W. Barbee, A.J. Meyer, T.J. Farnham, S.D. Raducan, D.C. Richardson, E. Dotto, A. Zinzi, V. Della Corte, T.S. Statler, S. Chesley, S.P. Naidu, M. Hirabayashi, **J.-Y. Li**, S. Eggl, O.S. Barnouin, N.L. Chabot, S. Chocron, G.S. Collins, R.T. Daly, T.M. Davison, M.E. DeCoster, C.M. Ernst, F. Ferrari, D.M. Graninger, S.A. Jacobson, M. Jutzi, K.M. Kumamoto, R. Luther, J.R. Lyzhoft, P. Michel, N. Murdoch, R. Nakano, **E.E. Palmer**, A.S. Rivkin, D.J. Scheeres, A.M. Stickle, J.M. Sunshine, J.M. Trigo-Rodriguez, J.-B. Vincent, J.D. Walker, K. Wünnemann, Y. Zhang, M. Amoroso, I. Bertini, J.R. Brucato, A. Capannolo, G. Cremonese, M. Dall'Ora, P.J.D. Deshapriya, I. Gai, P.H. Hasselmann, S. Ieva, G. Impresario, S.L. Ivanovski, M. Lavagna, A. Lucchetti, E.M. Epifani, D. Modenini, P. Maurizio, P. Palumbo, D. Perna, S. Pirrotta, G. Poggiali, A. Rossi, M. Zannoni, G. Zanotti (2023). Momentum transfer from the DART mission kinetic impact on asteroid Dimorphos. Nature 616, 457-460. https://doi.org/10.1038/s41586-023-05878-z.

Cheng, L., R. Lillis, Y. Wang, A. Mittelholz, S. Xu, D. Mitchell, **C.L. Johnson**, Z. Su, J. Halekas, B. Langlais, T. Zhang, G. Wang, S. Xiao, Z. Zou, Z. Wu, Y. Chi, Z. Pan, K. Liu, X. Hao, Y. Li, M. Chen, J. Espley, F. Eparvier, S. Curry (2023). Martian bow shock oscillations driven by solar wind variations: Simultaneous observations from Tianwen-1 and MAVEN. Geophys. Res. Lett. 50, id. e2023GL104769. https://doi.org/10.1029/2023GL104769.

**Chipera, S.J.**, **D.T. Vaniman**, E.B. Rampe, T.F. Bristow, G. Martínez, V.M. Tu, T.S. Peretyazhko, A.S. Yen, R. Gellert, J.A. Berger, W. Rapin, R.V. Morris, D.W. Ming, L.M. Thompson, S. Simpson, C.N. Achilles, B. Tutolo, R.T. Downs, A.A. Fraeman, E. Fischer, D.F. Blake, A.H. Treiman, S.M. Morrison, M.T. Thorpe, S. Gupta, W.E. Dietrich, G. Downs, **N. Castle**, **P.I. Craig**, D.J. Des Marais, R.M. Hazen, A.R. Vasavada, E. Hausrath, P. Sarrazin, J.P. Grotzinger (2023). Mineralogical investigation of Mg-sulfate at the Canaima drill site, Gale Crater, Mars. J. Geophys. Res.: Planets 128, id. e2023JE008041. https://doi.org/10.1029/2023JE008041.

Clark, B.E., A. Sen, **X.-D. Zou**, D.N. DellaGiustina, S. Sugita, N. Sakatani, M. Thompson, D. Trang, E. Tatsumi, M.A. Barucci, M. Barker, H. Campins, T. Morota, C. Lantz, **A.R. Hendrix**, **F. Vilas**, L. Keller, V.E. Hamilton, K. Kitazato, S. Sasaki, M. Matsuoka, T. Nakamura, A. Praet, S.M. Ferrone, T. Hiroi, H.H. Kaplan, W.F. Bottke, **J.-Y. Li, L. Le Corre**, **J.L. Molaro**, R.-L. Ballouz, C.W. Hergenrother, B. Rizk, K.N. Burke, C.A. Bennett, D.R. Golish, E.S. Howell, K. Becker, A.J. Ryan, J.P., Emery, S. Fornasier, A.A. Simon, D.C. Reuter, L.F. Lim, G. Poggiali, P. Michel, M. Delbo, O.S. Barnouin, E.R. Jawin, M. Pajola, L. Riu, T. Okada, J.D. Deshapriya, J.R. Brucato, R.P. Binzel, D.S. Lauretta (2023). Overview of the search for signs of space weathering on the low-albedo asteroid (101955). Icarus 400, id. 115563. https://doi.org/10.1016/j.icarus.2023.115563.

Cunje, A.B., A.J. Dombard, **R.R. Ghent** (2023). Investigating the relaxation of small craters emplaced on solidified melt sheets on the Moon. Icarus 398, id. 115532. https://doi.org/10.1016/j.icarus.2023.115532.

Czajka, E., K. Retherford, **G. Kramer**, **A. Hendrix**, J. Cahill, B. Byron, B. Greenhagen, T. Greathouse, L. Magaña, K. Mandt, C. Grava (2023). New insights into Aristarchus crater with LRO LAMP far-ultraviolet observations. Planet. Sci. J. 4, 137. https://doi.org/10.3847/PSJ/acdee9.

DerKacy, J.M., S. Paugh, **E. Baron**, P.J. Brown, C. Ashall, C.R. Burns, E.Y. Hsiao, S. Kumar, J. Lu, N. Morrell, M.M. Phillips, M. Shahbandeh, B.J. Shappee, M.D. Stritzinger, M.A. Tucker, Z. Yarbrough, K. Boutsia, P. Hoeflich, L. Wang, L. Galbany, E. Karamehmetoglu, K. Krisciunas, P. Mazzali, A.L. Piro, N.B. Suntzeff, A. Fiore, C.P. Gutiérrez, P. Lundqvist, A. Reguitti (2023). SN 2021fxy: mid-ultraviolet flux suppression is a common feature of Type Ia supernovae. Mon. Not. Royal Astron. Soc. 522, 3481-3505. https://doi.org/10.1093/mnras/stad1171.

Deshapriya, J.D.P., P.H. Hasselmann, I. Gai, M. Hirabayashi, E. Dotto, A. Rossi, A. Zinzi, V.D. Corte, I. Bertini, S. Ieva, E.M. Epifani, M. Dall'Ora, S. Ivanovski, D. Perna, T.L. Farnham, M. Amoroso, J.R. Brucato, A. Capannolo, S. Caporali, M. Ceresoli, N.L. Chabot, A. Cheng, G. Cremonese, R.T. Daly, E.G. Fahnestock, L. Gomez Casajus, E. Gramigna, G. Impresario, R.L. Manghi, M. Lavagna, **J.-Y. Li**, M. Lombardo, A. Lucchetti, D. Modenini, M. Pajola, **E.E. Palmer**, P. Palumbo, S. Pirrotta, G. Poggiali, A.S. Rivkin, P. Sanchez, G. Tancredi, P.J. Tortora, F. Tusberti, M. Zannoni, G. Zanotti (2023). Characterization of DART impact ejecta plume on Dimorphos from LICIACube observations. Planet. Sci. J. 4, 231. https://doi.org/10.3847/PSJ/ad09ba.

Dobson, M.M., M.E. Schwamb, **S.D. Benecchi**, A.J. Verbiscer, A. Fitzsimmons, L.J. Shingles, L. Denneau, A.N. Heinze, K.W. Smith, J.L. Tonry, H. Weiland, D.R. Young (2023). Phase curves of Kuiper belt objects, centaurs, and Jupiter-family comets from the ATLAS survey. Planet. Sci. J. 4, 75. https://doi.org/10.3847/PSJ/acc463.

**Domingue D.L.**, **J.R. Weirich**, **F. Chuang**, **A. Sickafoose**, L. Hsia Yao, S. **Courville**, **E.E. Palmer**, **R. Gaskell** (2023). Spectrophotometric and topographic correlations within the Mare Ingenii swirl region: Evidence for a highly mobile lunar regolith. Planet. Sci. J. 4, 240. https://doi.org/10.3847/PSJ/ace433.

