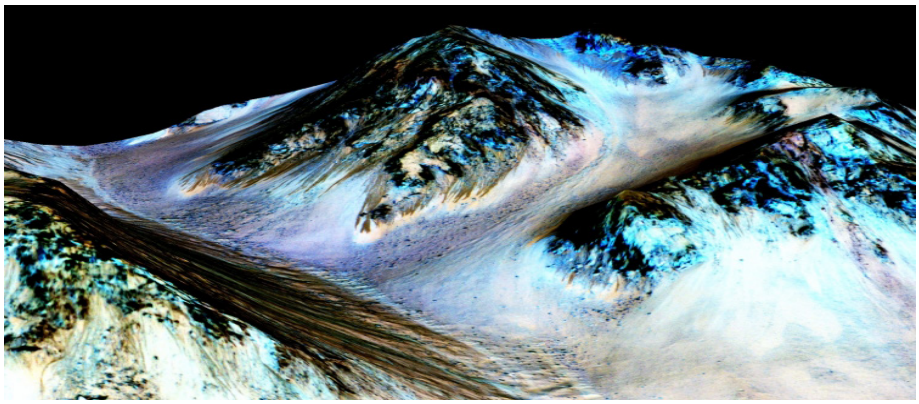
UA SCIENCE
LUNAR & PLANETARY LABORATORY
Department of Planetary Sciences

LUNAR AND PLANETARY LABORATORY NEWSLETTER FALL 2015

HiRISE Images Show Signs of Liquid Water on Mars

by Ari Spinoza - September 28, 2015



New findings from NASA's Mars Reconnaissance Orbiter provide the strongest evidence yet that liquid water flows intermittently on present-day Mars.

Researchers measured the spectral signatures of hydrated minerals on the planet's slopes where mysterious, possibly water-related streaks are found. Lujendra Ojha first discovered the streaks in 2010 when he was a University of Arizona undergraduate.

The streaks, known as recurring slope lineae, or RSL, darken and appear to flow down the planet's steep slopes during warm seasons when temperatures exceed -10 degrees Fahrenheit and then fade during cooler times.

Ojha was using images from the orbiter's High Resolution Imaging Science Experiment, or HiRISE, which is managed at LPL. HiRISE observations have now documented RSL at dozens of sites on Mars. The new study pairs HiRISE observations with mineral mapping by the same orbiter's Compact Reconnaissance Imaging Spectrometer for Mars, or CRISM.

Ojha, now a graduate student at the Georgia Institute of Technology, is lead author of a report on these findings published by Nature Geosciences in September (*Nature Geoscience* 8:829-832).

"We only found the hydrated salts when RSL were widest, which suggests that either RSL or the processes that form RSL is the source of hydration. In either case, the detection of hydrated salts on these slopes means that water plays a vital role in the formation of these streaks," Ojha said.

Alfred McEwen, director of LPL's Planetary Image Research Laboratory, said, "The presence of water on Mars today, however fleeting, raises the possibility of present-day life near the surface of Mars, so the RSL should be a key target for future exploration."

Ojha and his seven co-authors interpret the spectral signatures as caused by hydrated minerals called perchlorates. The hydrated salts most consistent with the chemical signatures are probably a mixture of magnesium perchlorate, magnesium chlorate and sodium perchlorate. Some perchlorates have been shown to keep liquids from freezing even when conditions are as cold as minus- 94 degrees Fahrenheit. On Earth, naturally produced perchlorates are concentrated in deserts.

McEwen, HiRISE's principal investigator, and CRISM principal investigator Scott Murchie of the Johns Hopkins University Applied Physics Laboratory are co-authors of the new report.

Welcome from the Director

Welcome to the LPL newsletter for Fall of 2015. This fall has been dominated by news of Mars. The most exciting is further evidence for liquid water present at the surface of Mars, based on the "Recurring Slope Lineae" detected by HiRISE. These were originally seen by Lujendra Ojha when he was an undergraduate working with Alfred McEwen and the HiRISE team. Lujendra continued to study these intriguing features when he went to graduate school at Georgia Tech. In a paper published this fall, he and Alfred (and others) showed that these features are associated with the presence of salts, suggesting that they do indeed represent salty water flowing across the surface of Mars.

A broader spectrum of Mars studies here was highlighted when the blockbuster movie "The Martian," about a stranded astronaut trying to survive on Mars, came out a week later. Alfred McEwen was interviewed several times about HiRISE, Peter Smith was interviewed about the Imager for Mars Pathfinder (IMP) that he built at LPL in the 1990s (and which is a key part of the movie), and there were stories about UA's lunar and martian greenhouse project, a part of Arizona Space Grant Consortium (headquartered at LPL).

In the middle of the summer, of course, the hot topic was Pluto, and as a member of the New Horizons mission science team, LPL's Veronica Bray was the face of the mission for a lot of the Southern Arizona public. Although it's not in the press releases, we noticed that the mission's surface composition team was led by LPL alum Will Grundy and that another LPL alum, John Spencer, was deputy lead for both the encounter planning team and the geology and geophysics team. And we're now less than a year away from the launch of the OSIRIS-REx asteroid sample return mission, headed by LPL's Dante Lauretta.

