

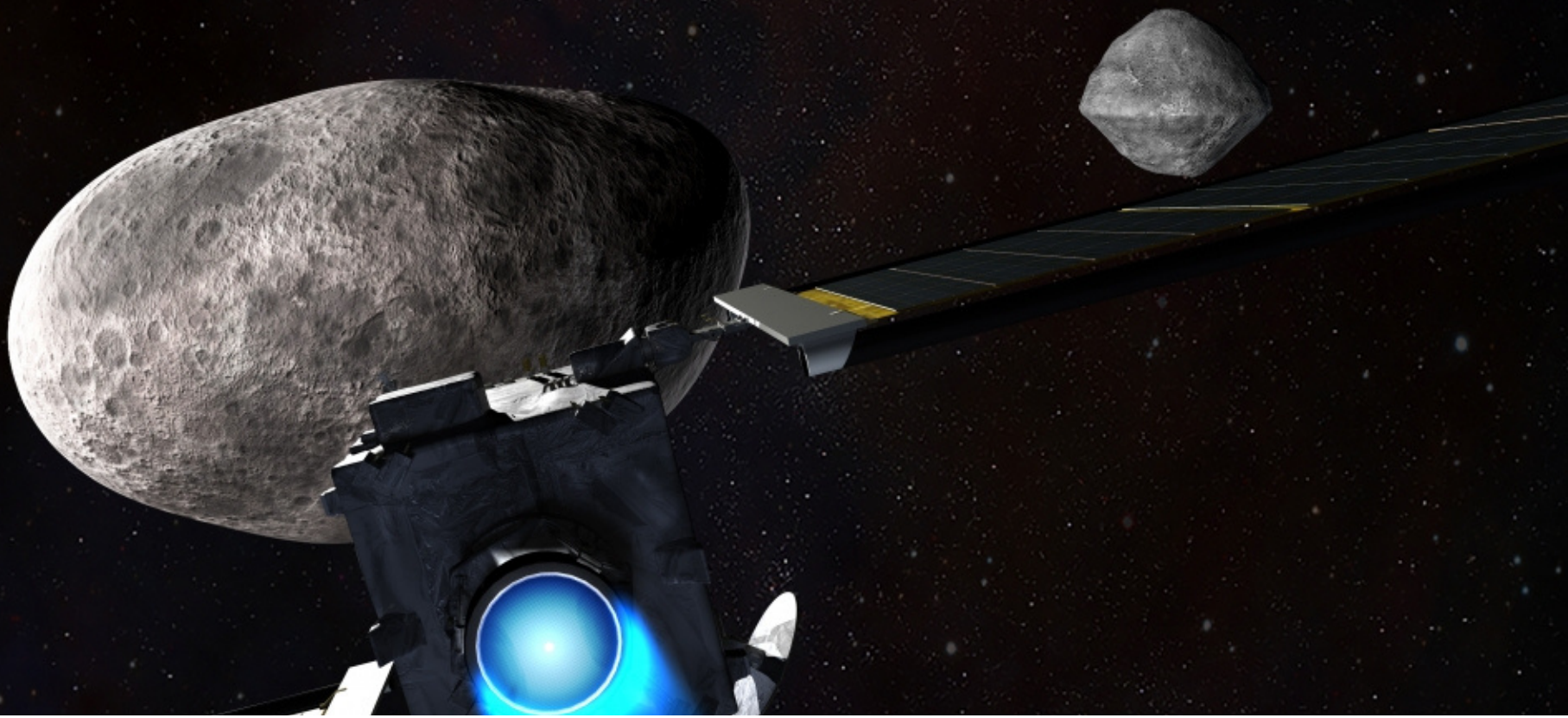


THE UNIVERSITY OF ARIZONA
COLLEGE OF SCIENCE

LUNAR & PLANETARY LABORATORY

FALL 2022

LPL NEWSLETTER



Spacewatch Discovered Binary Asteroid System Didymos, targeted by DART mission

On Sept. 26, 2022, NASA's **Double Asteroid Redirection Test (DART)** mission spacecraft slammed into asteroid Dimorphos, giving scientists the opportunity to study how the impact altered its orbit around its larger twin, Didymos. DART launched on Nov. 24, 2021, with the aim of testing technology that could redirect asteroids that potentially threaten life on Earth.

But it was on a spring night in 1996 that a camera on the University of Arizona Steward Observatory's 36-inch telescope atop Kitt Peak captured three important images of a bright object sweeping across a backdrop of seemingly static stars. The object turned out to be a half-mile-wide, potentially hazardous near-Earth asteroid, caught on camera by **Joseph Montani**, a member of the university's **Spacewatch** group at LPL. Originally dubbed **1996 GT**, the asteroid would later be renamed **Didymos** – Greek for "twin" – at Montani's suggestion. The name was inspired by the discovery in 2003 that the asteroid has a small companion, only 525 feet across.

Spacewatch is led by principal investigator **Melissa Brucker**. She is also on the science investigation team for DART. Spacewatch and other research groups plan to collect data on the light reflected from the two asteroids after impact. "We'll take a long series of images to measure the brightness of the system over time. Didymos and Dimorphos will look brighter when they're next to each other than when one is in front. In a series of images, we will be able to determine how long it takes Dimorphos to orbit Didymos," Brucker said. "Working on this mission is very exciting. I've been working on near-Earth asteroid tracking for eight years, so being able to participate in the first planetary defense demonstration is a really great opportunity."

Spacewatch was founded by LPL planetary scientists **Tom Gehrels** and **Robert S. McMillan** in 1980. The original goal of Spacewatch was to survey and discover small objects orbiting the sun, such as asteroids and comets, to better understand the evolution of the solar system. Spacewatch started shifting focus in 1998 and now follows up on discoveries made by astronomical surveys, such as LPL's **Catalina Sky Survey**, by monitoring the positions and movement of newly discovered potentially hazardous objects so that they do not become lost.

