



THE UNIVERSITY OF ARIZONA
COLLEGE OF SCIENCE

LUNAR & PLANETARY LABORATORY

FALL 2020

LPL NEWSLETTER

OSIRIS-REx Samples Bennu



On October 20, the LPL-led **OSIRIS-REx** spacecraft made history for NASA when it tagged the surface of asteroid Bennu for 4.7 seconds, triggering a flush of nitrogen gas and collecting the largest sample of extraterrestrial material since the Apollo moon landings. In preparation for the sample collection, the spacecraft had spent two years photographing and mapping the asteroid in tremendous detail. Collecting a sample from Bennu involved what essentially amounted to parallel parking a 15-passenger van and dodging hazards including a boulder as tall as a two-story building – all 200 million miles away from Earth.

Two days after touching down on asteroid Bennu, the mission team received images confirming that the spacecraft has collected more than enough material to meet one of its main mission requirements – acquiring at least 2 ounces, or 60 grams, of the asteroid's surface material. The team soon realized the Touch-And-Go Sample Acquisition Mechanism (TAGSAM) head collector head appeared to be full of asteroid particles and that some of these particles were slowly escaping, likely through small gaps where a mylar flap—the collector's lid—was wedged open by larger rocks. In order to avoid sample loss, the team decided to forego a planned mass measurement activity in order to expedite the sample stowage process, originally scheduled for early November, and avoid sample loss.

The mission team spent two days working around the clock to carry out the stowage procedure, with preparations for the stowage event beginning Oct. 24. By the evening of Oct. 27, the spacecraft's TAGSAM, arm had placed the collector head into the Sample Return Capsule. The following morning, the OSIRIS-REx team verified that the collector head was thoroughly fastened into the capsule by performing a "backout check." This sequence commanded the TAGSAM arm to attempt to back out of the capsule – which tugged on the collector head and ensured the latches are well secured. On Oct. 28, the mission team sent commands to the spacecraft, instructing it to close the Sample Return Capsule; the spacecraft closed the lid and then fastened two internal latches. As of late Oct. 28, the sample of Bennu is safely stored and ready for its journey to Earth. StowCam images of the stowage sequence show that a few particles escaped during the stowage procedure, but the team is confident that a plentiful amount of material remains inside of the head.

OSIRIS-REx (Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer), launched from the Cape Canaveral Air Force Station in Florida on Sept. 8, 2016. It arrived at Bennu on Dec. 3, 2018, and began orbiting the asteroid Bennu for the first time on Dec. 31, 2018. The spacecraft is scheduled to return to Earth on Sept. 24, 2023, when it will parachute the Sample Return Capsule into Utah's west desert where scientists will be waiting to collect it.

Read more

- <https://osirisrex.arizona.edu/news>
- <https://www.asteroidmission.org>



WELCOME TO THE LPL NEWSLETTER

Tim Swindle, Ph.D.
Department Head and Laboratory Director

“It was the best of times. It was the worst of times.”

So said Charles Dickens at the start of *A Tale of Two Cities*. Ours is a tale not of two cities, but of one laboratory in three buildings. But Dickens’ description would fit the fall of 2020 for the **Lunar and Planetary Laboratory**. While editing this newsletter, I was reminded by one of our staff that I started a newsletter intro with the same quote in 2011. But I think I get to use Dickens once each decade, in part because I love the quote, and in part because it is the same combination of euphoria and mourning.

This fall was the best of times because, after more than 15 years of planning, proposing, finally getting accepted (that was part of the [Fall 2011 newsletter](#)), building, and flying, the **OSIRIS-REx** spacecraft finally sampled the asteroid Bennu. Not only did OSIRIS-REx get a sample, but the sample was so large that there was material leaking out of the sample canister before it was sealed. As well as the success of OSIRIS-REx, we had three students who successfully completed their careers (with Ph.D. defenses on Zoom), we had seven new graduate students join us, and we had a successful virtual version of **The Art of Planetary Science**.

But it was the worst of times, too. The COVID-19 pandemic meant that we spent the semester with virtually all of our interactions being virtual, with the associated stress of the lack of human companionship. Moreover, three valued members of the LPL family passed away: **Regents' Professor Emeritus Jay Melosh**, longtime **Senior Research Scientist Lyle Broadfoot**, and alumna **Nadine Barlow**.

You can read about all of this and more in this newsletter. For more science news, go online to catch up on OSIRIS-REx and other research from fall 2020: [LPL.Arizona.edu/news/2020/fall](https://lpl.arizona.edu/news/2020/fall).

Stay safe until we can all meet again in person.

Thanks to LPL Donors

We would like to thank all those who have donated to LPL in 2019 and 2020. Thanks for supporting research, education, and outreach at LPL.