But while missions and movies are exciting, there is also exciting science going on every day, often without headlines. We feature some of them here, but we could never capture them all. We also have been working on helping the public understand our science, with events ranging from fairly traditional things like our Summer Science Saturday activities (which was again a big hit with Tucsonans this July), to less standard events such as the graduate students' spectacularly successful Art of Planetary Science show and even a joint event celebrating the UA Moon Tree, co-sponsored with the UA Poetry Center and the UA Arboretum.

What really makes LPL work, of course, is the people, and we've included some information about some of them here. There's information about new graduate students, but also about a couple of alumni who have returned as Research Scientists (Dr. Ellen Howell and Dr. Mike Nolan).

I hope you enjoy reading about what's going on in the LPL family, and please keep us up to date on what's happening in your life and career.

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

Astronaut Mark Kelly Joins LPL External Advisory Board

We are proud to welcome retired NASA astronaut and decorated U.S. Navy Captain Mark Kelly as a member of the LPL External Advisory Board. An experienced pilot who flew combat missions during the Gulf War, Mark Kelly became a NASA Space Shuttle pilot in 1996. He went on to pilot STS-108 (2001) and STS-121 (2006); he commanded STS-124 (2008) and STS-134 (2011). STS-134 was his final mission and the final mission of Space Shuttle Endeavour. Captain Kelly is familiar with LPL and its history, having narrated Desert Moon, the documentary about LPL and the start of the space program. He is the author of two very successful children's books: Mousetronaut: Based on a (Partially) True Story (2012) and its sequel, Mousetronaut Goes to Mars (2013). He and his wife, former Congresswoman Gabrielle Giffords, live in Tucson. Kelly's identical twin brother, Scott, is also an astronaut and is currently spending a year on the International Space Station.

Department

Kudos to Professor Alfred McEwen

Professor Alfred McEwen was named the recipient of the 2015 Whipple Award from the American Geophysical Union (AGU). The award, which recognizes outstanding contributions in the field of planetary science, will be presented at the 2015 AGU Fall Meeting in San Francisco. Past recipients of the Whipple Award (established in 1989) include Gene Shoemaker, David Stevenson, and Hap McSween. In addition, he was named a Galileo Circle Fellow in UA's College of Science, an honor reserved for 10% of the College faculty. Professor Renu Malhotra is the only other LPL faculty member named as a Galileo Circle Fellow.

Professor McEwen earned his Ph.D. in Planetary Geology from Arizona State University in 1988. He has been with LPL since 1996. He serves as director of the Planetary Image Research Laboratory and is a member of the imaging science team of the Cassini mission to Saturn; co-investigator on the Lunar Reconnaissance Orbit Camera (LROC) team; and principal investigator of the High Resolution Imaging Science Experiment (HiRISE) for the Mars Reconnaissance Orbiter (MRO). Professor McEwen has advised, mentored, and supported many students at both the graduate and undergraduate levels. In 2011, he received NASA's Distinguished Public Service Medal.

Christopher Hamilton Receives NASA Early Career Fellowship

Dr. Christopher Hamilton received a 2015 NASA Fellowship for Early Career Researchers, which was established to facilitate the integration of new planetary science researchers into funding programs and advanced positions. The award included $100,000 in support of establishing "Precision Geodetic Constraints for Terrestrial Analog Studies of Planetary Surface Processes." The award was used to purchase Differential Global Positioning System (DGPS) survey equipment through Trimble's University Partnership Program. The Trimble DGPS equipment was used to help support Dr. Hamilton's 2015 field campaign in Iceland.

Ellen Howell and Michael Nolan Join LPL Faculty

Dr. Ellen Howell received a Ph.D. from LPL in December, 1995. She moved to Puerto Rico, and worked as a post-doc in the Geology Department of the University of Puerto Rico, Mayagüez. She then spent 14 years at the Arecibo Observatory as a staff scientist. Ellen specializes in remote sensing of asteroids and comets, and combining different types of data at different wavelengths. She studies thermal properties of near-Earth asteroids, radar imaging, and compositional spectroscopy. She also studies the coma of comets at radio wavelengths, for which the Arecibo Observatory is especially well suited. Since returning to Tucson in August, she has been working on the OSIRIS-REx mission to Bennu, in the spectral analysis and imaging processing groups.

Dr. Michael Nolan returned to LPL in July as a Senior Research Scientist after twenty years at the Arecibo Observatory in Arecibo, Puerto Rico. After graduating with a Ph.D. from LPL in 1995, Mike joined Cornell University as a post-doctoral researcher at the Arecibo Observatory, and stayed at Arecibo in a number of scientific, technical, and management roles, including Observatory Director from 2008 to 2011. His research concentrates on the structure and evolution of asteroids and planetary surfaces using radar imaging and numerical simulation. At LPL, he will be the Asteroid Geophysical Scientist for the OSIRIS-REx project, and will continue remote sensing and modeling research on asteroids.