**Dyar, M.D.**, M. McCanta, A. Lanzirotti, C.J. Steven, C. Ytsma (2023). Calibration for iron redox state and oxygen fugacity in silicate glasses from x-ray absorption spectroscopy. Chem. Geo. 635, id. 121605. https://doi.org/10.1016/j.chemgeo.2023.121605.

**Dyar, M.D.**, S.M. Wallace, **T.H. Burbine**, D.R. Sheldon (2023). A machine learning classification of meteorite spectra applied to understanding asteroids. Icarus 406, id. 115718. https://doi.org/10.1016/j.icarus.2023.115718.

Elder, C.M., **R.R. Ghent**, J. Haber, P.O. Hayne, **G. Morgan**, M.S. Robinson, **M. Siegler**, J.-P. Williams (2023). The variability of lunar mare basalt properties from surface rock abundance. Planet. Sci. J. 4, 244. https://doi.org/10.3847/PSJ/ad06a8.

**Feng, J.**, **M.A. Siegler**, Y. Su, C. Ding, I. Giannakis (2023). Layered structures in the upper several hundred meters of the Moon along the Chang'E-4 rover's first 1,000-m traverse. J. Geophys. Res.: Planets 128, id. e2022JE007714. https://doi.org/10.1029/2022JE007714.

Flynn, I.T.W., M.O. Chevrel, **D.A. Crown**, M.S. Ramsey (2023). The effects of digital elevation model resolution on the PyFLOWGO thermorheological lava flow model. Enviro. Model. Software 167, id. 105768. https://doi.org/10.1016/j.envsoft.2023.105768.

Fraser, W.C., R.E. Pike, M. Marsset, M.E. Schwamb, M.T. Bannister, L. Buchanan, J.J. Kavelaars, **S.D. Benecchi**, N.J. Tan, N. Peixinho, S.D.J. Gwyn, M. Alexandersen, Y.-T. Chen, B. Gladman, **K. Volk** (2023). Col-OSSOS: The two types of Kuiper belt surfaces. Planet. Sci. J. 4, 80. https://doi.org/10.3847/PSJ/acc844.

**Gaskell R.W.**, O.S. Barnouin, M.G. Daly, **E.E. Palmer**, **J.R. Weirich**, C.M. Ernst, R.T. Daly, D.S. Lauretta (2023). Stereophotoclinometry on the OSIRIS-REx mission: Mathematics and methods. Planet. Sci. J. 4, 63. https://doi.org/10.3847/PSJ/acc4b9.

Goldberg, C., C. Lejoly, **N. Samarasinha** (2023). Analysis of CN coma morphology features of comet 21P/Giacobini-Zinner. Planet. Sci. J. 4, 28. https://doi.org/10.3847/PSJ/acb436.

Gilmore, M., **M.D. Dyar**, N. Mueller, J. Helbert, J. Brossier, A. Santos, J. Filiberto, M. Ivanov, R. Ghail, P. Byrne, S. Smrekar, N. Izenberg, L. Carter, T. Gerva (2023). Mineralogy of the Venus surface. Space Sci. Rev. 219, id. 52. https://doi.org/10.1007/s11214-023-00988-6.

Golombek, M., T. Hudson, P. Bailey, N. Balabanska, E. Marteau, C. Charalambous, M. Baker, M. Lemmon, B. White, R.D. Lorenz, T. Spohn, J. Maki, P. Kallemeyn, J.B. Garvin, C. Newman, K. Hurst, N. Murdoch, N. Williams, W.B. Banerdt, P. Lognonné, P. Delage, R. Lapeyre, E. Gaudin, C. Yana, N. Verdier, M. Panning, A. Trebi-Ollennu, K. Ali, A. Mittelholz, **C.L. Johnson**, B. Langlais, N. Warner, J. Grant, I.J. Daubar, V. Ansan, C. Vrettos, A. Spiga, D. Banfield, A. Gomez, P. Mishra, R. Dotson, C. Krause, G. Sainton, T. Gabsi (2023). Results from InSight robotic arm activities. Space. Sci. Rev. 219, id. 20. https://doi.org/10.1007/s11214-023-00964-0.

González-Romero, A., C. González-Flórez, A. Panta, J. Yus-Díez, C. Reche, P. Córdoba, N. Moreno, A. Alastuey, K. Kandler, M. Klose, C. Baldo, **R.N. Clark**, Z. Shi, X. Querol, C. Pérez García-Pando (2023). Variability in sediment particle size, mineralogy, and Fe mode of occurrence across dust-source inland drainage basins: the case of the lower Drâa Valley, Morocco. Atmosph. Chem. Phys. 23, 15815–15834. https://doi.org/10.5194/acp 23-15815-2023.

Gullikson, A.G., R.B. Anderson, **R.M.E. Williams** (2023). Spatial distribution and morphometry of sinuous ridges in southeastern Terra Sabea and the northern region of Hellas Planitia. Icarus 394, id. 115399. https://doi.org/10.1016/j.icarus.2022.115399.

Hazen, R.M., R.T. Downs, S.M. Morrison, B.M. Tutolo, D.F. Blake, T.F. Bristow, **S.J. Chipera**, H.Y. McSween, D. Ming, R.V. Morris, E.B. Rampe, M.T. Thorpe, A.H. Treiman, V.M. Tu, **D.T. Vaniman** (2023). On the diversity and formation modes of Martian minerals. J. Geophys. Res.: Planets 128, id. e2023JE007865. https://doi.org/10.1029/2023JE007865.

**Hendrix, A.R.**, C.H. House (2023). Low effective UV exposure ages for Enceladus surface organics. Comm. Earth Enviro. 4, id. 485. https://doi.org/10.1038/s43247-023-01130-8.

Hopkins, R.J., **E.C. Sklute**, **M.D. Dyar**, A.D. Rogers, **R. Clark**, R. McKeegan (2023). A spectroscopic study of Mars-analog materials with amorphous sulfate and chloride phases: implications for detecting amorphous materials on the Martian surface. Planet. Sci. J. 4, 173. https://doi.org/10.3847/PSJ/aced52.

Householder, M.A., T. Subramani, K. Lilova, **J.R. Lyons**, R.M. Stroud, A. Navrotsky (2023). Calorimetric measurement of the surface energy of enstatite, MgSiO3. J. Phys. Chem. C 127, 20106−20112. https://doi.org/10.1021/acs.jpcc.3c04211.

**Howard, A.D.**, H.M. Moore, O.M. Umurhan, O.L. White, K.N. Singer, P.M. Schenk (2023). Are the surface textures of Pluto's Wright Mons and its surroundings exogenic? Icarus 405, id. 115719. https://doi.org/10.1016/j.icarus.2023.115719.

Jackson, B., **E.R. Adams**, **J.P. Morgenthaler** (2023). Metrics for optimizing searches for tidally decaying exoplanets. Astronom. J. 166, id.142. https://doi.org/10.3847/1538-3881/acef00.

Jawin, E.R., R.L. Ballouz, A.J. Ryan, H.H. Kaplan, T.J. McCoy, M.M. Al Asad, **J.L. Molaro**, B. Rozitis, L.P. Keller (2023). Boulder diversity in the Nightingale region of asteroid (101955) Bennu and predictions for physical properties of the OSIRIS-REx sample. J. Geophys. Res.: Planets 128, id. e2023JE008019. https://doi.org/10.1029/2023JE008019.

Jiang, H., J.H. Ji, L.L. Yu, **B. Yang**, S. Hu, Y. Zhao (2023). Mid-IR observations of IRAS, AKARI, WISE/NEOWISE, and Subaru for large icy asteroid (704) Interamnia: A new perspective of regolith properties and water ice fraction. Astrophys. J. 944, id. 202. https://doi.org/10.3847/1538-4357/acaeaa.