Spacewatch continues to use the Steward Observatory 0.9-meter (36-inch) telescope atop Kitt Peak, as well as the LPL 1.8-meter (72-inch) telescope, which has been operational on Kitt Peak since 2002. As one of the longest running asteroid tracking groups, Spacewatch can claim many firsts. It was the first group to use a **charge-coupled device (CCD) camera** to routinely survey the sky for comets and asteroids. It also claims the first CCD-discovered near-Earth asteroid, 1989 UP (now called 496816), and comet, dubbed 125P/1991 R2 Spacewatch. Spacewatch was also the first astronomical group to develop automated, real-time software for moving-object detection and the first to discover a near-Earth asteroid by software – 1990 SS (now called 11885 Summanus). Between May 1984 and June 2022, using UArizona telescopes on Kitt Peak, Spacewatch submitted 15,777,248 astrometric records of asteroids and comets to the Minor Planet Center. Of those 151,805 were of 15,072 unique near-Earth objects, including 1,883 potentially hazardous objects.

Read more: <https://bit.ly/SpacewatchDiscoversDidymos>



WELCOME TO THE LPL NEWSLETTER

Mark S. Marley, Ph.D.
Department Head and Laboratory Director

The Fall 2022 semester has passed like a whirlwind at LPL.

We welcomed our largest ever incoming class of new graduate students (13). They are an exciting and dynamic group who I know will make a big mark during their time here. Finding space for so many new folks was a bit of a challenge that even found its way into the grad student holiday party video. We are happy to have them all here.

We were also excited to welcome to campus our two newest faculty members, Associate Professor **Tyler Robinson** and Assistant Professor **Sukrit Ranjan**, first introduced in the Spring 2022 newsletter. Ty is a UArizona alum (B.S. in Physics) and an expert on **extrasolar planet atmospheres**. Sukrit studies the **chemistry of planetary atmospheres**, including surface-atmosphere interactions. Both are deeply involved in thinking about the signatures and detectability of life on extrasolar atmospheres, a timely topic as **NASA Administrator Bill Nelson** has announced plans to move forward with the **Habitable Worlds Observatory**. The two of them, along with Professor **Ilaria Pascucci**, gave very well attended LPL Public Lectures this fall, our first public lectures since COVID.

This newsletter also highlights a few of the great successes of our LPL alums and features the many roles our alums play on the **DART** and **Lunar Flashlight** missions leadership and science teams. We counted 11 LPL alums among the DART mission leadership and science team! Lunar Flashlight just launched and we wish alum **Barbara Cohen** and her team great success peering into permanently shadowed lunar craters.

All of our asteroid survey teams have been busy this fall. The DART impact was made possible by **Spacewatch's original discovery** of what turned out to be binary asteroid Didymos, while the **Catalina Sky Survey** discovered another asteroid prior to it harmlessly impacting Earth's atmosphere. We are thrilled that Spacewatch is now back to full strength on Kitt Peak following fires and floods this summer. The **NEOS** mission meanwhile just passed its **Key Decision Point-C review**, a major milestone in its continued development.

You can read about all of the above and more, as well as the many accolades accumulated this fall by our amazing students and faculty, in this semester's newsletter. For more content and **expanded stories with links**, visit: [LPL.Arizona.edu/news/2022/fall](https://lpl.arizona.edu/news/2022/fall).

Thanks to LPL Donors

We would like to thank all those who have donated to LPL in 2022. Thanks for supporting research, education, and outreach at LPL. To give to LPL programs, visit: <https://give.uafoundation.org/science-lpl>.

Individual Donors: Edward Beshore, Gordon Bjoraker, Richard Bruns, Daniel Cavanaugh, David Choi, Laura Dugie, Katherine Gall, William Hubbard, Guy Jette, Michael Kaiserman, Colin Leach, Robert McMillan, Michelle Rouch, Timothy Swindle

Corporate and Foundation Donors: Brinson Foundation, Employees Charity Organization of Northrop Grumman, Hitachi High Technologies U.S.A.

CARSON FELLOWSHIP AWARDED TO DAVID CANTILLO

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



David earned a B.S. from the University of Arizona in Spring 2022 with a major in **Geosciences** and minors in **Math** and **Planetary Sciences**.

As an undergraduate, David began working with LPL professor **Vishnu Reddy**, who he had met while working as a high school intern at the **Johns Hopkins Applied Physics Laboratory**. Their collaboration led to David's first [first-author paper](#) that better constrained the surface regolith of asteroid **16 Psyche**.

In recognition of his undergraduate work, David received the Spring 2022 **Excellence in Undergraduate Research Award** for both the UArizona Department of Geosciences and the entire College of Science, as well as the **Outstanding Senior Award** for the UArizona Honors College (honors thesis titled *Spectral Characterization of the Near-Earth Environment with the RAPTORS II Telescope*).

David joined the LPL graduate program in fall 2022 with research interests in asteroids and space situational awareness. His current research involves using laboratory spectroscopy to better interpret the surfaces of near-Earth asteroids as well as taking direct observations of near-Earth asteroids with the **NASA IRTF in Hawaii**. For summer 2023, David plans on traveling to Australia to help construct a new observatory for remote observations of artificial satellites.

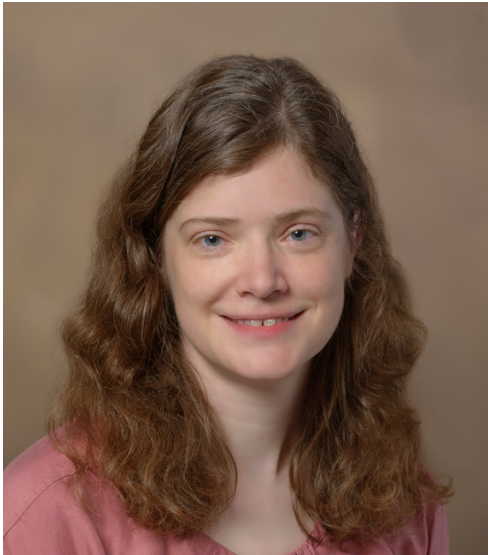
When he's not doing science, David is focused on music. He is the singer and lead songwriter for the alternative Tucson rock band, **Daytrails**. David appreciates the intersection of science and art and has been a regularly supporter and contributor to **The Art of Planetary Science** events sponsored by LPL.

David was featured as a PTYS undergraduate minor in the [Fall 2021 newsletter](#).