Individual Donors: Jeffrey Andrews-Hanna, 2 Anonymous donors, Sushil Atreya, Victor Baker, Travis Barman, Jane Benfey, Ed Beshore & Amy Phillips, Dan Cavanagh, Elliott Cheu, David Choi, Jonathan Fortney, Yuhan Fu, Joe Giacalone, Eneida Guerra De Lima, Mary Guerrieri, Tristan Guillot, Christopher Hamilton, Lijie Han, Hao Yongqiang, Walt Harris, Bill Hubbard, Brian Jackson, Guy Jette, Michael Kaiserman, Chrysantha Kapuranis, Yohan Kaspi, Xenia King, Norm Komar, Jozsef Kota, Colin Leach, Martha Leake, Renu Malhotra, Alfred McEwen, Laura McGill, Bob & Gloria McMillan, Izetta M. Morris, Kelly Kolb Nolan, Molly O'Donnell, Jani Radebaugh, Timothy Reckart, Vishnu Reddy, Michelle Rouch, Didier Saumon, Christian Schaller, Kamber Schwarz, Dinah Showman, Margi Showman, Maria Steinrueck, David Stevenson, Cristie Street, Timothy Swindle, Eric Tilenius, Kathryn Volk, Janice Wallace, Michael Wong, Jun Yan, Xi Zhang, Ruth Zollinger

Corporate and Foundation Donors: Brinson Foundation, Exxon Mobil, Hitachi, Northrop Grumman



NADINE GAIL BARLOW (1958-2020)

Professor Nadine Barlow died on August 17. Nadine was an alumna of the University of Arizona, where she earned a B.S. in Astronomy (1980) and a Ph.D. in Planetary Sciences from LPL in 1987. Nadine's research spanned impact cratering on planets and satellites throughout the solar system, from Mercury to Pluto and her curiosity about cratering processes increased along with the reach of our satellite explorations. Her dissertation (**Relative Ages and the Geologic History of Martian Terrain Units**) mapped, measured, and classified every Martian crater larger than 8 km in diameter. These data were used to establish the detailed relative chronology of Martian geologic features. Nadine maintained and expanded this database throughout her career as later missions returned increasingly detailed images of the planet. After completing her Ph.D., Nadine held postdoctoral appointments at the Lunar and Planetary Institute and NASA's Johnson Space Center. In 1998, she became an Assistant

Professor at the University of Central Florida, where she was recognized with the **2002 University Excellence in Undergraduate Teaching Award**. Nadine joined the Department of Physics and Astronomy at Northern Arizona University (NAU) in 2002, becoming **Department Chair of Astronomy and Planetary Science** in 2010. At NAU, Professor Barlow was the recipient of numerous awards for teaching excellence and was largely responsible for doubling the size of the department and developing its curriculum into that of a doctoral program.

Professor Barlow supervised many students over the years and was a popular mentor and friend to those students. A prize for **Undergraduate Research Excellence** is being established at NAU's Department of Astronomy and Planetary Sciences in her name. Professor Barlow was active in the science community and academic outreach was also a priority; Nadine introduced the **Arizona Space Grant Program** to NAU, and fostered cooperation between NAU, Lowell Observatory, and the U.S. Geological Survey. Asteroid 15466 Barlow is named in her honor. (Excerpted from *Arizona Daily Sun*, September 1, 2020.)

A. LYLE BROADFOOT (1930-2020)

Dr. Lyle Broadfoot passed away on August 30. Lyle earned a Bachelor of Engineering at the University of Saskatchewan in Saskatoon, Canada, in 1956, and then spent two years as an engineer with the Defense Research Board in Ottawa. He returned to the University of Saskatchewan to earn an M.S. (1960) and Ph.D. (1963) in physics. Lyle worked for 15 years at the **Kitt Peak National Observatory** as a physicist in the space division. In 1979, Dr. Broadfoot became a research scientist and associate physicist at the Space Engineering Research Center at the University of Southern California, Los Angeles. Lyle joined LPL in 1982 as a **Senior Research Scientist**; he retired from LPL in 2003.



At LPL, Dr. Broadfoot led the group responsible for building the first Extreme Ultraviolet Spectrometers to observe every planet but Earth and Mars. He also discovered the auroras on Jupiter, Saturn, Uranus, Neptune, and determined the vertical profiles of atmospheric density and composition for Jupiter, Saturn, Uranus, Neptune, Titan and Triton by occultation. Dr. Broadfoot received multiple awards from NASA, including several **Exceptional Scientific Achievement Medals** and **Group Achievement Awards for Voyager** science instrument development and for Voyager science investigations. He was also recognized with **Group Achievement Awards** for the **Galileo** Gaspra encounter team and the Galileo Ida encounter/Dactyl discovery team. (Excerpted from *Marquis Who's Who*, February 22, 2019.)