Kareta, T.T., C. Thomas, **J.-Y. Li**, M.M. Knight, N. Moskovitz, A. Rożek, M.T. Bannister, S. Ieva, C. Snodgrass, P. Pravec, E.V. Ryan, W.H. Ryan, E.G. Fahnestock, A.S. Rivkin, N. Chabot, A. Fitzsimmons, D. Osip, T. Lister, G. Sarid, M. Hirabayashi, T. Farnham, G. Tancredi, P. Michel, R. Wainscoat, R. Weryk, B. Burrati, J. Pittichová, R. Ridden-Harper, N.J. Tan, P. Tristram, T. Brown, M. Bonavita, M. Burgdorf, E. Khalouei, P. Longa, M. Rabus, S. Sajadian, U.G. Jorgensen, M. Dominik, J.-B. Kikwaya, E. Mazzotta Epifani, E. Dotto, P. Deshapriya, P. Hasselmann, M. Dall'Ora, L. Abe, T. Guillot, D. Mékarnia, A. Agabi, P. Bendjoya, O. Suarez, G. Amaury, G. Thomas, M.N. Günther, M. Kueppers, B. Merin, J. Chatelain, E. Gomez, H. Usher, C. Stoddard-Jones, M. Bartnik, M. Bellaver, B. Chetan, E. Dugan, T. Fallon, J. Fedewa, C. Gerhard, S.A. Jacobson, S. Painter, D.-M. Peterson, J.E. Rodriguez, C. Smith, K.V. Sokolovsky, H. Sullivan, K. Townley, S. Watson, L. Webb, J.M. Trigo-Rodríguez, J.M. Llenas, I. Pérez-García, A.J. Castro-Tirado, J.-B. Vincent, A. Migliorini, M. Lazzarin, F. La Forgia, F. Ferrari, T. Polakis, B. Skiff (2023). Ejecta evolution following a planned impact into an asteroid: the first five weeks. Astrophys. J. Lett. 959, id. L12. https://doi.org/10.3847/2041-8213/ad0fdd.

Lavorenti, F., **E.A. Jensen**, S. Aizawa, F. Califano, M. D'Amore, **D. Domingue**, P. Henri, S. Lindsay, J.M. Raines, D.W. Savin (2023). Maps of solar wind plasma precipitation onto Mercury's surface: A geographical perspective. Planet. Sci. J. 4, 163. https://doi.org/10.3847/PSJ/acef15.

Leblanc, F., M. Sarantos, **D. Domingue**, A. Milillo, D.W. Savin, P. Prem, J. Benkhoff, J. Zender, A. Galli, G. Murakami, S. Sasaki, M. Thompson, J. Raines (2023). How does the thermal environment affect the exosphere/surface interface at Mercury? Planet. Sci. J. 4, 227. https://doi.org/10.3847/PSJ/ad07da.

**Le Corre, L.**, **J.A. Sanchez**, V. Reddy, A. Battle, D. Cantillo, B. Sharkey, R. Jedicke, D. Scheeres (2023). Mineralogical characterization and phase angle study of two binary near-Earth asteroids, potential targets for NASA's Janus mission. Planet. Sci. J. 4, id. 91. https://doi.org/10.3847/PSJ/acd10d.

Lepore, K.H., **M.D. Dyar**, C.R. Ytsma (2023). Effect of plasma temperature on major element accuracy from laser-induced breakdown spectroscopy. Geophys. Res. Lett. 50, id. e2023GL102919. https://doi.org/10.1029/2023GL102919.

Lepore, K.H., **M.D. Dyar**, C.R. Ytsma (2023). Sharing calibration information among laser-induced breakdown spectroscopy instruments using spectral line binning and calibration transfer. Spectro. Acta B. 211, id. 106839. https://doi.org/10.1016/j.sab.2023.106839.

**Li, J.-Y.**, M. Hirabayashi, T.L. Farnham, J.M. Sunshine, M.M. Knight, G. Tancredi, F. Moreno, B. Murphy, C. Opitom, S. Chesley, D.J. Scheeres, C.A. Thomas, E.G. Fahnestock, A.F. Cheng, L. Dressel, C.M. Ernst, F. Ferrari, A. Fitzsimmons, S. Ieva, S.L. Ivanovski, T. Kareta, L. Kolokolova, T., Lister, S.D.

Raducan, A.S. Rivkin, A. Rossi, S. Soldini, A.M. Stickle, A. Vick, J.-B. Vincent, H.A. Weaver, S. Bagnulo, M.T. Bannister, S. Cambioni, A. Campo Bagatin, N.L. Chabot, G. Cremonese, R.T. Daly, E. Dotto, D.A. Glenar, M. Granvik, P.H. Hasselmann, I. Herreros, S. Jacobson, M. Jutzi, T. Kohout, F. La Forgia, M. Lazzarin, Z.-Y. Lin, R. Lolachi, A. Lucchetti, R. Makadia, E. Mazzotta Epifani, P. Michel, A. Migliorini, N.A. Moskovitz, J. Ormö, M. Pajola, P. Sánchez, S.R. Schwartz, C. Snodgrass, **J. Steckloff**, T.J. Stubbs, J.M. Trigo-Rodríguez (2023). Ejecta from the DART-produced active asteroid Dimorphos. Nature 616, 452-456. https://doi.org/10.1038/s41586-023-05811-4.

Li, L., L. Guan, S. Li, C. Luu, K. Heng, P.M. Fry, E.C. Creecy, X. Wang, R.J. Albright, G. Karandana, D. Thishan, X. Jiang, R.A. West, C.A. Nixon, M.E. Kenyon, **A. Hendrix**, U. Dyudina (2023). Bond albedo of Enceladus. Icarus 394, id. 115429. https://doi.org/10.1016/j.icarus.2023.115429.

Li, S., A.R. Poppe, T.M. Orlando, B.M. Jones, O.J. Tucker, W. Farrell, **A.R. Hendrix** (2023). Formation of lunar surface water associated with high-energy electrons in Earth's magnetotail. Nature Astron. 7, 1427-1435. https://doi.org/10.1038/s41550-023-02081-y.

Lien, R.R., K.L. Craft, **M.E. Walker**, G.W. Patterson, A.R. Rhoden (2023). Tidally induced fault motion within Europa's ice shell and implications for subsurface communication development. Icarus 410, id. 115726. https://doi.org/10.1016/j.icarus.2023.115726.

Limaye, A.B., J.B. Adler, A.J. Moodie, K.X. Whipple, **A.D. Howard** (2023). Effect of standing water on formation of fan-shaped sedimentary deposits at Hypanis Valles, Mars. Geophys. Res. Lett. 50, id. e2022GL102604. https://doi.org/10.1029/2022GL102367.

Luo, W., **A.D. Howard**, R.A. Craddock, E.A. Oliveira, R.S. Pires (2023). Global spatial distribution of Hack's law exponent on Mars consistent with early arid climate. Geophys. Res. Lett. 50, id. e2022GL102604. https://doi.org/10.1029/2022GL102604.

Luther R., **N. Artemieva**, A. Schmalen (2023). Campo del Cielo modeling and comparison with observations: II. Funnels and craters. Meteorit. Planet. Sci. 58, 1832-1847. https://doi.org/10.1111/maps.14104.

Magaña, L., K.D. Retherford, B.D. Byron, **A.R. Hendrix**, C. Grava, K.E. Mandt, U. Raut, E. Czajka, P.O. Hayne, D.M. Hurley, G.R. Gladstone, M.J. Poston, T.K. Greathouse, W. Pryor, J.T. Cahill, A. Stickle (2023). LRO-LAMP survey of lunar south pole cold traps: Assessment of H2O and potential CO2 and NH3 reserves. J. Geophys. Res.: Planets 128, id. e2023JE007863. https://doi.org/10.1029/2023JE007863.

Mainzer, A.K., J.R. Masiero, P.A. Abell, J.M. Bauer, W. Bottke, B.J. Buratti, S.J. Carey, D. Cotto-Figueroa, R.M. Cutri, D. Dahlen, P.R.M. Eisenhardt, Y.R. Fernandez, R. Furfaro, T. Grav, T.L. Hoffman, M.S. Kelley, Y. Kim, J.D. Kirkpatrick, C.R. Lawler, **E. Lilly**, X. Liu, F. Marocco, K.A. Marsh, F.J. Masci, C.W. McMurtry, M. Pourrahmani, L. Reinhart, M.E. Ressler, A. Satpathy, C.A. Schambeau, **S. Sonnett**, T.B. Spahr, J.A. Surace, M. Vaquero, E.L. Wright, G.R. Zengilowski (2023). NEO surveyor mission team 2023, The near-Earth object surveyor mission. Planet. Sci. J. 4, 224. https://doi.org/10.3847/PSJ/ad0468.