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

**Support PTYS graduate students by donating to the
Carson Graduate Fellowship endowment:**

<https://give.uafoundation.org/science-lpl>



LYNN CARTER

ENVISION VENSAR TEAM LEAD

Associate Professor Lynn Carter, a **UArizona Distinguished Scholar**, was selected to be the Science Team Lead for the NASA JPL **VenSAR** radar system onboard the **EnVision** mission to Venus. EnVision, a low-altitude polar orbiter, is the M5 mission candidate in the ESA Science Program. It will carry 5 instruments and 1 experiment (an S-band Synthetic Aperture Radar, a Subsurface Radar, 3 spectrometers and a radio science experiment). EnVision will investigate Venus from its inner core to its atmosphere at an unprecedented scale of resolution, characterizing in particular, core and mantle structure, signs of active and past geologic processes and looking for evidence of the past existence of oceans. EnVision will help understanding why the most Earth-like planet in the solar system has turned out so differently, opening a new era in the exploration of our closest neighbor.



KRISTOPHER KLEIN

LANDAU-SPITZER AWARD

Assistant Professor Kristopher Klein received the 2022 **Landau-Spitzer Award for Outstanding Contribution to Plasma Physics** awarded by the American Physical Society.

The award recognizes outstanding theoretical, experimental, or technical contributions in plasma physics and for advancing the collaboration and unity between Europe and the United States of America by joint research or research that advances knowledge that benefits the two communities in a unique way.

Dr. Klein was recognized as part of a team with colleagues in Iowa and London for the theoretical development of the field-particle correlation technique and its application to spacecraft measurements directly showing that Landau damping heats electrons in turbulent plasmas that comprise Earth's magnetosheath.

PROMOTION TO FULL PROFESSOR VISHNU REDDY



Dr. Reddy joined LPL as an assistant professor in 2016. His research focuses on understanding the behavior of space objects (natural and artificial) using a range of Earth and space-based assets. His work on natural moving objects (asteroids, near-Earth objects) is directed towards their characterization for impact hazard assessment/mitigation, asteroid-meteorite link and resource utilization. To support this effort, Dr. Reddy uses the **NASA Infrared Telescope Facility** on Mauna Kea, Hawai'i.

The orbital space around the Earth is an invaluable resource that is increasingly becoming congested, contested, and competitive with the ever increasing threat from artificial and our adversaries. Dr. Reddy uses the same techniques used to characterize asteroid to study the behavior of artificial objects to identify their nature, intent and origin. He is Director of the University of Arizona's **Space Safety, Security and Sustainability Center (Space4)**.

WOMEN OF IMPACT

JESSICA BARNES AND DANI DELLAGIUSTINA

CELEBRATED FOR RESEARCH, INNOVATION, AND ENGAGEMENT

In August, Assistant Professors **Jessica Barnes** and **Daniella DellaGiustina** were recognized with a **Women of Impact** award by the University of Arizona's **Office of Research, Innovation & Impact**.

Criteria for selection to this inaugural class of honorees included commitment to the mission and values of the university, an application of skills toward discovery and innovation, the enrichment of the community, and the empowerment of others to ensure lasting change.



Professor Jessica Barnes researches the origin and evolution of volatiles in the inner Solar System using nano and microanalytical techniques to study mineralogy, geochemistry, and petrological histories of extraterrestrial materials. She is preparing for the analysis of samples from asteroid Bennu, collected by the OSIRIS-REx mission. This much anticipated analysis is in part supported by a **\$1.5M gift** that enabled the purchase of a nanoscale secondary ion mass spectrometer. The contribution arose partly from admiration for Barnes' expertise in sample analysis and from an interest in supporting an early-career female scientist. In 2019, Professor Barnes was selected to receive funding to study previously unopened lunar samples collected by Apollo 17. She won a **NASA Early Career Award in 2019**, supporting and advancing her research and professional development. Also in 2019, **Nature** magazine named Professor Barnes as one of **five young scientists who will shape the next 50 years of lunar research and exploration**.

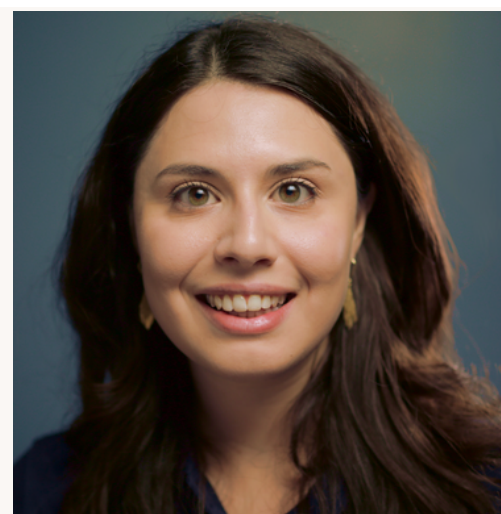
The **Meteoritical Society** has recognized her work by selecting her for the the **2023 Nier Prize**, awarded to young scientists for outstanding research in meteoritics.

Professor Daniella DellaGiustina is Deputy Principal Investigator for the **OSIRIS-REx** mission. She is responsible for oversight of extended mission activities. She is also Principal Investigator for **OSIRIS-APEX**, which will swing by near-Earth asteroid Apophis in 2029 for an 18-month campaign of investigation and discovery.

Professor DellaGiustina received her **Ph.D. in Geosciences** from UArizona in 2021 and holds a **M.S. in Computational Physics** (University of Alaska

Fairbanks) and a **B.S. in Physics** from UArizona. She investigates the surface and near-surface structure of small airless worlds across the solar system by developing and utilizing remote-sensing and geophysical instruments deployed by spacecraft. She enjoys field testing and validating instrumentation techniques at analog sites across on Earth and is especially interested in water distribution throughout the solar system and how to establish its presence using remote-sensing and in-situ techniques.

In October 2022, **Popular Science** magazine named her as one of the **brilliant 10 top up-and-coming minds in science**, taking on the biggest challenges and succeeding.



CATALINA SKY SURVEY DISCOVERS ASTEROID 2022 WJ1

ASTEROID BROKE UP OVER ONTARIO ON
NOVEMBER 19

In the early hours of Nov. 19, the skies over southern Ontario, Canada, lit up as a tiny asteroid harmlessly streaked across the sky high in Earth's atmosphere, broke up, and likely scattered small meteorites over the southern coastline of Lake Ontario. Roughly 1 meter (3 feet) wide, the asteroid was detected 3.5 hours before impact, making this event the sixth time in history a small asteroid has been tracked in space before impacting Earth's atmosphere.