H. JAY MELOSH (1947-2020)

Dr. Jay Melosh joined the LPL faculty in 1982. Before moving to **Purdue University** in 2009, he served as advisor for twelve LPL Ph.D. students and three M.S. students, and led many memorable LPL field trips. One of the world's foremost experts in impact cratering, Jay was elected to the **National Academy of Sciences** in 2003. He was named a University of Arizona **Regents' Professor** (2001), won the **Barringer Medal of the Meteoritical Society** (1999), the **Gilbert Award of the Geological Society of America** (2001), and the **Hess Medal of the American Geophysical Union** (2008). A tribute to Jay Melosh is available from **The Meteoritical Society** (Oct. 27, 2020): <https://meteoritical.org/news/h-jay-melosh-1947-2020>

CARSON FELLOWSHIP AWARDED TO SAM MYERS

FELLOWSHIP PROVIDES ONE ACADEMIC YEAR OF SUPPORT, INCLUDING TUITION, SCHOLARSHIP, AND SUPPLY STIPEND

Sam is a first-year graduate student at LPL; he seeks to understand how we might find and characterize inhabited exoplanets. Sam developed an early interest in math and physics, which led him to focus on science and physics in high school. He attended the University of Idaho specifically because of the opportunity to begin a research program as an undergraduate. At Idaho, Sam majored in physics and astronomy with LPL alumnus **Dr. Jason Barnes** as an advisor. Sam's first research experience as an undergraduate was characterizing exoplanet orbits; he also had the opportunity to assist with a graduate research project that led to the publication of his own work.



The **Lt. Col. Kenneth Rondo Carson and Virginia Bryan Carson Graduate Fellowship** is an endowment established by the estate of Virginia B. Carson, honoring her husband, a former member of the "Flying Tigers," a former member of the Joint Strategic Target Planning Staff Strategic Air Command, retired master navigator and enthusiast of space exploration. Colonel Carson greatly admired the professionalism and accomplishments of NASA's space program. The Carson Fellowship is awarded to students pursuing degrees in the Department of Planetary Sciences, Lunar and Planetary Laboratory, selected on the basis of academic achievement and the promise of further scholarly endeavor.



ADAM P. SHOWMAN DISTINGUISHED LECTURESHIP

YOUR GIFT WILL ENDOW A VISITING LECTURESHIP AT LPL

Professor Adam P. Showman passed away unexpectedly on March 16, 2020. His untimely passing has been felt widely in the international planetary science community which has lost an outstanding theorist, dedicated teacher of many graduate students, and a sought-after collaborator to a world-wide network of exoplanet astronomers.

Dr. Showman investigated the dynamics and evolution of planetary interiors and atmospheres, including those of the hundreds of giant planets that are being detected around other stars, and studied the atmospheric structure and dynamics of brown dwarfs. Dr. Showman also had a long-term interest in the atmospheric dynamics, climate, interior state, and geophysics of the terrestrial planets. Professor Showman was a renowned teacher who enjoyed explaining to his students the complicated details of planetary physics and hammering out ideas to solve research problems.

Join us in remembering our friend and colleague Adam Showman with a gift of any size for the **Adam P. Showman Distinguished Visiting Lectureship**. With your generous support, we plan to establish an endowed fund that will allow LPL to bring guest lecturers to campus in Adam's memory in perpetuity. We can think of no better way to honor him than to bring exceptional planetary scientists with similarly broad interests to engage with and inspire our students, just as Adam did. Donors to date have pledged a total of more than \$13,000.

Donate online <https://crowdfund.arizona.edu/project/20743>



HAMILTON WINS FULBRIGHT SCHOLAR AWARD

FULBRIGHT EXCHANGE PROGRAM IS SPONSORED BY THE U.S. GOVERNMENT

Associate Professor Christopher Hamilton is the recipient of a **Fulbright U.S. Scholar Award** to Iceland for *Planetary Analog Research in Iceland: Investigations of the 1783–1784 Laki and 2014–2015 Holuhraun Lava Flow-Fields*.

Dr. Hamilton will work with colleagues at the University of Iceland to document the products of Icelandic flood lava eruptions as well as their impacts on the environment, including astrobiologically relevant lava-water interactions.

Research objectives include:

- geomorphological mapping of the Holuhraun lava flow-field to relate observed surface textures to eyewitness accounts of the eruption;
- determination of sources for endospore-forming microbial organisms identified within Holuhraun's lava-induced hot springs;
- and examination of newly exposed deposits at the northern end of the Laki cone row, where a previously undocumented subglacial fissure segment is now exposed due to ice retreat.

HELIOSWARM SELECTED FOR PHASE A

KRIS KLEIN IS DEPUTY PI

Kudos to Assistant Professor Kristopher Klein, Deputy Principal Investigator for **HelioSwarm**, on having the mission proposal chosen by NASA as one of five Medium-Class Explorer proposals that will each receive \$1.25 million to conduct a nine-month mission concept study.