Manelski, H.T., **R.Y. Sheppard**, A.A. Fraeman, R. Wiens, J. Johnson, J. Frydenvang, N. Lanza, O. Gasnault (2023). Compositional variations in sedimentary deposits in Gale crater as seen by ChemCam passive and active spectra. J. Geophys. Res.: Planets 128, id. e2022JE007706. https://doi.org/10.1029/2022JE007706.

Marsset, M., M. Brož, J. Vermersch, N. Rambaux, M. Ferrais, M. Viikinkoski, J. Hanuš, E. Jehin, E. Podlewska-Gaca, P. Bartczak, G. Dudziński, B. Carry, P. Vernazza, R. Szakáts, R. Duffard, A. Jones, D. Molina, T. Santana-Ros, Z. Benkhaldoun, M. Birlan, C. Dumas, R. Fétick5, T. Fusco, L. Jorda, F. Marchis, F. Vachier, **B. Yang** (2023). The equilibrium shape of (65) Cybele: primordial or relic of a large impact? Astron. Astrophys. 670, id 52. https://doi.org/10.1051/0004-6361/202243859.

Marsset, M., W.C. Fraser, M.E. Schwamb, L.E. Buchanan, R.E. Pike, **K. Volk**, N. Peixinho, **S. Benecchi**, M.T. Bannister, N.J. Tan, J. Kvelaars (2023). Col-OSSOS: Evidence for a compositional gradient inherited from the protoplanetary disk? Planet. Sci. J. 4, 160. https://doi.org/10.48550/arXiv.2206.04096.

Martinez, M., L.E. Rodriguez, **R.Y. Sheppard**, Z. Yi, C. Cid, A. Khodayari, L.M. Barge (2023). Nitrate reactivity in iron (oxy)hydroxide systems: Effect of pH, iron redox state, and phosphate. Earth Space Chem. 7, 2287-2297. https://doi.org/10.1021/acsearthspacechem.3c00218.

McDonnell, M.D., E. Jones, M.E. Schwamb, K.-M. Aye, G. Portyankina, **C.J. Hansen** (2023). Planet Four: A neural network's search for polar spring-time fans on Mars. Icarus 391, id. 115308. https://doi.org/10.1016/j.icarus.2022.115308.

McGlasson, R.A., A.M. Bramson, **G.A. Morgan**, M.M. Sori (2023). Varied histories of outlier polar ice deposits on Mars. J. Geophys. Res.: Planets 128, id. e2022JE007592. https://doi.org/10.1029/2022JE007592.

Mc Keown, L.E., S. Diniega, G. Portyankina, **C.J. Hansen**, K.-M. Aye, S. Piqueux, J.E.C. Scully (2023). Martian araneiforms: A review. J. Geophys. Res.: Planets 128, id. e2022JE007684. https://doi.org/10.1029/2022JE007684.

Mittelholz, A., L. Heagy, **C.L. Johnson**, J. Bapst, J. Espley, A.0. Fraeman, B. Langlais, R. Lillis, W. Rapin (2023). Exploring Martian magnetic fields with a helicopter. Planet. Sci. J. 4, 155. https://doi.org/10.3847/PSJ/ace9c1.

Mittelholz, A., **C.L. Johnson**, M. Fillingim, R.E. Grimm, S. Joy, S.N. Thorne, W.B. Banerdt (2023). Mars' external magnetic field as seen from the surface with InSight. J. Geophys. Res.: Planets 128, id. e2022JE007616. https://doi.org/10.1029/2022JE007616.

Moreno, F. A. Campo Bagatin, G. Tancredi, **J.-Y. Li,** A. Rossi, F. Ferrari, M. Hirabayashi, E. Fahnestock, A. Maury, R. Sandness, A.S. Rivkin, A. Cheng, T.L. Farnham, S. Soldini, C. Giordano, G. Merisio, P. Panicucci, M. Pugliatti, A.J. Castro-Tirado, E. Fernández-García, I. Perez-García, S. Ivanovski, A. Penttila, L. Kolokolova, J. Licandro, O. Muñoz, Z. Gray, J.L. Ortiz, Z.-Y Lin (2023). Characterization of the ejecta from NASA/DART impact on Dimorphos: bservations and Monte Carlo models. Planet. Sci. J. 4, 138. https://doi.org/10.3847/PSJ/ace827.

**Morgan, G.A.**, E.R. Jawin, B.A. Campbell, G.W. Patterson, A.M. Bramson, C.A. Nypaver, J.D. Stopar, L.M. Jozwiak, A.M. Stickle, S.S. Bhiravarasu (2023). Radar perspective of the aristarchus pyroclastic deposit and implications for future missions. Planet. Sci. J. 4, 209. https://doi.org/10.3847/PSJ/ad023a.

Moulane, Y., E. Jehin, J. Manfroid, D. Hutsemékers, C. Opitom, Y. Shinnaka, D. Bodewits, Z. Benkhaldoun, A. Jabiri, S. Hmiddouch, M. Vander Donckt, F.J. Pozuelos, **B. Yang** (2023). Activity and composition of the hyperactive comet 46P/Wirtanen during its close approach in 2018. Astron. Astrophys. 670, id. A159. https://doi.org/10.1051/0004 6361/202244779.

Murphy, B.P., C. Opitom, C. Snodgrass, M.M. Knight, J.-Y. Li, N.L. Chabot, A.S. Rivkin, S.F. Green, P. Guetzoyan, D. Gardener, J. de León (2023). VLT/MUSE characterization of Dimorphos ejecta from the DART impact. Planet. Sci. J. 4, 238. https://doi.org/10.3847/PSJ/ad0a87.

Nakamura, T., M. Matsumoto, K. Amano, Y. Enokido, M.E. Zolensky, T. Mikouchi, H. Genda, S. Tanaka, M.Y. Zolotov, K. Kurosawa, S. Wakita, R. Hyodo, H. Nagano, D. Nakashima, Y. Takahashi, Y. Fujioka, M. Kikuiri, E. Kagawa, M. Matsuoka, A.J. Brearley, A. Tsuchiyama, M. Uesugi, J. Matsuno, Y. Kimura, M. Sato, R.E. Milliken, F. Tatsumi, S. Sugita, T. Hiroi, K. Kitazato, D. Brownlee, D.J. Joswiak, M. Takahashi, K. Ninomiya, T. Takahashi, T. Osawa, K. Terada, F.E. Brenker, B.J. Tkalcec, L. Vincze, R. Brunetto, A.

Aléon-Toppani, Q.H.S. Chan, M. Roskosz, J.-C. Viennet, P. Beck, E.E. Alp, T. Michikami, Y. Nagaashi, T. Tsuji, Y. Ino, J. Martinez, J. Han, A. Dolocan, R.J. Bodnar, M. Tanaka, H. Yoshida, K. Sugiyama, A.J. King, K. Fukushi, H. Suga, S. Yamashita, T. Kawai, K. Inoue, A. Nakato, T. Noguchi, **F. Vilas**, **A.R. Hendrix**, C. Jaramillo-Correa, **D.L. Domingue**, G. Dominguez, Z. Gainsforth, C. Engrand, J. Duprat, S.S. Russell, E. Bonato, C. Ma, T. Kawamoto, T. Wada, S. Watanabe, R. Endo, S. Enju, L. Riu, S. Rubino, P. Tack, S. Takeshita, Y. Takeichi, A. Takeuchi, A. Takigawa, D. Takir, T. Tanigaki, A. Taniguchi, K. Tsukamoto, T. Yagi, S. Yamada, K., Yamamoto, Y. Yamashita, M. Yasutake, K. Uesugi, I. Umegaki, I. Chiu, T. Ishizaki, S. Okumura, E. Palomba, C. Pilorget, S.M. Potin, A. Alasli, S. Anada, Y. Araki, N. Sakatani, C. Schultz, O. Sekizawa, S.D. Sitzman, K. Sugiura, M. Sun, E. Dartois, E. De Pauw, Z. Dionnet, Z. Djouadi, G. Falkenberg, R. Fujita, T. Fukuma, I.R. Gearba, K. Hagiya, M.Y. Hu, T. Kato, T. Kawamura, M. Kimura, M.K. Kubo, F. Langenhorst, C. Lantz, B. Lavina, M. Lindner, J. Zhao, B. Vekemans, D. Baklouti, B. Bazi, F. Borondics, S. Nagasawa, G. Nishiyama, K. Nitta, J. Mathurin, T. Matsumoto, L. Mitsukawa, H. Miura, A. Miyake, Y. Miyake, H. Yurimoto, R. Okazaki, H. Yabuta, H. Naraoka, K. Sakamoto, S. Tachibana, H.C. Connolly, D.S. Lauretta, M. Yoshitake, M. Yoshikawa, K. Yoshikawa, K. Yoshihara, Y. Yokota, K. Yogata, H. Yano, Y. Yamamoto, D. Yamamoto, M. Yamada, T. Yamada, T. Yada, K. Wada, T. Usui, R. Tsukizaki, F. Terui, H. Takeuchi, Y. Takei, A. Iwamae, H. Soejima, K. Shirai, Y. Shimaki, H. Senshu, H. Sawada, T. Saiki, M. Ozaki, G. Ono, T. Okada, N. Ogawa, K. Ogawa, R. Noguchi, H. Noda, M. Nishimura, N. Namiki, S. Nakazawa, T. Morota, A. Miyazaki, A. Miura, Y. Mimasu, K. Matsumoto, K. Kumagai, T. Kouyama, S. Kikuchi, K. Kawahara, S. Kameda, T. Iwata, Y. Ishihara, M. Ishiguro, H. Ikeda, S. Hosoda, R. Honda, C. Honda, Y. Hitomi, N. Hirata, N. Hirata, T. Hayashi, M. Hayakawa, K. Hatakeda, S. Furuya, R. Fukai, A. Fujii, Y. Cho, M. Arakawa, M. Abe, S. Watanabe, Y. Tsuda (2023). Formation and evolution of carbonaceous asteroid Ryugu: Direct evidence from returned samples. Science 379, id. eabn8671. https://doi.org/10.1126/science.abn8671.