Asteroid **2022 WJ1** was discovered by LPL's **Catalina Sky Survey** (CSS) on the evening of Nov. 18 during routine search operations for near-Earth objects. CSS observations were quickly reported to the Minor Planet Center and the data were then automatically posted to the Near-Earth Object Confirmation Page.

NASA's Scout impact hazard assessment system automatically fetched the new data from that page and began calculating the object's possible trajectory and chances of impact. Seven minutes after the asteroid was posted on the confirmation page, Scout had determined it had a 25% probability of hitting Earth's atmosphere, with possible impact locations stretching from the Atlantic Ocean off the East Coast of North America to Mexico. More observations were then provided by the astronomical community to better refine the asteroid's trajectory and possible impact site.

As CSS continued to track the asteroid over the next few hours, Scout used this new data to update the asteroid's trajectory and the system's assessment of the chance of impact, posting those results on the hazard-assessment system's webpage.

2022 WJ1 is the fourth pre-impact asteroid discovered so far by CSS and attests to the ability of the survey to rapidly find and enable the orbit characterization of potentially hazardous objects.

CONTRERAS FIRE RESULTED IN EVACUATION OF KITT PEAK SPACEWATCH RESUMES REGULAR OPERATIONS

Spacewatch is enjoying the return to full-time regular operations, which resumed on December 7 after recovery from the **Contreras Wildfire** in June. **Kitt Peak** had previously been closed from March 2020 through October 2020 due to COVID, allowing only remote observing and daytime visits until June 2021.

Lightning caused the fire on June 11 in the **Baboquivari Mountain** range. Kitt Peak was evacuated on June 14 when high winds and dry conditions greatly accelerated the approach of the fire toward the observatory. Heroic efforts from the firefighter and flight crews and incident management teams preserved all of the science facilities. Only four structures were lost: two outbuildings, a residence, and the **Arizona Radio Observatory (ARO) dorm**. This is remarkable considering the fire swept over the southwest ridge that includes the **ARO, Very Long Baseline Array antenna**, and **MDM Observatory**. The official incident burn size was 29,482 acres.

The fire was deemed contained on June 24 and Bureau of Indian Affairs Type 4 Incident Management Team and National Burned Area Emergency Response Team took over. The Arizona Department of Transportation and the Tohono O'odham Utility Authority began work on the road and electrical infrastructures. Helicopters were required to fly in new electrical poles sited away from the road.

Spacewatch staff were allowed to begin clean-up operations in August, while on alert for emergency evacuation in case of a monsoon. After **Kitt Peak National Observatory (KPNO)** installed temporary extra generators and a **Starlink** dish, Spacewatch was able to restart operations on September 6, although operations were hampered by the unreliability of generators --- dome shutters are not opened unless there is some form of backup power. Line power was restored to the summit on October 7. With extremely limited bandwidth for the summit, Spacewatch was restricted to onsite observing and experienced frequent blips in connectivity. The internet fiber connection was restored on December 8, bringing Spacewatch back to full strength. However, the road is still closed to traffic, with only staff or experienced tenant drivers permitted to navigate the road without an escort vehicle.



Photo caption: August 22, boulder on Hwy 386 near mile 10.5. Boulder size was reported to be 12'x8'. Without vegetation, many rocks and boulders washed down and into culverts. There were many rockslides reported during the monsoon season. In addition, the posts for the road guardrails burned along the top several miles of the road. Many electrical poles burned or were damaged, severing the line power and internet cables. Photo courtesy: Michelle Edwards, Associate Director of Kitt Peak National Observatory.



EMILEIGH SHOEMAKER EARHART FELLOWSHIP

\$10,000 FELLOWSHIP AWARDED EACH YEAR BY ZONTA INTERNATIONAL TO UP TO 35 WOMEN PURSUING DOCTORAL DEGREES IN AEROSPACE ENGINEERING AND SPACE SCIENCES

Emileigh Shoemaker is a 2022 recipient of an **Amelia Earhart Fellowship**. Emileigh is a fifth-year Ph.D. student advised by **Dr. Lynn Carter**. Her research focuses on investigating the subsurface of volcanic environments on Mars and Earth using orbital and ground penetrating radar (GPR) systems. Eruptive products like lava flows from effusive volcanic activity or ash and pumice from explosive activity provide a glimpse into the evolution of the interior of a planet. On Mars, volcanic activity is primarily effusive—resulting in shield-like volcanic edifices and extensive lava flows similar to those seen in Hawaii. Explosive activity is less common; however, there is evidence on the surface that these types of eruptions have taken place in the past.

Emileigh uses the **Shallow Radar (SHARAD)** instrument currently orbiting Mars to investigate the subsurface and the stratigraphy of the largest volcanic province on the planet known as Tharsis. This region has been volcanically active for most of Mars' history which makes it an excellent site to study the evolution of the planet over time. SHARAD has assisted Emileigh in making measurements of the thickness of lava flows and ash deposits there.

Emileigh has taken part in several NASA field expeditions to the Icelandic Highlands, where she mapped ice buried by ash and pumice from two eruptions of the Askja Volcano using GPR. This area was used to test operational methods to map subsurface ice using these handheld radar systems for future astronauts who will need to access this precious resource during missions on other terrestrial bodies like Mars and the Moon. During these expeditions, Emileigh is able speak to the general public and hopes these interactions will encourage other students to participate in planetary field geology and geophysics in the future.

Read more about Emileigh's research with the **NASA GIFT Team** in Iceland in the [Fall 2021 LPL Newsletter](#).

USRA UNDERGRADUATE RESEARCH AWARD BROOKE CARRUTHERS

JAMES B. WILLETT EDUCATION MEMORIAL SCHOLARSHIP

Brooke Carruthers (Molecular and Cellular Biology major, **Astrobiology** minor) was been selected as a **Universities Space Research Association (USRA) Distinguished Undergraduate** for 2022 based on the strength of her academic accomplishments and leadership qualities. She was one of 5 recipients chosen from 85 applicants.