HelioSwarm would observe the solar wind over a wide range of scales to determine the fundamental space physics processes that lead energy from large-scale motion to cascade down to finer scales of particle movement within the plasma that fills space, a process that leads to the heating of such plasma. Using a swarm of nine SmallSat spacecraft, HelioSwarm would gather multi-point measurements and be able to reveal the three-dimensional mechanisms that control the physical processes crucial to understanding our neighborhood in space.



LPL PARTNERS WITH ASTEROIDS LABORATORY

LPL has partnered with the **ASTEROIDS Laboratory** (Asteroid Science, Technology and Exploration Research Organized by Inclusive eDucation Systems), a new, multi-disciplinary research and educational unit based in the **UArizona Aerospace and Mechanical Engineering** (AME) department and sponsored by **NASA's Minority Undergraduate Research and Education Program** (MUREP). The laboratory will apply planetary science principles to conceive, implement and validate space technologies—from systems design and control solutions, to robots and sensor networks, to mobility and excavation platforms for asteroid exploration and mining. The new lab is creating dozens of direct research opportunities for undergraduate students, thereby increasing the diversity of student and faculty involvement related to small missions in near-Earth space.

Students who join ASTEROIDS lead their own research projects under the mentorship of faculty and work with a team of experienced graduate students and staff to build a space-bound CubeSat that will advance planetary science objectives.

One of the centerpiece activities for the ASTEROIDS Laboratory is the development of AOSATs, or Asteroid Origin Satellites. These relatively low-cost 3U CubeSats, each about the size of a loaf of bread, are being designed to orbit the Earth and spin at approximately 1 rpm (the speed of a clock's second-hand) to simulate the weak but non-zero gravity field of asteroids. AOSATs have a customizable chamber that can be used for studying basic physics of asteroid accretion and evolution, or for testing technological approaches to asteroid mobility and excavation, or for developing approaches to water or mineral extraction under realistic gravity. Lessons learned from these AOSATs will be applied to the design of larger Earth orbiting satellites that can serve as permanent low-gravity research testbeds for the full-scale validation of future asteroid technologies, from exploration to resource extraction to hazard mitigation.

The ASTEROIDS program encourages new ideas and unconventional methods—examples include: efficient sample return from dozens of asteroids in one mothership mission; multi-spacecraft deployments of seismic and ground-penetrating sensors for global imaging of asteroid interiors; coordinated swarms of small-satellites to perform rapid imaging, multipoint observations, and persistent observations of surface features or events; orbiters that can perform multiple landings and resource assessments balanced on one or two extended booms; and a tiny inflatable lander that stays upright as a low-cost imaging/sensing outpost or node on the rapidly-rotating landscape.



*“Those of us who grew up on **Star Trek** know that the spaceships of the 23rd century will be made out of asteroid materials,” says **LPL Professor Erik Asphaug**, one of the members of the **ASTEROIDS** faculty team. “The science and engineering fields in academics can do much more to be representative of the diverse populations that we serve, and by focusing on small missions we’re creating a kind of melting pot where a lot of new ideas can come together and rapidly advance.”*

RECENT PTYS GRADUATES

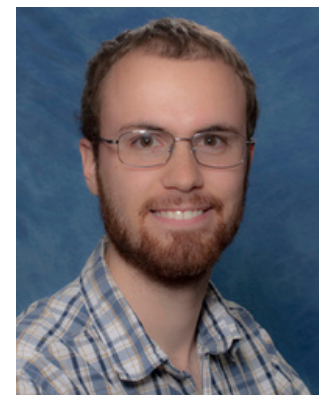


Saverio Cambioni, *On the Application of Machine Learning to Planetary Sciences*, Sept. 10, advisor: **Professor Erik Asphaug**.

Saverio is now a postdoctoral research associate at Caltech.



Kyle Pearson, *The Detection and Characterization of Transiting Exoplanets*, June 2, advisor: **Professor Caitlin Griffith**. Kyle is currently a Data Scientist at JPL.



Jess Vriesema, *Modelling Electrodynamics in Saturn's Upper Atmosphere*, Oct. 12, advisor: **Professor Roger Yelle**. Jess is currently an Associate Lecturer in the departments of Computer Science and Mathematics, Univ. of Wisconsin, Eau Claire.



BRAMSON AND SORI JOIN PURDUE FACULTY

LPL alumna **Dr. Ali Bramson** (2018) and **Dr. Michael Sori** (Ph.D. in Planetary Sciences, MIT) have joined the faculty of the Department of Earth, Atmospheric, and Planetary Sciences (EAPS) at Purdue University as Assistant Professors. Before joining Purdue, both Ali and Mike were postdoctoral scholars at LPL.