Noonan, J.W., J.W. Parker, W.M. Harris, S. Bromley, M. Saki, Y. Moulane, D. Farnocchia, M. Micheli, **J.-Y. Li**, K.E. Mandt, K. Venkataramani, D. Bodewits (2023). The evolution of activity and chemical composition in Rosetta's comet targets across multiple apparitions: Evidence for additional CS parents in comet nuclei. Planet. Sci. J. 4, 73. https://doi.org/10.3847/PSJ/accb58.

Norvell, B., T. Kyritz, G.A. Spinelli, R.N. Harris, K. Dickerson, A.M. Tréhu, S. Carbotte, S. Han, B. Boston, M. Lee, The CHINOoK Project Science Party (including **Matthew Perry**) (2023). Thermally significant fluid seepage through thick sediment on the Juan de Fuca plate entering the cascadia subduction zone. Geochem. Geophys. Geosys. 24, id. e2023GC010868. https://doi.org/10.1029/2023GC010868.

Opher, M., J. Richardson, G. Zank, V. Florinski, J. Giacalone, J.M. Sokół, G. Toth, **S. Buxner**, M. Kornbleuth, M. Gkioulidou, R. Nikoukar, B. Van der Holst, D. Turner, N. Gross, J. Drake, M. Swisdak, K. Dialynas, M. Dayeh, Y. Chen, B, Zieger, E. Powell, C. Onubogu, X. Ma, E. Bair, H. Elliott, A. Galli, L. Zhao, L. Adhikari, M. Nakanotani, M.E. Hill, P. Mostafavi, S. Du, F. Guo, D. Reisenfeld, S. Fuselier, V. Izmodenov, I. Baliukin, A. Cummings, J. Miller, B. Wang, K. Ghanbari, J. Kota, A. Loeb, J. Burgess, S.C. Hokanson, C. Morrow, A. Hong, A. Boldon (2023). Solar wind with hydrogen ion charge exchange and large-scale dynamics (SHIELD) DRIVE science center. Front. Astron. Space Sci. 10, id. 1143909. https://doi.org/10.3389/fspas.2023.1143909.

Opitom, C., B. Murphy, C. Snodgrass, S. Bagnulo, S.F. Green, M.M. Knight, J. de Léon, **J.-Y. Li**, D. Gardener (2023). Morphology and spectral properties of the DART impact ejecta with VLT/MUSE. Astron. Astrophys. 671, id. L11. https://doi.org/10.1051/0004-6361/202345960.

Osinski, G.R., H.J. Melosh, J. Andrews-Hanna, D. Baker, B. Denevi, D. Dhingra, **R. Ghent**, P.O. Hayne, P. Hill, P.B. James, S. Jaret, B. Johnson, T. Kenkmann, D. Kring, P. Mahanti, D. Minton, **C.D. Neish**, G. Neumann, J. Plescia, R.W.K. Potter, **J. Richardson**, E.A. Silber, J.M. Soderblom, M. Zanetti, N. Zellner (2023). Lunar impact features and processes. Rev. Mineral. Geochem. 89, 339–371. https://doi.org/10.2138/rmg.2023.89.08.

Palucis, M.C., **A.D. Howard**, D.A. Kring, K. Nishiizumi, M. Cafee, W.E. Dietrich (2023). Runoff required to drive postimpact gully development on the walls of Meteor crater (Arizona, USA). Geo. Soc. Amer. Bull. 136, 1003–1022. https://doi.org/10.1130/B36863.1.

Palucis, M.C., **A.M. Morgan**, J.V. Strauss, F. Rivera-Hernandez, J.A. Marshall, E. Menio, R. Miller (2023). Rates and processes controlling periglacial alluvial fan formation: Implications for Martian fans. Geo. Soc. Amer. Bull. 135, 937-954. https://doi.org/10.1130/B36459.1.

Patzek, M., O. Rüsch, **J.L. Molaro** (2023). On the response of chondrites to diurnal temperature change – simulating asteroidal surface conditions. J. Geophys. Res.: Planets 129, id. e2023JE007944. https://doi.org/10.1029/2023JE007944.

Plattner, A.M., **C.L. Johnson**, M. J. Styczinski, S.D. Vance, A.C. Mills (2023). On Ganymede's magnetic quadrupolar strength. Planet. Sci. J. 4 ,134. https://doi.org/103847/PSJ/acde7f.

Praet, A., G. Poggiali, M.A. Barucci, B.E. Clark, **X.D. Zou**, A.A. Simon, H.H. Kaplan, **J.-Y. Li**, C. Alcaria (2023). Evaluating possible spectroscopic variation of Bennu's sampling site. Mon. Not. Royal Astron. Soc. 519, 1464-1475. https://doi.org/10.1093/mnras/stac2969.

Petit, J.-M., B. Gladman, J.J. Kavelaars, M.T. Bannister, M. Alexandersen, **K. Volk**, Y.T. Chen (2023). The hot main Kuiper belt size distribution from OSSOS. Astrophys. J. 947, id. L4. https://doi.org/10.3847/2041-8213/acc525.

Praet, A., G. Poggiali, M.A. Barucci, B.E. Clark, **X.-D. Zou**, A.A. Simon, H.H. Kaplan, **J.-Y. Li**, C. Alcaria (2023). Evaluating possible spectroscopic variation of Bennu's sampling site. Mon. Not. Royal Astronom. Soc. 519, 1464-475. https://doi.org/10.1093/mnras/stac2969.

Pike, R.E., W.C. Fraser, **K. Volk**, J.J. Kavelaars, M. Marsset, N. Peixinho, M.E. Schwamb, M.T. Bannister, L. Peltier, L.E. Buchanan, **S. Benecchi**, N.J. Tan, (2023). Col-OSSOS: The distribution of surface classes in Neptune's resonances. Planet. Sci. J. 4, 200. https://doi.org/10.3847/PSJ/ace2c2.

Polishook, D., F.E. DeMeo, B.J. Burt, C.A. Thomas, A.S. Rivkin, **J.A. Sanchez**, V. Reddy (2023). Near-IR spectral observations of the Didymos system: Daily evolution before and after the DART impact indicates that Dimorphos originated from Didymos. Planet. Sci. J. 4, 12. https://doi.org/10.3847/PSJ/ad08ae.

Potter, S.F., S. Bertone, **N. Schörghofer**, E. Mazarico (2023). Fast hierarchical low-rank view factor matrices for thermal irradiance on planetary surfaces. J. Comp. Phys. X 17, id. 100130. https://doi.org/10.1016/j.jcpx.2023.100130.