The USRA awards are granted to students who tackle challenging problems in aerospace engineering, space science research and exploration, demonstrate leadership, promote diversity in science and engineering, and are poised to make significant contributions to their fields. Faculty from USRA's member universities reviewed the applications and made their recommendations for selection to the USRA President and CEO, Dr. Jeffery Isaacson.

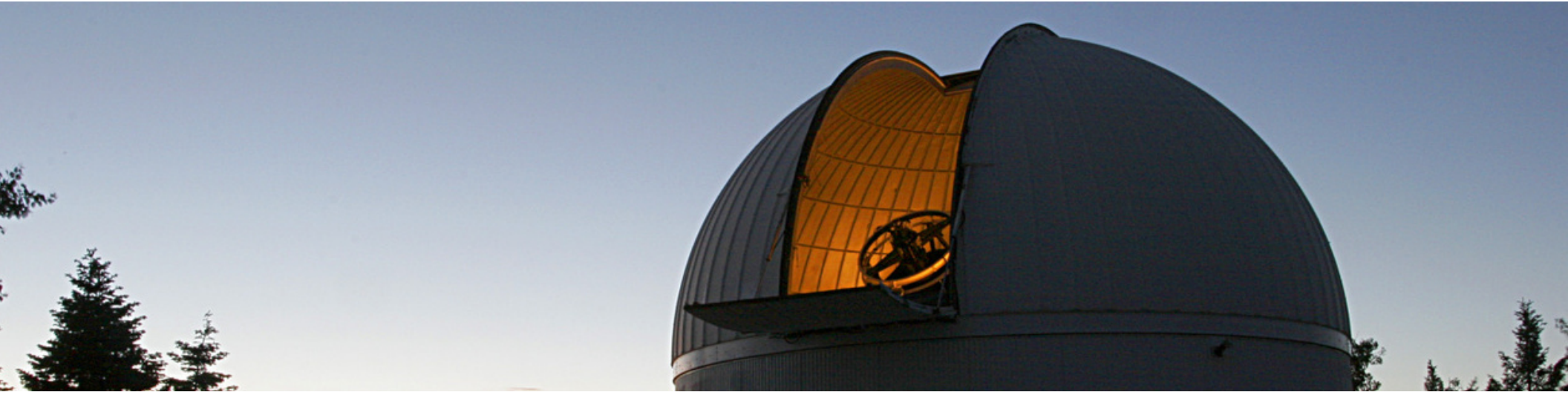


The research award consists of a certificate, an award letter, and a scholarship in the amount of \$5,000. Regents Professor **Renu Malhotra**, current chair of USRA Council of Institutions, presented the award to Brooke on behalf of USRA and UArizona.

Read more about Brooke in the [Spring 2022 LPL Newsletter](#).

UARIZONA GETS TOP MARKS FOR SPACE SCIENCES RESEARCH

HIGH RANKINGS FOR EXPENDITURES, RESEARCH AND PUBLICATION FREQUENCY



Recent rankings by *U.S. News & World Report* and the **National Science Foundation (NSF)** once again recognize UArizona as one of the world's top research institutions.

UArizona ranked 108 out of 2,000 higher education institutions across 95 countries in the **2023 by U.S. News & World Report Best Global Universities** ranking, released on Oct. 24. The university was No. 44 among universities in the U.S. and No. 23 among public universities. UArizona again earned its best placement in the space science category, placing No. 10 overall, No. 6 (up from No. 7 last year) in the U.S. and No. 2 among public universities. The university earned top marks for its research reputation in space sciences, along with the number of citations and publications by UArizona researchers.

U.S. News & World Report's Best Global Universities ranks colleges and universities in 47 separate subjects. UArizona earned a spot on 34 of the subject ranking lists. The university's overall research reputation ranked No. 49 in the U.S. and No. 94 globally. To produce the global rankings, *U.S. News & World Report* uses a methodology that focuses on a university's global and regional reputation and academic research performance using indicators such as citations and publications. *U.S. News* uses a separate methodology for the subject-specific rankings that is based on academic research performance in each subject. *U.S. News* uses various measures, including publications and citations, as well as indicators for global and regional reputation in each specific subject area.

On Dec. 13, the **NSF Higher Education Research and Development (HERD)** survey again ranked UArizona among the nation's top public research universities, with **\$770 million** in total research activity in fiscal year 2021. The HERD survey annually ranks more than 900 colleges and universities and is considered the primary source of information on research and development expenditures at U.S. colleges and universities. UArizona also retained its **No. 1 ranking in astronomy and astrophysics (including planetary science) expenditures** at more than **\$113 million** – more than \$40 million ahead of the No. 2-ranked university.

UArizona saw an increase of more than \$9 million over its fiscal year 2020 total. Research and development expenditures rank No. 20 among public institutions and No. 36 overall, placing UArizona in the **top 4%** of all U.S. universities ranked in this list, both public and private. UArizona ranked **No. 5 in NASA-funded activity** and No. 6 in the physical sciences.

UArizona has held the No. 1 ranking in astronomy/astrophysics and planetary science expenditures each year since 1987.

NEO SURVEYOR

APPROVED FOR LAUNCH

The **Near-Earth Object (NEO) Surveyor** project recently passed its **Key Decision Point C review** and NASA has approved the mission for flight launch is scheduled no earlier than June 2028.

NEO Surveyor is an infrared space telescope designed to help advance NASA's planetary defense efforts by expediting the ability to discover and characterize at least 90% of the potentially hazardous asteroids and comets that come within 30 million miles of Earth's orbit, collectively known as near-Earth objects, or NEOs. NEO Surveyor's successful completion of this review furthers NASA's commitment to planetary defense and the search for NEOs that could one day pose an impact threat to Earth.

LPL Professor **Amy Mainzer** is Principal Investigator for the NEO Surveyor mission.