Ali and Mike will be teaching undergraduate and graduate courses in planetary geology while expanding their current research.

HÖRST AWARDED AGU MACELWANE MEDAL

LPL ALUMNA (2011) SARAH HÖRST



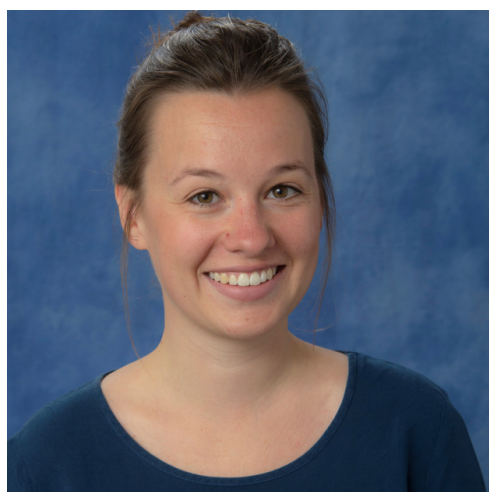
Dr. Sarah Hörst is the recipient of a 2020 **Macelwane Medal** from the American Geophysical Union (AGU). The Macelwane Medal is awarded to early career scientists making significant contributions to Earth and space science and recognizes excellence in research, creativity, service, outreach, and diversity.

In 2019, Sarah received a 2020 **Early Career Award** from the Laboratory Astrophysics Division of the American Astronomical Society, which recognized her work in advancing our understanding of photochemical haze formation in planetary atmospheres within our solar system and beyond. Dr. Hörst is currently Assistant Professor of Earth and Planetary Sciences at Johns Hopkins University.

EMILEIGH SHOEMAKER

John Mather Nobel Scholar

Third-year student **Emileigh Shoemaker** was named a **John Mather Nobel Scholar** for 2020. Scholars receive a \$3000 scientific travel grant over a two-year period, in support of costs for presenting research papers at professional conferences. The program is open to summer interns at NASA/Goddard Space Flight Center. Awards are given by The John and Jane Mather Foundation for Science and the Arts in partnership with the National Space Grant Foundation. Emileigh's advisor is **Associate Professor Lynn Carter**.



JOANA VOIGT

Earhart Fellowship

Joana Voigt has won an **Amelia Earhart Fellowship**. The \$10,000 fellowship is awarded each year by **Zonta International** to up to 35 women pursuing doctoral degrees in aerospace engineering and space sciences. The fellowship was established in 1938 in honor of Amelia Earhart, famed pilot and member of the Zonta Clubs of Boston and New York. Joana is a fourth-year student advised by **Associate Professor Christopher Hamilton**.

FINESST

Future Investigators in NASA Earth and Space Science Technology



ALESSONDRA SPRINGMANN

Inner Coma Grain Environments of Jupiter Family Comets
(Advisor: Walt Harris)



ZOE WILBUR

Investigating Degassing Histories of Apollo 15 and 17 Lunar Basalts with 3D Visualization and Coordinated Microanalysis (Advisor: Jess Barnes)

JOANA VOIGT

Deciphering Effusive Eruption Styles throughout Elysium Planitia, Mars: Linking Lava Emplacement Dynamics with Magmatic Storage Condition (Advisor: Christopher Hamilton)

NEW GRADUATE STUDENTS

SEVEN INCOMING STUDENTS FOR 2020/2021



Galen Bergsten

University of Utah
astrobiology,
exoplanets,
atmospheres



Mackenzie Mills

Johns Hopkins University
surfaces/interiors/small bodies



Dingshan Deng

Beijing Normal University
planetary formation,
astrobiology, exoplanets



Nathan Hadland

Florida Inst. of
Technology
astrobiology, surfaces,
exoplanets



Samuel Myers

University of Idaho
exoplanets, atmospheres,
planetary formation



Lucas Smith

Appalachian State University
cosmochemistry, planetary
formation, astrobiology



Samantha Moruzzi

Cornell University
surfaces/interiors/formation

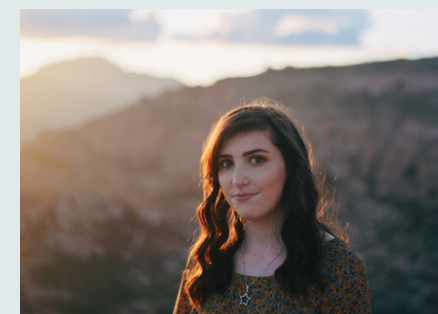
PTYS UNDERGRADUATE MINORS

25 students are pursuing minor programs of study in Planetary Sciences. We're proud to profile two of them here. For the complete Q&A, visit [LPL.Arizona.edu/news/2020/fall](https://lpl.arizona.edu/news/2020/fall)