**Putzig, N.E.**, **G.A. Morgan**, **H.G. Sizemore**, D.M.H. Baker, E.I. Petersen, **A.V. Pathare**, C.M. Dundas, A.M. Bramson, **S.W. Courville**, **M.R. Perry**, S. Nerozzi Z.M. Bain, R.H. Hoover, B.A. Campbell, M. Mastrogiuseppe, M.T. Mellon, R. Seu, **I.B. Smith** (2023). Ice resource mapping on Mars. In Handbook of Space Resources (eds. V. Badescu, K. Zacny, Y. Bar-Cohen). Cham: Springer International Publishing, pp. 583-616. https://doi.org/10.1007/978-3-030-97913-583-616.

Raymond, S.N., A. Izidoro, **N.A. Kaib** (2023). Oort cloud (exo)planets. Mon. Not. Royal Astron. Soc. 524, id. L72-L77. https://doi.org/10.1093/mnrasl/slad079.

Raymond, S.N., **N.A. Kaib**, F. Selsis, H. Bouy (2024). Future trajectories of the Solar System: dynamical simulations of stellar encounters within 100 au. Mon. Not. Royal Astron. Soc. 527, 6126-6138. https://doi.org/10.1093/mnras/stad3604.

**Rodriguez, J.A.P.**, **D. Do mingue**, **B. Travis**, **J.S. Kargel**, **O. Abramov**, M. Zarroca, M.E. Banks, **J. Weirich**, **A. Lopez**, **N. Castle**, Y. Jianguo, **F.**

**Chuang** (2023). Mercury's hidden past: Revealing a volatile-dominated layer through glacier-like features and chaotic terrains. Planet. Sci. J. 4, id. 219. https://doi.org/10.3847/PSJ/acf219.

**Rodriguez, J.A.P.**, M.B. Wilhelm, **B. Travis**, **J.S. Kargel**, M. Zarroca, **D.C. Berman**, J. Cohen, V. Baker, A. Lopez, D. Buckner (2023). Exploring the evidence of middle Amazonian aquifer sedimentary outburst residues in a Martian chaotic terrain. Scient. Rep. 13, id. 17524. https://doi.org/10.1038/s41598-023-39060-2.

Rommel, F.L., F. Braga-Ribas, L.J. Ortiz, B. Sicardy, P. Santos-Sanz, J. Desmars, J.I.B. Camargo, R. Vieira-Martins, M. Assafin, B.E. Morgado, R.C. Boufleur, G. Benedetti-Rossi, A.R. Gomes-Júnior, E. Fernández-Valenzuela, B.J. Holler, D. Souami, R. Duffard, G. Margoti, M. Vara-Lubiano, J. Lecacheux, J.L. Plouvier, N. Morales, A. Maury, J. Fabrega, P. Ceravolo, E. Jehin, D. Albanese, H. Mariey, S. Cikota, D. Ruždjak, A. Cikota, R. Szakáts, D. Baba Aissa, Z. Gringahcene, V. Kashuba, N. Koshkin, V. Zhukov, S. Fişek, O. Çakir, S. Özer, C. Schnabel, M. Schnabel, F. Signoret, L. Morrone, T. Santana-Ros, C.L. Pereira, M. Emilio, A.Y. Burdanov, J. de Wit, K. Barkaoui, M. Gillon, G. Leto, A. Frasca, G. Catanzaro, R.Z. Sanchez, U. Tagliaferri, M. Di Sora, G. Isopi, Y. Krugly, I. Slyusarev, V. Chiorny, H. Mikuž, P. Bacci, M. Maestripieri, M.D. Grazia, I. de la Cueva, M. Yuste-Moreno, F. Ciabattari, O.M. Kozhukhov, M. Serra-Ricart, M.R. Alarcon, J. Licandro, G. Masi, R. Bacci, J.M. Bosch, R. Behem, J.-P. Prost, S. Renner, M. Conjat, M. Bachini, G. Succi, L. Stoian, A. Juravle, D. Carosati, B. Gowe, J. Carrillo, A.P. Zheleznyak, N. Montigiani, C.R. Foster, M. Mannucci, N. Ruocco, F. Cuevas, P. Di Marcantonio, I. Coretti, G. Iafrate, V. Baldini, M. Collins, A. Pál, B. Csák, E. Fernández-Garcia, A.J. Castro-Tirado, L. Hudin, J.M. Madiedo, R.M. Anghel, J.F. Calvo-Fernández, A. Valvasori, E. Guido, R.M. Gherase, S. Kamoun, R. Fafet, M. Sánchez-González, L. Curelaru, C.D. Vîntdevară, C.A. Danescu, J.-F. Gout, C.J. Schmitz, A. Sota, I. Belskaya, M. Rodríguez-Marco, Y. Kilic, E. Frappa, A. Klotz, M. Lavayssière, J.M. Oliveira, M. Popescu, L.A. Mammana, E. Fernández-Lajús, M. Schmidt, U. Hopp, R. Komžík, T. Pribulla, D. Tomko, M. Husárik, O. Erece, S. Eryilmaz, L. Buzzi, B. Gährken, D. Nardiello, K. Hornoch, E. Sonbas, H. Er, V. Burwitz, P.W. Sybilski, W. Bykowski, T.G. Müller, W. Ogloza, R. Gonçalves, J.F. Ferreira, M. Ferreira, M. Bento, S. Meister, M.N. Bagiran, M. Tekeş, A. Marciniak, Z. Moravec, P. Delinčák, G. Gianni, G.B. Casalnuovo, M. Boutet, J. Sanchez, B. Klemt, N. Wuensche, W. Burzynski, M. Borkowski, M. Serrau, G. Dangl, O. Klös, C. Weber, M. Urbaník, L. Rousselot, J. Kubánek, P. André, C. Colazo, J. Spagnotto, **A.A. Sickafoose**, R. Hueso, A. Sánchez-Lavega, R.S. Fisher, A.W. Rengstorf, C. Perelló, M. Dascalu, M. Altan, K. Gazeas, T. de Santana, R. Sfair, O.C. Winter, S. Kalkan, O. Canales-Moreno, J.M. Trigo-Rodríguez, V. Tsamis, K. Tigani, N. Sioulas, G. Lekkas, D.N. Bertesteanu, V. Dumitrescu, A.J. Wilberger, J.W. Barnes, S.K. Fieber-Beyer, R.L. Swaney, C. Fuentes, R.A. Mendez, B.D. Dumitru, R.L. Flynn, D.A. Wake (2023). A large topographic feature on the surface of the trans-Neptunian object (307261) 2002 MS4 measured from stellar occultations. Astron. Astrophys. 678, id.A167. https://doi.org/10.1051/0004-6361/202346892.

Roth, N.X., S.N. Milam, A.J. Remijan, M.A. Cordiner, M.W. Busch, C.A. Thomas, A.S. Rivkin, A. Moullet, T.L. Roush, M.A. Siebert, **J.-Y. Li**, E.G. Fahnestock, J.M. Trigo-Rodriguez, C. Opitom, M. Hirabayashi (2023). ALMA observations of the DART impact: Characterizing the ejecta at sub-millimeter wavelengths with ALMA. Planet. Sci. J. 4 206. https://doi.org/10.48550/arXiv.2306.05908.

**Royer, E.**, **A. Hendrix**, J. Elliott, L. Esposito, C. Howett, L. Spilker (2023). Helene's surface properties from a photometric multi-wavelength analysis. Icarus 392, id. 115376. https://doi.org/10.1016/j.icarus.2022.115376.

Salari, G., G. Tognon, F. Zambon, C. Carli, F. Tosi, L. Giacomini, **J.-P. Combe**, R. Pozzobon, S. Fonte, M. Massironi, G. Rinaldi (2023). Spectral analysis of Mare Ingenii basin (lunar farside). J. Geophys. Res.: Planets 128, id. e2023JE007963d. https://doi.org/10.1029/2023JE007963.

Schambeau, C.A., **E. Lilly**, M. Micheli, Y.R. Fernandez, P. Jevčák, **N. Samarasinha** (2023). 2023 recovery observations and characterization of the active centaur P/2010 TO20 (LINEAR-Grauer). Res. Notes AAS 7, id.134. https://doi.org/10.3847/2515-5172/ace0c5.