NEW GRADUATE STUDENTS

THIRTEEN INCOMING STUDENTS FOR 2022/2023



**Roberto Aguilar
Martinez**

Skolkovo Inst. of Science
and Technology
Planetary Surfaces
Advisor: Jack Holt



Arin Avsar

University of California,
Berkeley
Exoplanets
Advisor: Daniel Apai



Namya Baijal

Imperial College London
Planetary Surfaces
Advisor: Erik Asphaug



Naman Bajaj

College of
Engineering, Pune
Planetary Formation
Advisor: Ilaria Pascucci



David Cantillo

University of Arizona
Small Bodies
Advisor: Vishnu Reddy



Searra Foote

Arizona State University
Astrobiology
Advisor: Tyler Robinson



Lori Huseby

College of Saint
Scholastica
Exoplanets
Advisor: Travis Barman



Ricky Maciel

University of Arizona
Atmospheres
Advisor: Walt Harris



Fuda Nguyen

Vietnam National
University
Exoplanets
Advisor: Daniel Apai



Iunn Jenn Ong

University of Arizona
Cosmochemistry
Advisor: Jessica Barnes



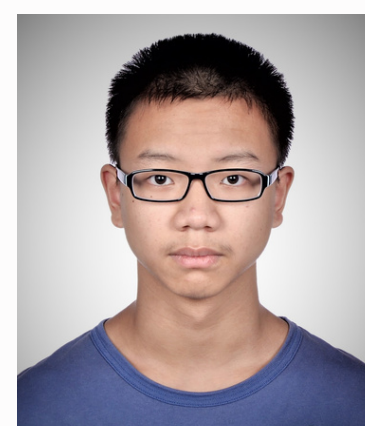
Beau Prince

Northern Arizona University
Cosmochemistry
Advisor: Tom Zega



Akash Satpathy

University of Arizona
Small Bodies
Advisor: Amy Mainzer



Chengyan Xie

Xiamen University
Planetary Atmospheres
Advisor: Ilaria Pascucci

LPLC 2022

BY CLAIRE COOK

The **Lunar and Planetary Laboratory Conference (LPLC)** marks the start of the academic year for the LPL community and other planetary scientists in the Tucson area. This year, LPLC was hosted in a hybrid format on August 19. Over 70 participants gathered at the Kuiper Building and on Zoom to watch 30 presentations given by faculty, staff, postdocs, and graduate

students from LPL and other departments. Among the five invited speakers was **Galen Bergsten**, winner of the “Best Grad Student Presentation” in 2021. Galen gave a great talk titled ***There’s No Place Like Home: Exoplanets and Accessibility in a Local Context***, which addressed both exoplanet science and how to make the science more inclusive and accessible. The “Best Grad Student Presentation” award went to **Sam Myers**, with a talk on near-Earth asteroids titled ***Comparing NEATM-like Models to IRTF and NEOWISE Data to Constrain Model Results***. Sam will be invited to present at LPLC in 2023.

In addition to the invited speakers, 25 others gave presentations about their current or upcoming research. LPLC concluded with a keynote from **OSIRIS-APEX** Deputy Principal Investigator **Dr. Michael Nolan** on ***The OSIRIS-APEX Mission***. A catered reception followed the conference, helping to keep the discussions going and bringing together the local planetary science community. The LPLC Organizing Committee, composed solely of LPL graduate students, is proud of this year's excellent turnout, engagement, and participation. We wish to thank the Tucson planetary science community for your continued support and are looking forward to another successful conference next fall!

BARBARA COHEN

LUNAR FLASHLIGHT

Congratulations to **Dr. Barbara Cohen (2000)**, Principal Investigator for **NASA's Lunar Flashlight**, which launched successfully on Dec. 11 and has begun its four-month trip to the Moon. Lunar Flashlight is a small satellite on a mission to seek out surface water ice in permanently shadowed craters of the Moon's south pole. Flashlight fans can track the **SmallSat** using NASA's fully interactive **[Eyes on the Solar System](#)** tool.



Lunar Flashlight will use a near-rectilinear halo orbit – designed for energy efficiency – to take it as near as 9 miles to the lunar south pole. The SmallSat has a reflectometer equipped with four lasers that emit near-infrared light in wavelengths readily absorbed by surface water ice. If the lasers hit bare rock or regolith, the light will reflect back to the spacecraft. However, if the target absorbs the light, the presence of water ice would be indicated. The greater the absorption, the more ice there may be.

Data collected by Lunar Flashlight will be compared with observations made by other lunar missions to help reveal the distribution of surface water ice on the Moon for potential use by future astronauts.

Dr. Cohen is a planetary scientist at **NASA Goddard Space Flight Center**.

Read more about **Lunar Flashlight**
jpl.nasa.gov/missions/lunar-flashlight

JOHN MOORES

SCIENCE ADVISOR TO CANADA'S PRESIDENT

Alumnus **John Moores (2008)** was named **Science Advisor to the President of Canada**. He is the York Research Chair in Space Exploration at **York University** and is the Director of Technologies for Exo-Planetary Science with **Canada's Collaborative Research and Training Experience Program**. Dr. Moores previously held positions as Associate Dean of Research and Graduate studies for the Lassonde School of Engineering at York University.

Dr. Moores is a Participating Scientist on **NASA's Mars Science Laboratory** mission and contributed to the 2005 **Cassini Huygens** probe to Titan and to the **Phoenix** mission to Mars.

DIMORPHOS IMPACTED BY DART ON SEPT. 26

EARLY RESULTS FROM DART

When NASA's **Double Asteroid Redirection Test (DART)** spacecraft slammed into asteroid moonlet **Dimorphos**, it altered the moonlet's orbit by 33 minutes. Since the impact, DART scientists, including LPL alumni **Nancy Chabot** (DART Coordination Team Lead) and **Andy Rivkin** (Investigation Team Co-Lead), have been analyzing the impact ejecta and studying the observations to determine the object's composition and clues to its formation, in addition to how to defend Earth if an asteroid were headed our way.

DART's impact displaced over two million pounds of the moonlet into space and researchers are trying to learn just how much of the asteroid's displacement occurred as a result of the impact versus the recoil.

Read more about **DART**: dart.jhuapl.edu

DAVID GRINSPOON

UAP STUDY TEAM

Dr. David Grinspoon (1989) was selected as a member of the 16-member NASA independent study team on **unidentified aerial phenomena (UAP)**. The 9-month long study began on Oct. 24 and will focus on unclassified data. The team will release its findings in 2023.