Department

Get to Know a Staff Scientist: Carl Hergenrother

Staff Scientist Carl Hergenrother is a member of the OSIRIS-REx science and operations team. He began his undergraduate career at the University of Arizona in 1991 and ultimately earned a B.S. in Atmospheric Sciences. Soon after arriving at the UA, he began working with LPL Senior Staff Scientist Steve Larson on CCD observations of comets. This work included helping Steve and Tim Spahr conduct a photographic survey for new asteroids and comets called the Bigelow Sky Survey, which was the precursor to the highly productive, and still active, CCD-based Catalina Sky Survey. Carl's current research also includes telescopic measurements of the activity level of comets and rotation and color photometry of near-Earth asteroids. Carl is an avid amateur astronomer and actively contributes visual, video and CCD observations of comets, meteors and variable stars. In support of amateur–professional astronomy collaborations, he serves as Associate Editor of the International Comet Quarterly; Handling Editor for the International Meteor Organization; Coordinator of the Comet Section of the Association of Lunar and Planetary Observers; Secretary of the American Meteor Society; and co-lead (with LPL Senior Research Specialist Dolores Hill) of the OSIRIS-REx Target Asteroids! program to characterize analogues to the OSIRIS-REx target Bennu. In addition to his astronomical pursuits, Carl enjoys following baseball, playing softball, collecting ancient Roman and Byzantine coins, reading just about anything on history and spending time with his wife, Alyse, and twin boys, Luke and Daniel.

Get to Know a Post-doc: Mike Sori

Mike Sori joined LPL in September 2014, working as a post-doctoral research associate on viscous flow modeling with Dr. Shane Byrne and Dr. Christopher Hamilton. His current research focuses on two specific areas. The first is quantifying the importance of ice flow in the evolution of topography at the poles of Mars, with a particular focus on steep scarps of ice. The second is a comparison of lava flow behavior between Earth and Mars, with a focus on quantifying stresses and predicting fracture locations. His planned future work at LPL will include extensions of these themes in addition to research on mountain-building on Io and ice on Umbriel. Mike is from Cooper City, Florida. He studied at Duke University, where he earned a B.S. in Mathematics and a B.A. in Physics (2008). Mike earned his Ph.D. in 2014 from Massachusetts Institute of Technology with a thesis focused on (1) gravity-based studies of topics in lunar geophysics including volcanism, isostasy, and impact cratering and (2) the development of techniques to analyze stratigraphy in the martian polar layered deposits. In theory, his free time is spent traveling, playing frisbee, and watching Duke win national championships, though in practice it is almost entirely spent with his puppy, Apollo.

Meet LPL Staff

Daniella DellaGiustina works as the Lead Image Processing Scientist for NASA's OSIRIS-REx Asteroid Sample Return Mission. She holds a B.S. in Physics from the University of Arizona, and an M.S. in Computational Physics from the University of Alaska. She got her start at LPL as an undergraduate in the Arizona Space Grant program working with Professor Dante Lauretta to characterize mineral phases in meteorites. Daniella returned to the University of Arizona in 2012 as a Research Scientist in the Department of Physics, and transitioned back to LPL in early 2014. In her spare time she is an avid rock-climber and outdoor enthusiast, and serves as a Director for the Climbing Association of Southern Arizona (CASA).

Kenny Fine is a Senior Systems Administrator with the Planetary Image Research Lab/HiRISE. He has been with HiRISE since 2010. As one of the team of systems administrators for the project, Kenny helps ensure that technical issues both large and small are resolved with minimal disruption to HiRISE science and operations. Prior to coming to LPL, Kenny studied Computer Science at the University of Colorado-Boulder and worked in industry and academia in Phoenix, Los Angeles, and Denver. He joined the Phoenix Mars Lander team in 2008, and enjoys the daily variety that comes with working on spacecraft missions. In his free time Kenny enjoys playing soccer, board games, computer games, and well, basically any kind of game.

Betty Fridena began work as LPL librarian in August. Betty is a native Arizonan born in Cochise County. She has worked at Steward Observatory (SO) for many years. How many? The current SO Director was a graduate student when she started working there. Before working for the UA, Betty was Serials Department Head at Pima Community College. You can be sure that experience is most likely the reason she started working with LPL serials collection first. She enjoys working at SO and LPL due to the international community, the great focus on mission by everyone no matter their position, and the interesting research areas. Be sure to stop by and welcome Betty and check out the changes to the LPL library.

Department

LPL Field Trip Fall 2015: Salton Sea

by Margaret Landis

Late October saw the PTYS 594A LPL field trip group heading off for three days of exploring the area around the Salton Sea, an inland body of water caused by accidental flooding in 1905. While accidental flooding may not make for the best planetary analog, the intermittent lacustrine history of the Salton Sea area is an interesting analog to both Mars and Titan. In addition to the Salton Sea itself, the surrounding Californian landscape was also home to dunes, faults, and mud volcanoes.