Schmidt, C., M. Sharov, K. de Kleer, N. Schneider, I. de Pater, P.H. Phipps, A. Conrad, L. Moore, P. Withers, J. Spencer, **J. Morgenthaler**, I. Ilyin, K. Strassmeier, C, Veillet, J. Hill, M. Brown (2023). Io's optical aurorae in Jupiter's shadow. Planet. Sci. J. 4, 36. https://doi.org/10.3847/PSJ/ac85b0

**Schörghofer, N.** (2023). Adsorption kinetics of water and argon on lunar grains. Planet. Sci. J. 4, 164. https://doi.org/10.3847/PSJ/acf19b.

**Schörghofer, N.**, R. Rufu (2023). Past extent of lunar permanently shadowed areas. Sci. Advan. 9, id. eadh4302. https://doi.org/10.1126/sciadv.adh4302.

Schwamb, M.E., R.L. Jones, P. Yoachim, **K. Volk**, R.C. Dorsey, C. Opitom, S. Greenstreet, T. Lister, C. Snodgrass, B.T. Bolin, L. Inno, M.T. Bannister, S. Eggl, M. Solontoi, M.S.P. Kelley, M. Jurić, H.W. Lin, D. Ragozzine, P.H. Bernardinelli, S.R. Chesley, T. Daylan, J. Ďurech, W.C. Fraser, M. Granvik, M.M. Knight, C.M. Lisse, R. Malhotra, W.J. Oldroyd, A. Thirouin, Q. Ye (2023). Tuning the Legacy Survey of Space and Time (LSST) observing strategy for Solar System science. Astrophys. J. Supple. Series 266, id. 22. https://doi.org/10.3847/1538-4365/acc173.

Shaner, A., **S. Buxner**, D. Kring (2023). ExMASS: Implementation and evaluation of an authentic, inquiry-based research experience for secondary students. Astron. Edu. J. 3, 1. https://doi.org/10.32374/AEJ.2023.3.1.051aep.

Sharkey, B.N.L., V. Reddy, O. Kuhn, **J.A. Sanchez**, W.F. Bottke (2023). Spectroscopic links among giant planet irregular satellites and trojans. Planet. Sci. J. 4, 223. https://doi.org/10.3847/PSJ/ad0845.

Sharma, S., R.D. Roppel, **A.E. Murphy**, L.W. Beegle, R. Bhartia, A. Steele, J.R. Hollis, S. Siljeström, F.M. McCubbin, S.A. Asher, W.J. Abbey, A.C. Allwood, E.L. Berger, B.L. Bleefeld, A.S. Burton, S.V. Bykov, E.L. Cardarelli, P.G. Conrad, A. Corpolongo, A.D. Czaja, L.P. DeFlores, K. Edgett, K.A. Farley, T. Fornaro, A.C. Fox, M.D Fries, D. Harker, K. Hickman-Lewis, J. Huggett, S. Imbeah, R.S. Jakubek, L.C. Kah, C. Lee, Y. Liu, A. Magee, M. Minitti, K.R. Moore, A. Pascuzzo, C. Rodriguez Sanchez-Vahamonde, E.L. Scheller, S. Svetlana, K.M. Stack, K. Steadman, M. Tuite, K. Uckert, A. Werynski, R.C. Wiens, A.J. Williams, K. Winchell, M.R. Kennedy, A. Yanchilina (2023). Diverse organic-mineral associations in Jezero crater, Mars. Nature 619, 724-732. https://doi.org/10.1038/s41586-023-06143-z.

**Sickafoose, A.A.**, S.E. Levine, A.S. Bosh, M.J. Person, C.A. Zuluaga, B. Knieling, M.C. Lewis, K. Schindler (2023). Material around the Centaur (2060) Chiron from the 2018 November 28 UT stellar occultation. Planet Sci. J. 4, id. 221. https://doi.org/10.3847/PSJ/ad0632.

**Siegler, M.A.**, **J. Feng**, K. Lehman-Franco, J.C. Andrews-Hanna, R.C. Economos, M.S. Clair, C. Million, J.W. Head, T.D. Glotch, M.N. White (2023). Remote detection of a lunar granitic batholith at Compton–Belkovich. Nature 620, 116-121. https://doi.org/10.1038/s41586-023-06183-5.

**Sklute, E.C.**, D.A. Leopo, K.A. Neat, K.J.T. Livi, **M.D. Dyar**, J.F. Holden (2023). Fe(III) (oxyhydr)oxide reduction by the thermophilic iron-reducing bacterium desulfovulcanus ferrireducens. Front. Microbio. ≠14, id. 1272245. https://doi.org/10.3389/fmicb.2023.1272245.

Stern, S.A., O.L. White, W.M. Grundy, B.A. Keeney, J.D. Hofgartner, D. Nesvorný, W.B. McKinnon, D.C. Richardson, J.C. Marohnic, A.J. Verbiscer, **S. Benecchi**, P.M. Schenk, J.M. Moore, New Horizons Geology and Geophysics Investigation Team (2023). The properties and origin of Kuiper belt object Arrokoth's large mounds. Planet. Sci. J. 4, 176. https://doi.org/10.48550/arXiv.2308.16834.

Tatsumi, E., **F. Vilas**, J. de Leon, M. Popescu, S. Hasegawa, T. Hiroi, F. Tinaut-Ruano, J. Licandro (2023). Near-ultraviolet absorption distribution of

primitive asteroids from spectrophotometric surveys. I. Radial distribution. Astron. Astrophys. 672, id. A189. https://doi.org/10.1051/0004-6361/202244499.

Teolis, B., M. Sarantos, **N. Schörghofer**, B. Jones, C. Grava, A. Mura, P. Prem, B. Greenhagen, M.T. Capria, G. Cremonese, A. Lucchetti, V. Galluzzi (2023). Surface exospheric interactions. Space Sci. Rev. 219, id. 4. https://doi.org/10.1007/s11214-023-00951-5.

Thompson, D.R., R.O. Green, C. Bradley, P.G. Brodrick, B. Dor, M. Bennett, M. Bernas, N. Carmon, K.D. Chadwick, **R.N. Clark**, R.W. Coleman, E. Cox, E. Diaz, M.L. Eastwood, R. Eckert, B. Ehlmann, P. Ginoux, M. Gonçalves Ageitos, K. Grant, L. Guanter, D. Heller Pearlshtien, M. Helmlinger, H. Herzog, T. Hoefen, Y. Huang, A. Keebler, O. Kalashnikova, D. Keymeulen, R. Kokaly, M. Klose, L. Li, S. Lundeen, N. Mahowald, J. Meyer, E. Middleton, R.L. Miller, P. Mouroulis, B. Oaida, V. Obiso, F. Ochoa, W. Olson-Duvall, G.S. Okin, T.H. Painter, C. Pérez García-Pando, V. Realmuto, L. Shaw, P. Sullivan, E. Thingvold, A.K. Thorpe, G. Swayze, S. Vannan, C. Villarreal, H.R. Pollock, C. Ung, D.W. Wilson, S. Zandbergen (2023). On-orbit calibration and performance of the EMIT imaging spectrometer. Remote Sensing of Enviro. 303, id. 113986. https://doi.org/10.22541/essoar.168988432.29040205/v1.

Tosi, F., A. Mura, A. Cofano, F. Zambon, C.R. Glein, M. Ciarniello, J.I. Lunine, G. Piccioni, C. Plainaki, R. Sordini, A. Adriani, S.J. Bolton, **C.J. Hansen**, T.A. Nordheim, A. Moirano, L. Agostini, F. Altieri, S.M. Brooks, A. Cicchetti, B.M. Dinelli, D. Grassi, A. Migliorini, M.L. Moriconi, R. Noschese, P. Scarica, G. Sindoni, S. Stefani, D. Turrini (2023). Salts and organics on Ganymede's surface observed by the JIRAM spectrometer onboard Juno. Nat. Astron. 8, 82–93. https://doi.org/10.1038/s41550-023-02107-5.