Kerst Kingsbury is a Senior in Mining Engineering. He is minoring in PTYS to learn more about the universe and develop skills toward a career in Space Resources. A favorite PTYS course was **Geology and Geophysics of the Solar System** with **Dr. Christopher Hamilton**, because of the "research tree" approach that led to a final paper on Kerst's chosen topic, potential *in-situ* resources of the lunar surface. Kerst is currently researching a solution to the problem of processing *in-situ* resources in reduced gravity environments; he presented a poster on the research this past summer. He wants to build a career within the mining industry and hopes to address problems with environmental and social responsibility by developing more community-company dialogue and growing companies' social license to operate. Kerst says, "I would like to work in the Space Resources industry on the problem of processing resources from near-Earth asteroids and the lunar surface. This work would hopefully help to establish a permanent, sustained human presence on the Moon. This human presence must be incorporated from a diverse background, and I would like to use skills I develop working with local communities across Latin America and sub-Saharan Africa to help those people have an equitable presence in that endeavor."

Shavonne Morin is a Senior majoring in Astronomy and minoring in Geosciences and Physics as well as PTYS. She enjoys learning about the geology and chemistry of the planets. **Chemistry of the Solar System** with **Dr. Tim and Swindle** was one of her favorite classes in part because of being able to choose the topic of her term paper; **Geology and Geophysics of the Solar System** was another favorite. Shavonne is currently working on an optical microscopy project with **Dr. Jessica Barnes** (LPL), "We are focused on identifying and classifying the volcanic rock fragments present in Luna 16 & 24 soil samples, as well as doing electron microprobe analysis of the volcanic rock fragments identified." Shavonne also works with the **HiRISE** project to produce 3D digital terrain maps for use by Mars researchers; she has made 20 maps so far. Shavonne plans to pursue a Ph.D. in planetary science, or in geology, with a planetary science emphasis. As for her career goal, Shavonne says, "I would love to become a professor for a research university."





JOHN PURSCH

Computing Systems Manager **John Pursch** retired from LPL on November 30. John was hired as a Principal Support Systems Analyst in 2001, just after moving to Tucson from California, where he had worked as a programmer for various technology startups during the technology boom of the 1980s and 1990s. At LPL, John began supporting infrastructure systems and working his behind the scenes "magic" in supervising daily operations for LPL mail, web, and file servers, backups, and user support. John's programming skills can be found in scripts in almost every LPL infrastructure system, keeping everything in check and running smoothly.

John holds a degree in mathematics from Caltech. Before moving to Tucson in 2001, he traveled extensively. One of John's interests and talents is memorization. In 2010, John held the U.S. record for reciting the most digits of pi, with 2104 digits memorized. LPL computing staff came to rely on John's memory for details of LPL system implementations and associated problems (and solutions). John's other interests include the Rubik's Cube (his solution time is nearly less than 20 seconds), poetry (several of his works have been published online), and meditation. John's expertise, talent, and dedication over his long career has helped to build a computing infrastructure that will continue to support research and discovery at LPL.

MARIA SCHUCHARDT

Maria Schuchardt retired from LPL on October 12 after nearly 30 years of service. She began her LPL career in April 1991, primarily as department photographer. In 1998, Maria became the Data Manager for the **Space Imagery Center**, where she organized tours of the facility, facilitated access to the collection for researchers as well as the public, and provided educational resources and kits to visitors and educators. She began to coordinate outreach activities for the entire department, working with other campus groups to support university projects and better serve local communities. Maria developed and organized the extremely popular **Summer Science Saturday** program that brought several hundred visitors to the Kuiper Building each year for science activities. When the **Tucson Festival of Books** came on the scene, Maria coordinated the Science City section. Another programmatic highlight from Maria's portfolio is the very popular **LPL Evening Lecture Series**.



Maria also supported the work done by other groups at LPL. She coordinated the **Kuiper Board's** K-12 community outreach in Tucson and served as a point of contact for outreach requests from the community. In addition, she was actively involved with special events such as **The Art of Planetary Science**. Maria greeted prospective graduate students with a joke as she took their first LPL portrait; her annual grad student group photo was a tradition. Her reputation extended well beyond Tucson; for example, each year, Maria hosted a group of Norwegian students on a science tour of the U.S. She was always "in demand" in part because she infused every interaction with joy, positivity, and enthusiasm for communicating science. Maria was named a recipient of a **2020 University Award for Excellence**, which recognized her outstanding service to the university community and visitors.



POLIT WINS GODDARD ACHIEVEMENT AWARD

Anjani Polit was awarded a **Robert H. Goddard Exceptional Achievement Award for Engineering** by NASA's Goddard Space Flight Center. Anjani is a project manager with UArizona **Earth Dynamics Observatory** and the Mission Implementation Senior Systems Engineer for **OSIRIS-REx**.