On Day One, we arrived at the Salton Sea by way of the Algodones Dunes, a dune field over 700 km2 in size that has been used as a movie set and recreation area. We were interested in the dunes themselves, formed from sediment from a previous paleolake that filled, at least in three distinct times, large amounts of the Salton Trough. We also took a moment to note the tectonic history of the Salton Trough and of the general basin and range province we had just driven through (and would continue to explore the rest of the trip). We camped the first night in the Anza-Borrego Mountains and were able to identify some of the edge of the dry lakebed of Lake Cahuilla, as well as numerous shells from the last period of lake filling.

On Day Two, our group visited mud volcanoes, unique features that erupt a mix of water and sediment due to pressurization from below (in this case due to the tectonic activity of the Salton Trough). We observed the eruptions of the sludgy material that built up almost person-height structures, and had an opportunity for mud volcano kite-based stereophotogrammetry conducted by LPL Associate Staff Scientist Stephen Scheidt.

Finally, we arrived at the Salton Sea. From the mined dacite domes (a safe distance from the shore), we were able to see the large body of water, populated by pelicans and other migratory water birds. We discussed the catastrophic formation of the Salton Sea from an overflowing notch in the Colorado River 110 years ago, subsequent recreational use, and continuing salinization and eutrophication as agricultural runoff slowly becomes the inland sea's only source of water (direct water supplies will be cut off by 2018 as a drought mitigation measure). The Imperial Valley is still a major producer of dates and other crops, serving as a reminder of how human land use, the environment, and geology all play a role in changing terrestrial landscapes.

We spent our remaining time at the Salton Sea continuing to explore the dune types, dry lakebeds, and alluvial fans of the strongly tectonic and variably lacustrine environment. Our group camped at Clark Dry Lake to observe another dry lakebed and vegetated dunes. On Day Three of the field trip, we went in search of the tufa deposits left by the previous high stands of lakes in the area, observed dunes in action as they crossed a paved (and previously accessible) road, and took a few minutes to discuss the long history of humans in the Southern California coastal regions before returning to Tucson.

LPL graduate student Ben Lew gives a talk. (Photo: M. Landis)

Group photo at a Salton Sea dune, with the inland sea in the background. (Photo: S. Byrne)

Raw kite image of the mud volcanoes. (Photo: S. Scheidt)

Outreach

UA Moon Tree Commemoration

by Dolores Hill and Maria Schuchardt

On October 30, LPL hosted a celebration of the University of Arizona (UA) Bicentennial Moon Tree, located between the Kuiper Space Sciences Building and Flandrau Science Center. The event was a collaboration of the UA Campus Arboretum, Lunar and Planetary Laboratory, UA Poetry Center, and the UA Laboratory of Tree-Ring Research.

The UA Moon Tree, an American sycamore, was planted on Arbor Day, April 30, 1976, in honor of the U.S. Bicentennial. Prescott and Flagstaff received the same honor, but the UA tree is the only original moon tree remaining in Arizona. David Williams at NASA Goddard Spaceflight Center documents it as one of only 64 surviving moon trees located around the world. The tree began as part of a U.S. Forest Service experiment on germination conducted by Astronaut Stuart Roosa, who carried 400-500 tree seeds (a mix of five species) to lunar orbit and back on the Apollo 14 mission to the Moon in 1971. The seeds experienced 34 orbits around the Moon and 9 days 2 minutes in space. During post-flight decontamination, the seed container burst open and the seeds commingled. However, they were sorted and eventually germinated properly after all.

Mr. Jack Roosa, Tucson resident and son of Apollo 14 astronaut Stuart Roosa, was the keynote speaker for the UA Moon Tree celebration. Tyler Meier, Executive Director of the UA Poetry Center, discussed the connection between words, events, emotions, and the environment. He recited a poem titled, "The Sycamore," by Wendell Berry. LPL Director Dr. Tim Swindle recounted the fast-paced events that led to LPL's involvement at the very beginning of the U.S.–Soviet race to the Moon in the 1960s and Apollo missions. He described the experiences that prepared LPL founder Dr. Gerard P. Kuiper, lunar astronomer Ewen Whitaker, and others for their future service to our country's robotic and manned lunar programs. Also speaking at the commemoration was Dr. Steve Leavitt, Acting Director of the UA Laboratory of Tree-Ring Research, who made a presentation about A.E. Douglass and his work with astronomy with dendrochronology, from Lowell Observatory to the University of Arizona. Dr. Tanya Quist, Director of the UA Campus Arboretum, reminded us of the beneficial interconnection between trees, science, poetry, and art. Retired LPL scientist and Moon expert Ewen Whitaker was in attendance and able to share his experiences from the early days of the space program and the Apollo program.