Dr. Grinspoon is a senior scientist at the **Planetary Science Institute** and is a member of science teams for several interplanetary spacecraft missions including the **DAVINCI** mission to Venus. He is the former inaugural **Blumberg NASA/Library of Congress Chair in Astrobiology**. His research focuses on comparative planetology especially regarding climate evolution and the implications of habitability on Earth-like planets. He was awarded the **Sagan Medal** by the American Astronomical Society and he is an elected **Fellow of the American Association for the Advancement of Science**. He is also an adjunct professor of Astrophysical and Planetary Science at the **University of Colorado (Boulder)** and **Georgetown University**.

2022 NASA FINESST RECIPIENTS

FUTURE INVESTIGATORS IN NASA EARTH AND SPACE
SCIENCE TECHNOLOGY



Mackenzie Mills

*Effects of subsurface Fluid Reservoirs on
Martian Geomorphology in Utopia Planitia*

Advisor: Alfred McEwen



Samantha Moruzzi

*Faulting in Pluto's Ice Shell: An
Investigation of Local Strain and Stress
Concentrations from Refreezing of the Ice
Shell Beneath Sputnik Basin*

Advisor: Jeff Andrews-Hanna



NSF GRADUATE RESEARCH FELLOWSHIP

Sam Myers

*Assessing the Limitations of NEATM-like
Models with IRTF and NEOWISE Data*

Advisor: Ellen Howell



Maizey Benner

*Correlative Analysis of P-bearing Assemblages in the QUE 97008 and
Orgueil Chondrites*

Best Student Poster

2022 Microscopy and Microanalysis Meeting



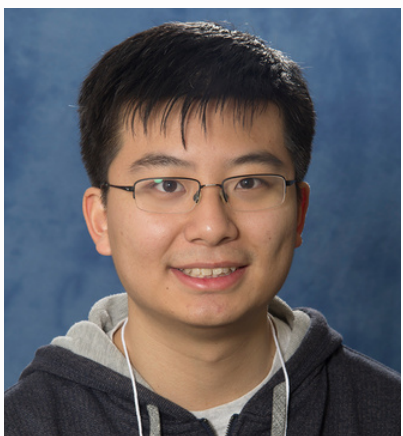
Sarah Sutton

PTYS Ph.D. May 2022

*Sinuuous Channels East of Olympus Mons, Mars: Implications for volcanic,
hydrological, and tectonic processes*

Pellas-Ryder Award

Meteoritical Society and Planetary Geology Division of the Geological
Society of America



Harry Tang

Invited to be member of **NASA SCoPE** (Science Mission Directorate Community of
Practice for Education) Team.

SCoPE will grow a community of practice and a collaborative effort to communicate
NASA science through the creation of inspiring educational materials that are
effective, scientifically authentic, and broaden participation of historically
marginalized communities.

CONGRATULATIONS PTYS GRADUATES

Alessandra Springmann

July 20, 2022

Heating of Small Solar System Body Materials

Advisor: **Professor Walt Harris**

New position: Postdoctoral Research Associate, Southwest Research Institute



Joana Voigt

September 26, 2022

Effusive Volcanism on Earth and Mars

Advisor: **Associate Professor Christopher Hamilton**

New position: Postdoctoral Research Associate, NASA Jet Propulsion Laboratory



Patrick O'Brien

October 31, 2022

The Rise and Fall of Lunar Topography

Advisor: **Professor Shane Byrne**

New position: Research Scientist, Laboratory for Atmospheric and Space Physics/University of Colorado, Boulder

Benjamin Sharkey

December 9, 2022

From Earth to Neptune: The Mineralogical Properties of Small Planetary Satellites and Co-orbital Objects

Advisor: **Professor Vishnu Reddy**

New position: Postdoctoral Research Associate, University of Arizona



POSTDOCTORAL RESEARCH ASSOCIATE ARNAUD SALVADOR



Dr. Arnaud Salvador joined LPL in August 2022 as a Postdoctoral Research Associate. He works with Associate Professor **Tyler Robinson** on the characterization of rocky exoplanets observed in direct imaging. In particular, he investigates the capabilities of future direct imaging observatories in retrieving atmospheric properties and surface conditions of distant rocky worlds. By considering the effects of observational constraints and prior information, his work aims to refine instruments design and define the most efficient observing strategies at recognizing a habitable planet.

Another aspect of his research is dedicated to the early evolution of rocky planets, focusing on the cooling, solidification, and outgassing of the magma ocean in interaction with the atmosphere, and the implications for early water ocean formation on Earth, Venus, and exoplanets.

Arnaud received his B.S. in Earth Sciences from **Blaise Pascal University** (Clermont-Ferrand, France) in 2013, his M.S. in Planetary Sciences from the **University of Versailles Saint-Quentin-en-Yvelines** in 2015, and his Ph.D. in Planetary Sciences from **Paris-Saclay University** in 2018. He was then a Postdoctoral Research Fellow at the **Institut de Physique du Globe de Paris (IPGP)**, and **Northern Arizona University** in January 2021.

Arnaud enjoys playing table tennis, skateboarding, reading, being in nature, and watching the night sky.

ASB/PTYS UNDERGRADUATE MINORS



Senior **Nick McFarlin** is majoring in **Ecology and Evolutionary Biology** with a minor in **Astrobiology**. He is interested in unanswered questions like "How did life originate on Earth?" and "Is there life elsewhere?" After graduation, Nick plans to become a researcher with the possibility of attending graduate school in a biology related field and perhaps someday working at NASA.

Nick's favorite astrobiology class was GEOS 484, **Coevolution of the Earth and Biosphere**. It was unique for being a small, interdisciplinary class that had students read research papers that dealt with nearly every type of science; in that way, it felt to Nick more like a graduate course. And, says Nick, "There were also three field trips that were really cool." Nick is currently involved with a vertically integrated project mostly associated with the Department of **Hydrology and Atmospheric Sciences**. The project is working to determine whether a model developed in the 1980s for the timing of flowering of Sonoran desert plants is still a valid one; depending on results, project researchers will question whether changes can be attributed to climate change.

In his spare time, Nick sings and plays the drums and eventually would like to produce his own music. He also enjoys trivia and MarioKart!



Reed Spurling is a senior majoring in **Aerospace Engineering** with minors in **Math** and **Planetary Sciences (PTYS)**. Favorite PTYS courses include PTYS 411, **Geology and Geophysics of the Solar System** and PTYS 442, **Mars**. Another favorite was Regents' Professor **Dante Lauretta's Spacecraft Mission Design** class; for this course, students were split into three teams to design concepts for robotic solar system missions. This classwork enabled Reed to successfully apply for a summer internship at **KinetX**, a company that navigates the **Lucy** and **New Horizons** solar system missions for NASA.