Anjani has participated in proposal and operations development for a number of missions, including current roles as Science Operations Manager for the proposed **Io Volcano Observer** and Deputy Project Manager for the proposed **RUSHeS** instrument. Before joining OSIRIS-REx in 2016, Anjani was a Targeting Specialist for the **HiRISE** camera on the Mars Reconnaissance Orbiter and the Uplink Operations Lead for HiRISE. During this time, Anjani planned and commanded over 10,000 images of Mars. Anjani holds a B.A. in Geology from Pomona College and an M.S. in Geological Engineering from the University of Nevada, Reno.



LPLC 2020

BY ADAM BATTLE

The **Lunar and Planetary Laboratory Conference (LPLC)** marks the start of the academic year for many planetary scientists in the Tucson area. LPLC 2020 prefaced the Fall 2020 semester full of online classes, meetings, and conferences. Whereas LPLC typically involves multiple days of poster presentations and live presentations, this year's conference was streamlined to just five hours and allowed participants to transition into the strange pace of the academic year. Participants recorded short presentations which attendees watched in the week leading up to the conference. On the day of LPLC, each participant had five minutes to answer live questions from the audience. These Q&A slots were grouped by topic into four themed sessions, each of which had one or two invited speakers who gave live presentations to the attendees. Among the invited speakers was **Zarah Brown**, the winner of the "Best Grad Student Presentation" in 2019; Zarah gave a great talk on *Tracing Hydrocarbons in the Upper Atmosphere of Saturn*. The winner of this year's "Best Grad Student Presentation" award is **Teddy Kareta** who will be invited to give a talk at LPLC 2021.

LPLC 2020 had the same level of attendance as previous years with over 70 people joining to watch the talks and ask questions to fellow scientists. In addition to the invited speakers, almost 20 people gave presentations about their current or upcoming research. For a conference largely designed to bring the planetary science community together, LPLC met all of its goals despite the difficulties presented in 2020. The conference concluded with a bittersweet keynote from **Tim Swindle** about his decade of experiences as director of LPL, including all the lessons learned while leading such a unique and wonderful department.

CATALINA OUTER SOLAR SYSTEM SURVEY

CITIZEN SCIENCE

The **Catalina Sky Survey (CSS)** has launched a citizen science program available from the Zooniverse platform.

The **Catalina Outer Solar System Survey** aims to discover Trans-Neptunian Objects (TNOs), the most distant objects in our solar system. Observers with the CSS, whose primary mission is to find near-Earth asteroids (some of the closest objects in the solar system), review and compare CSS images of the night sky taken over a period of several months. These observers scan for TNOs by identifying their slow movement through the series of images. After potential TNOs have been filtered and identified by a computer, volunteer citizen scientists are engaged to review the image data and determine whether a TNO has been discovered.

If you would like to learn more and join the hunt for TNOs, visit the Catalina Outer Solar System Survey site:

<https://www.zooniverse.org/projects/fulsdavid/catalina-outer-solar-system-survey>



THE ART OF PLANETARY SCIENCE



A Virtual Odyssey

BY ALLISON McGRAW

Organizers of the seventh exhibition of **The Art of Planetary Science (TAPS)** were met with new challenges and unexpected opportunities. For the first six exhibitions, TAPS was a physical event that attracted approximately 1,000 guests to the **Kuiper Space Sciences Building**, which was transformed into a gallery displaying works of space art. This year, due to COVID restrictions, TAPS went completely virtual in displaying art galleries as well as in hosting speakers and ceremonies for the event.

The virtual event allowed for participation from a broader scope of artists and attendees who may not have been able to participate in past TAPS exhibitions, resulting in a record number of submissions (nearly 450). To accommodate viewing, three virtual art galleries (Data Art, Fine Art and Moon Art) were made available online from September 25-October 31. We plan to use the virtual art gallery capabilities in future exhibitions to maintain that accessibility for our international colleagues and guests.

For the first time in TAPS history, a special sub-theme category of Moon art was added in order to honor the history of the Lunar and Planetary Laboratory. The Moon Art gallery was very popular, and included over 100 submissions. This year's **International Observe the Moon Night** (September 26) was a great opportunity for TAPS to highlight and celebrate lunar art with observers around the world. Moon-themed presentations from LPL faculty and staff (**Steve Kortenkamp, Alfred McEwen, Steve Larson** and **Jessica Barnes**) helped show off the many years of lunar science, exploration, and continued research at LPL. The Moon "SLAM" poetry segment was a hit, despite being completely virtual. Our partnership with **Flandrau Science Center & Planetarium** continued this year, with a streamed showing of **Desert Moon**, a documentary about the role that Gerard Kuiper and LPL played in the space race and the Apollo program. This was accompanied by a live Q&A with the creator/director of the film, **Jason Davis**. Thanks to the **Mt. Lemmon Sky Center**, participants were able to observe the Moon, Jupiter, and Saturn live on NASA TV.