The event also featured LPL exhibits of Apollo 14 images, original photographs from the collection of LPL lunar atlases, and other memorabilia; the other sponsoring departments displayed posters and materials pertaining to poetry, tree rings, and the Campus Arboretum. In addition, world-renowned space artists Simon Kregar, Michelle Rouch, and Jim Scotti graced the scene with beautiful Apollo-themed art pieces. Ms. Rouch created an original Moon Tree art piece especially for the celebration. The Tucson Amateur Astronomy Association brought telescopes for a stargazing party in hopes that it might clear. The evening ended with a special viewing of the award-winning film, Desert Moon, by filmmaker Jason Davis. The commemoration was a fitting, interdisciplinary, tribute to the legacy of Stuart Roosa and the moon tree project.

Jack Roosa visits with Ewen Whitaker

The UA Moon Tree

From Left to Right: Danielle, Kathleen, Jack, and Nannon Roosa. Photo courtesy: Michelle Rouch.

Outreach

The Art of Planetary Science Fall 2015

by Jamie Molaro

Again this fall, LPL hosted The Art of Planetary Science, an exhibition of art celebrating the beauty and elegance of science. This volunteer science outreach project was organized by graduate students Jamie Molaro, Sarah Peacock, James Keane, and Hannah Tanquary. Now in its third year, the show has really come into its own!

This year was by far our best year yet. Not only did we display more art than in the previous two years, but we've also made connections across campus that have brought new facets to the event. For example, we featured a special exhibit from the UA Museum of Art on legendary space artist Robert McCall. McCall worked as an artist for NASA, documenting the history of the space race. He was one of the first to combine science and art, and the impact of his work is still important today. His fantastical planetary landscapes and scenes futuristic spacecrafts and astronauts can be found on postage stamps, NASA mission patches, at the National Air and Space Museum, the National Gallery of Art, the Pentagon, Epcot Center, and the Lyndon B. Johnson Space Center. He has even contributed to numerous films, such as 2001: A Space Odyssey and Star Trek: The Motion Picture. This special display honored his work and his role in bringing science to the public. We were thrilled to be able to work with the UA Museum of Art, and will continue that partnership going into the future.

We also worked with an undergraduate class from the UA School of Art on art and community engagement. The students in this class organized "art interventions," interactive and collaborative art projects that show attendees could participate in during the exhibition. One group interviewed attendees about what inspired them about art and science, and is creating a video about the art show. Another group had paper tiles to color, which when put together, created colorful mosaics depicting visual representations of scientific equations. A third group built a chalkboard which simply had a fill in the blank statement: "When I look at the sky, I _____." These (very popular) projects brought a new level of engagement to the art show by allowing attendees to also become artists.

Despite inclement weather, there were approximately 750 attendees for the show.

We are already looking forward to next year, and know it'll be even better! This year included increased participation from graduate students and postdocs, and we hope to see more involvement from faculty and staff in the future. If you'd like to learn more about the event, feel free to email us at art@lpl.arizona.edu, or visit our webpage at www.lpl.arizona.edu/art.

Graduate

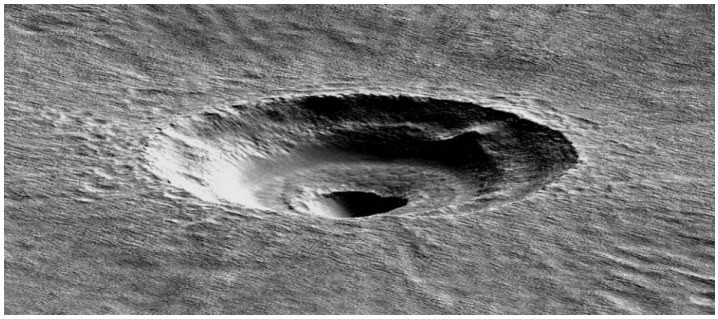
Terraced Craters: Windows Into Mars' Icy Past

LPL graduate student Ali Bramson spotted a "crazy-looking crater" on the face of Mars—terraced, not bowl shaped, like most craters of the same size. "It's worth mentioning that terraced craters of this size are quite rare," says LPL Associate Professor Shane Byrne. "But in this area of Mars (Arcadia Planitia), there are a lot of terraced craters. The craters may have formed at different times, but they all have terraces, which indicates something weird is going on in the subsurface."

Bramson and her colleagues created 3D models of craters in Arcadia Planitia using LPL's High Resolution Imaging Science Experiment (HiRISE) camera onboard the Mars Reconnaissance Orbiter (MRO). They then used MRO's Shallow Radar (SHARAD) instrument to beam radar pulses to Mars, allowing them to measure the time it took for the radar signals to penetrate the surface's buried layers and bounce back. Bramson combined the two data sets to measure the radar waves' speed, a pivotal clue to the layers' composition. In this crater's case, the layers turned out to be ice, and lots of it. Just beneath Mars' dirt surface, or regolith, the researchers found an enormous slab of water ice, measuring 130 ft thick and covering an area equivalent to that of California and Texas combined.