Treiman, A.H., N.L. Lanza, S. VanBommel, J. Berger, R. Wiens, T. Bristow, J. Johnson, M. Rice, R. Hart, A. McAdam, P. Gasda, P-Y. Meslin, A. Yen, A.J. Williams, A. Vasavada, **D. Vaniman**, V. Tu, M. Thorpe, E.D. Swanner, C. Seeger, S.P. Schwenzer, S. Schröder, E. Rampe, W. Rapin, S.J. Ralston, T. Peretyazhko, H. Newsom, R.V. Morris, D. Ming, M. Loche, S. Le Mouélic, C. House, R. Hazen, J.P. Grotzinger, R. Gellert, O. Gasnault, W.W. Fischer, A. Essunfeld, R.T. Downs, G.W. Downs, E. Dehouck, L.J. Crossey, A. Cousin, J.M. Comellas, J.V. Clark, B. Clark III, **S. Chipera**, G. Caravaca, J. Bridges, D.F. Blake, R. Anderson (2023). Manganese-iron phosphate nodules at the Groken site, Gale crater, Mars. Minerals 13, id. 1122. https://doi.org/10.3390/min13091122.

Turyshev, S.G., D. Garber, L.D. Friedman, A.M. Hein, N. Barnes, K. Batygin, M.E. Brown, L. Cronin, A. Davoyan, A. Dubill, T.M. Eubanks, S. Gibson, D.M. Hassler, N.R. Izenberg, P. Kervella, P.D. Mauskopf, N. Murphy, A. Nutter, C. Porco, D. Riccobono, J. Schalkwyk, K.B. Stevenson, **M.V. Sykes**, M. Sultana, V.T. Toth, M. Velli, S.P. Worden (2023). Science opportunities with solar sailing smallsats. Planet. & Sp. Science 235, id. 105744. https://doi.org/10.1016/j.pss.2023.105744

Varatharajan, I., **E. Sklute**, T.D. Glotch, **M.D. Dyar** (2023). Modelling wavelength dependent mid-infrared optical constants (5.5-25 μm) of silicate glasses: A genetic algorithm approach. Earth Space Sci. 10, id. e2023EA002938. https://doi.org/10.1029/2023EA002938.

Vaz, D.A., S. Silvestro, **M. Chojnacki**, D.C.A. Silva (2023). Constraining the mechanisms of aeolian bedform formation on Mars through a global morphometric survey. Earth Planet. Sci. Lett. 614, id. 118196. https://doi.org/10.1016/j.epsl.2023.118196.

Vos, E., **O. Aharonson**, **N. Schörghofer**, F. Forget, E. Millour (2023). Paleo-evolution of Martian subsurface ice and its role in the polar physical and isotopic layering. J. Geophys. Res.: Planets 128, id. e2023JE007822. https://doi.org/10.1029/2021JE007115.

Wakita, S., B.C. Johnson, J.M. Soderblom, J. Shah, **C.D. Neish**, **J.K. Steckloff** (2023). Modeling the formation of Selk impact crater on Titan: Implications for Dragonfly. Planet. Sci. J. 4, 51. https://doi.org/10.3847/PSJ/acbe40.

**Weirich, J.R.**, **D.L. Domingue**, **F.C. Chuang**, **A.A. Sickafoose**, **M.D. Richardson**, **E.E. Palmer**, **R.W. Gaskell** (2023). The search for topographic correlations within the Reiner gamma swirl. Planet. Sci. J. 4, 212. https://doi.org/10.3847/PSJ/ace2b8.

Wexler, D.B., W.B. Manchester, L.K. Jian, L.B. Wilson, N. Gopalswamy, P. Song, J.E. Kooi, B. van der Holst, E.A. Jensen (2023). Investigating a solar wind stream interaction region using interplanetary spacecraft radio signals: A magnetohydrodynamic simulation study. Astrophys. J. 955, id. 90. https://doi.org/10.3847/1538-4357/acedac.

Widemann, T., S.E. Smrekar, J.B. Garvin, A.G. Straume-Lindner, A.C. Ocampo, T. Voirin, S. Hensely, **M.D. Dyar**, J.L. Whitten, D.C. Nunes, S.A. Getty, G.N. Arney, N.M. Johnson, E. Kohler, T. Spohn, J.G. O'Rourke, C.F. Wilson, M.J. Way, C. Ostberg, F. Westall, D. Hoening, S. Jacobson, A. Salvador, G. Avice, D. Breuer, L. Cater, M.S. Gilmore, R. Ghail, J. Helbert, P. Byrne, A.R. Santos, R.R. Herrick, N. Izenbberg, E. Marcq, T. Rolf, M. Weller, C. Gillmann, O. Korablev, L. Zelenyi, L. Zasova, D. Gorinov, G. Seth, C.V. Narasimha Rao, N. Desai (2023). Venus evolution through time: Key science questions, selected mission concepts and future investigations. Space Sci. Rev. 219, id. 56. https://doi.org/10.1007/s11214-023-00992-w.

Wilk, K.A., J.L. Bishop, **C.M. Weitz**, M. Parente, A.M. Saranathan, Y. Itoh, C. Gross, J. Flahaut, F. Seelos (2023). Characterization of aqueous alteration and formation of salty exposures at Ius Chasma, Mars. Icarus 408, id. 115800. https://doi.org/10.1016/j.icarus.2023.115800.

Wogsland, B.V., M.E. Minitti, L.C. Kah, **R.A. Yingst**, W. Abbey, R. Bhartia, L. Beegle, B.L. Bleefeld, E.L. Cardarelli, P.G. Conrad, K. Edgett, K. Hickman-Lewis, J. Hugget, S. Imbeah, M.R. Kennedy, C. Lee, B.E. Nixon, J.I. Núñez, A. Pascuzzo, M. Robinson, C.R. Sanchez-Vahamonde, E. Scheller, S. Sharma, S. Siljeström, K. Steadman, K. Winchell, M.A. Ravine (2023). Science and science-enabling activities of the SHERLOC and WATSON imaging systems in Jezero Crater, Mars. Earth Space Sci. 10, id. e2022EA002544. https://doi.org/10.1029/2022EA002544.

Yan, C., A. Barik, S. Stanley, J. Leung, A. Mittelholz, **C.L. Johnson**, A.-C. Plesa, A. Rivoldini (2023). An ancient Martian dynamo driven by hemispheric heating: Effect of thermal boundary conditions. Planet. Sci. J. 4, id. 11. https://doi.org/10.3847/PSJ/acae93.

Yang, H., M. Dejam, **S.P. Tan**, H. Adidharma (2023). Experimental study on phase transitions of carbon dioxide confined in nanopores: Evaporation, melting, sublimation, and triple point. Langmuir 39, 16060-16068. https://doi.org/10.1021/acs.langmuir.3c02209.

Yang, H., K. Jayaatmaja, X. Qiu, M. Fan, M. Dejam, **S.P. Tan**, H. Adidharma (2023). Accurate measurement of the isothermal heat of capillary condensation in nanopores using differential scanning calorimetry and adsorption/desorption experiments. J. Phys. Chem. C 127, 21980-21988. https://doi.org/10.1021/acs.jpcc.3c05402.

**Yingst, R.A.**, **S.C. Mes**t, W.B. Garry, D.A. Williams, **D.C. Berman**, T.K.P. Gregg (2023). A geologic map of Vesta produced using a hybrid method for incorporating spectroscopic and morphologic data. Planet. Sci. J. 4, 157. https://doi.org/10.3847/PSJ/acebe9.

**Yingst, R.A.**, **A.C. Cowart**, L.C. Kah, S. Gupta, K. Stack, D. Fey, D. Harker, K. Herkenhoff, M.E. Minitti, S. Rowland (2023). Depositional and diagenetic processes of Martian lacustrine sediments as revealed at Pahrump Hills by the Mars hand lens imager, Gale Crater, Mars. J. Geophys. Res.: Planets 128, id. e2022JE007394. https://doi.org/10.1029/2022JE007394.

Yoshikawa, K., **N. Schörghofer**, F. Klasner (2023). Permafrost and seasonal frost thermal dynamics over fifty years on tropical Maunakea volcano, Hawai'i. Arctic. Antarct. Aline Res. 55, id. 2186485. https://doi.org/10.1080/15230430.2023.2186485.

# PSI 2023 ANNUAL RETREAT


PLANETARY SCIENCE INSTITUTE
EST. 1972

www.psi.edu