Other opening weekend events included an invited talk from the founder of TAPS, **Dr. Jamie Molaro**, a presentation from astro-photographer **Adam Block** about the interpretation of astronomical images, Flandrau's first live planetarium show since March, a musical performance by **Satellite Mirage**, an invited dance titled *The Tides of Mars from Circuit*, virtual solar telescope observing with **Tucson Amateur Astronomy Association**, live painting with PTYS graduate student **Laci Brock**, astro-photography tips with **Bettymaya Foott**, Director of Engagement for the International Dark-Sky Association, and an artist feature presentation from **Chrys Kapuranis**. Closing events included a **Haunted Skies** planetarium show, live at Flandrau, and a public telescope evening that was held in October. There was even a musical finale with **Nerd Immunity** and **DDouble Life** providing a rock-and-roll space-music stream.

The Art of Planetary Science would like to thank all the speakers, presenters and performers for contributions during this tumultuous time for humans on Earth. Best wishes to all on your virtual odyssey!

Video loops of submitted art are available on the TAPS web site
(www.lpl.arizona.edu/art/2020)

Virtual presentations and musical performances can be viewed on the TAPS YouTube channel
(www.youtube.com/channel/UCidCIVmrGC8YyLhyptnvvdQ)

LPL IN THE NEWS

Complete list of LPL headlines is available at: [LPL.Arizona.edu/news](https://lpl.arizona.edu/news)

Plumes on Icy Worlds Hold Clues About What Lies Beneath. New research co-led by LPL graduate student **Joana Voigt** shows how brine on Jupiter's moon Europa can migrate within the icy shell to form pockets of salty water that erupt to the surface when freezing; the findings are important for the Europa Clipper mission and may explain cryovolcanic eruptions across icy bodies in the solar system.

Escape from Mars: How Water Fled the Red Planet. New LPL-led research updates our understanding of how water escaped Mars—not like a leaky faucet but with a sudden splash.

Life on Ancient Earth and Alien Planets: UArizona to Lead NASA Astrobiology Projects. UArizona astrobiology researchers will establish two research teams to advance our fundamental understanding of early Earth biology and biogeochemistry, and with exploring which nearby planets outside our solar system may be suitable for hosting life.

OSIRIS-REx Successfully Touches Asteroid Bennu in Sample Grab. Ten years after NASA selected LPL to lead the OSIRIS-REx mission, the spacecraft successfully completed its most treacherous and rewarding task: sample collection.

OSIRIS-REx Spacecraft Collects Significant Amount of Asteroid. The spacecraft bit off more than it could chew, so the mission team expedited stowing the sample for the return trip home.

OSIRIS-REx Successfully Stows Sample of Asteroid Bennu. The mission team spent two days working around the clock to carry out the stowage procedure.

UArizona Mission Members Celebrate OSIRIS-REx Success. Members of the LPL-led OSIRIS-REx mission, along with UArizona leadership, gathered to watch NASA's live broadcast of the mission's much-anticipated Touch-and-Go, or TAG, sampling event.

What Touching an Asteroid Can Teach Us. NASA made history on Oct. 20 with its first-ever sample collection maneuver at an asteroid. LPL Professor Dante Lauretta, principal investigator for the OSIRIS-REx mission, discusses the significance of the mission for science and society.

An Asteroid of a Different Color...and Other Secrets of Bennu Unlocked. The LPL-led OSIRIS-REx mission collected a sample from asteroid Bennu on its first attempt. But before even touching the surface, scientists were learning about the material that makes up the asteroid.

Asteroid's Scars Tell Stories of its Past. Impact craters left by space debris in the boulders on asteroid Bennu's rugged surface allowed researchers to reconstruct the history of the near-Earth object in unprecedented detail.

NASA's OSIRIS-REx to Asteroid Bennu: "You've Got a Little Vesta on You..." Bits of the asteroid Vesta found on Bennu highlight the variety of asteroids in the solar system.

Where Rocks Come Alive: OSIRIS-REx Observes an Asteroid in Action. While studying asteroid Bennu up close, NASA's OSIRIS-REx spacecraft witnessed periodic outbursts of material being kicked up from the surface. A dedicated observation campaign revealed details of the activity and the processes likely causing it.

Jupiter's Moons Could Be Warming Each Other. The gravitational push and pull by Jupiter's moons could account for more warming than the gas giant Jupiter alone.

To Understand the Machinery of Life, a UArizona Scientist Breaks it on Purpose. By tinkering with some of life's oldest components, a group of astrobiologists led by UArizona's Betül Kaçar hope to find clues about how life emerged.