While the presence of ice came as little surprise to Bramson and Byrne, its age, amount and location did. Although scientists have known for some time about Mars' icy deposits at its poles and have used them to look at its climatic history, knowledge of icy layers at the planet's midlatitudes, analogous to earthly latitudes falling between the Canadian-U.S. border and Kansas, is something new.

"Knowing where the ice is and how thick it is can tell you about Mars' past climates," Byrne says. "The fact that the ice is so thick and widespread leads us to think it came into place during one of Mars' past climates when it snowed a bunch, ice accumulated, was buried, and then preserved. There have been a lot of climate changes between now and the tens of millions of years ago when we suspect the ice was put there. But it shouldn't be stable today, and other past climates of ice instability in this region mean the ice should've sublimated away into the dry Martian atmosphere by now. So, that's what we need to investigate."



Recent PTYS/LPL Graduates

Congratulations to Jamie Molaro and Davin Flateau, LPL's most recent graduates!

Jamie Molaro defended her Ph.D. dissertation titled, "Stress, on the Rocks: Thermally Induced Stresses in Rocks and Microstructures on Airless Bodies, Implications for Breakdown," on July 29, 2015. Her research advisor was Associate Professor Shane Byrne. Jamie has begun work as a NASA postdoc at JPL with Dr. Paul Hayne.

On November 23, Davin Flateau defended his M.S. thesis titled, "Weather On Other Worlds IV: In-Depth Study Of Photometric Variability And Radiative Timescales For Atmospheric Evolution In Four L Dwarfs." Davin's research advisor was Assistant Professor Daniel Apai.

2015 Incoming Graduate Students





From left to right: Tracy Esman (University of Virginia), Nathanial Hendler (University of Arizona), Ben Lew (National Tsing Hua University), Maria Steinrueck (Vienna University of Technology), Sarah Sutton (University of Arizona)

Graduate

Sarah Sutton is Recipient of University Fellows Award

Incoming PTYS graduate student Sarah Sutton received a University Fellows Award from the Graduate Center at the University of Arizona. The University Fellows award is a prestigious fellowship offered to the University of Arizona's top incoming graduate students. Sarah is new to the PTYS graduate program, but she has been a member of the HiRISE team since 2006. She works as a Photogrammetry and Image Processing Scientist, developing methods to correct geometric distortions of images (produced by spacecraft pointing jitter), which not only improve digital terrain models and orthoimages, but are also valuable and applicable to other scientific studies and to certifying landing sites.

Spring 2015 GTA Award to Ethan Schaefer

Ethan Schaefer earned the Outstanding Graduate Teaching Assistant Award for Spring 2015. Ethan earned the award for his work as a GTA with Professor Joe Giacalone in the PTYS/ASTR 206 class, which is a General Education Natural Sciences Tier II course. He is a fifth-year graduate student working with Professor Alfred McEwen. Recipients of the Outstanding GTA Award receive funds of up to $1,000 to travel to a professional meeting of their choice.

Keane Receives Shoemaker Award

LPL graduate student James Keane was awarded the 2015 Shoemaker Impact Cratering Award from the Planetary Geology Division of the Geological Society of America. The award comes with a $2500 prize for the study of cratering processes and impact craters. Assistant Professor Isamu Matsuyama is James' advisor.

2015 NESSF Awards

Kudos to LPL graduate students with new or continuing NESSF (NASA Earth and Space Science Fellowship) Awards!

New for 2015:

Hamish Hay, "Tidal Dissipation in the Subsurface Oceans of the Icy Satellites" (advisor: Isamu Matsuyama)

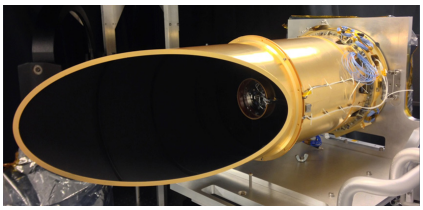
Sarah Peacock, "Understanding the Early Evolution of M Dwarf Extreme Ultraviolet Radiation" (advisor: Travis Barman)

Renewed for 2015:

- Patricio Becerra, "Wavelet Analysis of Martian Polar Stratigraphy from HiRISE Topography" (advisor: Shane Byrne)
- James Keane, "Stability of Asteroidal Regolith During Planetary Close Approaches" (advisor: Isamu Matsuyama)
- Tad Komacek, "Magnetic Effects in Hot Jupiters" (advisor: Adam Showman)
- Cecilia Leung, "Mesoscale Meteorological Modeling of the Martian Hydrological Cycle" (advisor: Alfred McEwen)
- Kelly Miller, "Tracing Sulfur in the Early Solar System with the Rumuruti Chondrites" (advisor: Dante Lauretta)
- Sarah Morrison, "Multiple Planet-Debris Disk Interactions: Probing Planetary System Evolution" (advisor: Kaitlin Kratter)
- Xianyu Tan, "Atmospheric Circulation of Brown Dwarfs" (advisor: Adam Showman)
- Michelle Thompson, "Understanding Space Weathering of Asteroids and the Lunar Surface: Analysis of Experimental Analogs and Samples from the Hayabusa and Apollo Missions" (advisor: Tom Zega)

LPL in the News

The All Seeing Eyes of OSIRIS-REx



The OSIRIS-REx Camera Suite, or OCAMS, is a set of three cameras designed to support the mission to the asteroid Bennu by imaging Bennu. The complexity of the mission is one of the reasons the spacecraft is fitted with three cameras. The other is redundancy—the cameras can provide backup if the need arises. The three cameras and their functions are:

• PolyCam: essentially an 8-inch telescope that doubles as a microscope. It will be the first to spot the asteroid from a million miles away. Once closer, PolyCam will help identify dangerous areas on the asteroid's surface by spotting and mapping large boulders and rocks, and characterize a dozen prospective sample sites in detail. It has a focus mechanism that converts it from a telescope into a microscope.

• MapCam: The medium-resolution Mapping Camera, or MapCam, will search for potential hazards to the spacecraft, such as small rocks trapped in Bennu's orbit, or outgassing plumes. MapCam will map the entire surface of Bennu from a safe distance of three miles, watching Bennu spin through a whole asteroid day every four hours and 20 minutes.

• SamCam: Once a suitable sampling site has been identified, the Sampling Camera, or SamCam, continuously documents the spacecraft's final trip onto the asteroid's surface and the sampling sequence. OSIRIS-REx is equipped to make three attempts at scooping up a sample of material from Bennu's surface. SamCam watches as the spacecraft's sampling arm touches the surface and jets of nitrogen gas blow pebbles and dust into the sampling chamber. During sampling, SamCam wears "safety goggles" in the form of one of three filters that are placed in front of the lens.

PolyCam's optics and structure were built through the UA College of Optical Sciences and LPL, while SamCam and MapCam were made exclusively by LPL. PolyCam's focus mechanism has been patented (LPL's first patent), and while the team that built the cameras has done its work, an engineering center will remain at LPL to take on outside work from companies such as Raytheon. "Our mission tries to attempt a lot of things at the same time," said OCAMS instrument scientist Bashar Rizk. "Navigation, mapping, reconnaissance, sample site selection, sampling—we do it on the same trip, so we need to understand what is going on at the asteroid at all times, so we can make decisions in real time when we're there. The most important goal of these cameras is to maximize the chances of successfully bringing back a sample."

Pluto: A Dream 3.7 Billion Miles in the Making

As a child, LPL Associate Staff Scientist Dr. Veronica Bray envisioned herself, "standing in mission control while images were coming down from a world no one had ever seen." Today, Bray is a science team member of NASA's New Horizons mission. On July 14, 2015, after spending almost 10 years traversing a 3.7-billion miles of space, the New Horizons spacecraft arrived at the Pluto system—consisting of Pluto and five lesser moons known as Charon, Hydra, Nix, Styx and Kerberos—providing the first close-up images of the dwarf planet. During the two weeks of New Horizons flyby, the science team met at the mission headquarters at Johns Hopkins University's Applied Physics Laboratory to ensure the mission gathered as much scientific data as possible. For Bray, the mother of a 4-month-old, this means dialing in every morning at 5 a.m. Arizona time.

Bray was able to join the mission team thanks in large part to a professional development grant funded by LPL. She will help interpret scans of Pluto's surface for evidence of craters. "Because I do computer simulations of impacts, I tend to think of the process visually," she says. "I see it happening in my simulations, and that allows me to interpret the shape of crater a bit differently from someone who, say, looks only at images taken of actual craters." The team will use data from two cameras aboard the New Horizons probe: the Long Range Reconnaissance Imager, and the Multispectral Visible Imaging Camera. "We'll compile the image data into a large mosaic, and we'll mark out the different geologic units that we recognize. As soon as we get data from the composition team, we can draw units based on not only what they look like but also what their composition is, and then we will count craters and assign approximate ages to the different parts of the surface." Once stereo images become available, Bray and her team will be able to create terrain models and measure how deep the craters are, revealing clues about Pluto's surface consistency and how the impact velocity affects the depth of craters. "I'll be struggling to pull out the information about what made the craters as they are," Bray says. "If there is any subsurface activity, the heat flow will make the craters shallower. Figuring out what makes a crater look like it does is like solving a Rubik's Cube." "Pluto is the last world in our solar system that we have not yet imaged up close," Bray says, "and this time, I can stand in mission control and watch."

Invest in LPL

Summer Travel: 2015 Curson Travel Award

The Curson Travel Scholarship helped support travel for two LPL graduate students this summer.

Ali Bramson in Iceland

Funding from the Curson award supported fourth-year student Ali Bramson's travel to Iceland to attend a joint team meeting for the HiRISE camera and the European Space Agency's Colour and Stereo Surface Imaging System (CaSSIS) instrument being built for the ExoMars Trace Gas Orbiter. The team meeting, held in Lake Myvatn from September 1-7, had the goal of encouraging collaboration between American and European spacecraft teams and scientists. Ali presented her research results at the meeting. In addition, for the two weeks before the team meeting, Ali participated in the Terrestrial Analogs for Planetary Surfaces field campaign under the direction of Assistant Professor Christopher Hamilton. Students studied and mapped the Holuhraun lava flow using a variety of tools, including differential GPS, unmanned aerial vehicles, a LiDAR scanner and thermal instruments. Ali reports, "Because my research interests are in working with remote sensing data to learn about planetary surface processes, this was an amazing opportunity for me to be involved with a field campaign to study terrestrial analogs, as studying processes on Earth provides the best way to 'ground truth' remote sensing observations. Participating in this field campaign improved my remote sensing knowledge and helped me to continue to work on developing my intuition for geologic and physical processes of planetary surfaces."

Kelly Miller is a fifth-year graduate student advised by Professor Dante Lauretta. She studies a group of primitive meteorites called the Rumuruti chondrites, which are formed in an environment that was rich in gaseous oxygen and sulfur. These elements are both biologically significant, and are among the ten most abundant elements in the Solar System. They are also relatively volatile, which means that they transition from the gas phase to the solid phase at low temperatures. Kelly's research focuses on understanding how, when, and where the R chondrites experienced oxygen- and sulfur-rich environments. The Curson award helped fund her travel to the Gordon Research Conference on Origins of Solar Systems, held June 28 to July 3, in South Hadley, MA, where she presented her research. Kelly notes that the "conference aims to foster a strong sense of community through frequent discussion sessions, communal meals, and a limited number of attendees. Attending the conference provided an excellent opportunity for networking and the exchange of ideas."

Kelly Miller

2015 Carson Fellowship to Nathanial Hendler

Nathanial Hendler is the recipient of the 2015 Carson Fellowship Award, which provides one academic year of support, including salary, tuition and a small supply stipend. Nathanial is beginning his first year of graduate studies at LPL. Nathanial is currently working with Dr. Pascucci to investigate the disk mass stellar mass relation using the Atacama Large Millimeter Array. He is interested in the evolution of the Solar System, planet formation, and the cosmochemistry of protoplanetary disks. More information about the Carson Fellowship and past recipients is at https://www.lpl.arizona.edu/graduate/fellowships/carson-graduate-fellowship.

Nathanial Hendler

LPL in the News

Links to the news stories below and others are available at: http://www.lpl.arizona.edu/news/2015/fall

OCAMS, UA Built Camera, Ready for Space Adventure - The OSIRIS-REx camera suite.

Microscopic Findings, Astronomic Implications - Planetary scientists are advancing our understanding of the local galaxy by analyzing grains of stardust preserved in meteorites.

The Life of the 'Moon Tree' on Campus - The seed of a sycamore tree nestled between the Kuiper Space Sciences Building and the Flandrau Science Center and Planetarium orbited the moon on Apollo 14's mission more than 40 years ago.

HiRISE Spots Huge Avalanche on Mars- Probe captures 65ft cascade of carbon dioxide scarring the red planet's surface.

Arizona Astronomers Track Piece of Falling Space Junk - A piece of space junk falls to Earth. Arizona astronomers discovered the object and track its firey descent.

Kuiper's Work Still Relevant Today - Today's space missions are still being built on the work of Kuiper.

New UA Grad to 'Pilot' OSIRIS-REx Spacecraft - Daniel Wibben, who spent his undergraduate and graduate years as a member of the team planning the OSIRIS-REx asteroid mission, was hired by an Arizona-based space navigation company to help steer the spacecraft to the asteroid Bennu and back.

Astronomers Discover 'Young Jupiter' Exoplanet - A team of scientists, including LPL's Associate Professor Travis Barman, has discovered a new exoplanet using the latest planet-hunting tool.

Icy Secrets From the Dawn of Time- As NASA's Dawn spacecraft spirals closer toward the surface of dwarf planet Ceres, a UA planetary researcher is hoping for new insights into how our solar system came to be.

Spiral Arms Discovered in Planet-Forming Disk - According to a new paper co-authored by UA researchers, an ultra-rare spiral structure lives inside a planet-forming disk, some 400 light-years from here.

Weird Orbit Puzzles, Fascinates Astronomers - Pluto's orbit may hold the key to the development of our solar system.

Likelihood Low of Danger From Asteroid- Eric Christensen, director of the UA's Catalina Sky Survey, talks about the odds and consequences of an asteroid wreaking havoc on Earth.

'The Martian' Food-Growing System: It's Here - A team of UA researchers can already "farm" on the red planet with a fully functional prototype greenhouse that produces sweet potatoes and strawberries.

LPL Part of UA Delegation to Japan - Recent overseas visit by a University delegation indicates that the relationship will extend beyond the parallel asteroid-sample missions of OSIRIS-REx and Hayabusa 2.