Reed works with Drs. **Virginia Gulick** and **Stefano Nerozzi** to analyze flood channel systems on Mars. He maps the locations and sizes of impact craters in and around these channels and then runs statistics on the data to determine an approximate age for the channels. Reed also works with Aerospace professors **Sergey Shkarayev** and **Adrien Bouskela** on communication systems for dynamic soaring sailplane gliders. Engineless sailplanes should be able to fly for extended periods of time above Earth, Mars, Venus, Titan, and other planets with sufficient atmospheres, bridging gaps in observing capabilities between orbiting missions and surface missions.

Reed is the founder of the UArizona **Near Space Club** and is planning on a career in solar system exploration. When not in class or mapping craters, Reed likes to cook and read.

FALL 2022 PTYS 590 FIELD TRIP

MT. LEMMON AND TANQUE VERDE FALLS

BY CHRISTOPHER HAMILTON



This semester, the **PTYS 590 Planetary Geology Field Studies** course intended to explore sedimentary units in Northern Arizona, but unfortunately—due to a last-minute case of COVID-19—the main field trip was cancelled. The health and safety of our students is paramount and the potential risk for developing an outbreak was too great to undertake a five-day trip to a remote field site.

Instead, the class took a daytrip to explore highlights in the Tucson area. LPL's **Eric Christensen** and **Carson Fuls** were fantastic in arranging an impromptu visit to UArizona's magnificent telescopes on **Mt. Lemmon**, with Carson providing an outstanding tour of the **Catalina Sky Survey's 1.5-meter (60-inch) f/1.6 telescope**. The Catalina Sky Survey is responsible for the discovery of nearly half the total known near-Earth objects (NEO) population and it was incredible to not only see the massive telescope, but also to learn about the lightning-fast processing techniques used to identify the NEOs in near-real time.

After descending the mountain—stopping at several magnificent overlooks from the Catalina mountains along the way—the class visited **Tanque Verde Falls** for a hike to explore the local geology and natural beauty of the Tucson area.

Later in the semester, the class met for an off-campus social event to get to know one another better and hear the excellent presentations that the students had prepared for the field trip. In the coming year, we plan to return to Northern Arizona and anticipate this will be an excellent opportunity for students to explore **aeolian landforms** deposited during the time of Pangea as well as more recent products of fluvial erosion—ranging from slot canyons to Glen Canyon, Monument Valley, the Painted Desert, Petrified Forest, and aspects of Native American history and culture in the region.

In the meantime, students are preparing for an exciting field trip to the **Big Island of Hawai'i** in March 2023, which will be led by **Shane Byrne**, **Christopher Hamilton**, and **Brett Carr**. Students will explore the island's incredible volcanic landscapes—including products of the **2018 Kilauea eruption** in the East Rift Zone and this year's new eruption from **Mauna Loa** (the world's largest active volcano)—as a planetary analog.

Top left: Scenic overlook from Windy Point Vista, between Tucson and Mt. Lemmon.

Top right: Carson Fuls provides a tour of the Catalina Sky Survey's 1.5-meter (60-inch) telescope on Mt. Lemmon.

Support the LPL Graduate Field Trip by donating to the Wilkening-Sill endowment:

<https://give.uafoundation.org/science-lpl>



On Dec. 13, NASA's flying observatory, the **Stratospheric Observatory for Infrared Astronomy (SOFIA)**, flew over the **Kuiper Space Sciences building** and the UArizona mall, concluding its final flight to **Davis Monthan Air Force Base** before becoming an exhibit at the **Pima Air and Space Museum**.

SOFIA replaced the venerable **Kuiper Airborne Observatory**. Many LPL researchers collected infrared observations of Solar System objects on these flying observatories over the years.

LPL IN THE NEWS

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

Giant Mantle Plume Reveals Mars is More Active Than Previously Thought. Orbital observations unveil the presence of an enormous mantle plume pushing the surface of Mars upward and driving intense volcanic and seismic activity. (Broquet, Andrews-Hanna)

Arizona Scientists Thrilled by Unprecedented 'Portrait' of an Alien World. Thanks to the James Webb Space Telescope, scientists have identified a "mystery molecule" that previously stumped astronomers. They've also gained insights needed to interpret potential signs of habitability on other exoplanets. (Moran)

Mapping Rock Glaciers to Understand Their Future on Earth and Mars. University of Arizona researchers developed a new method for analyzing rock glaciers, which could help scientists better understand these "hidden giants" on Earth and Mars. (Meng, Holt)

Scientists Identify Potential Source of 'Shock-Darkened' Meteorites, with Implications for Hazardous Asteroid Deflection. University of Arizona planetary scientists identified a potential source of a special kind of meteorite. Its characteristics could explain certain discrepancies in how near-Earth asteroids are classified. (Battle, Reddy)

Dying Stars Could Seed Interstellar Medium with Carbon Nanotubes. Evidence suggests that carbon nanotubes, tiny tubes consisting of pure carbon, could be forged in the envelopes of dust and gas surrounding dying stars. The findings propose a simple, yet elegant mechanism for the formation and survival of complex carbon molecules in space. (Bernal, Zega)

LPL's Spacewatch Discovered the Larger of the Twin Asteroids Targeted by NASA's DART Mission. In 1996, the University of Arizona Spacewatch program discovered Didymos, the larger of the two asteroids that are the focus of NASA's upcoming DART mission encounter. (Brucker, Gehrels, McMillan)

Planetary Defense Exercise Uses Apophis as a Hazardous Asteroids Stand-In. Over 100 participants from 18 countries – including UArizona scientists and NASA's LPL-led NEOWISE mission – took part in the international exercise. (Reddy, Mainzer)

LPL's Spacewatch Discovered the Larger of the Twin Asteroids Targeted by NASA's DART Mission. In 1996, the University of Arizona Spacewatch program discovered Didymos, the larger of the two asteroids that are the focus of NASA's upcoming DART mission encounter. (Brucker, Gehrels, McMillan)

OSIRIS-REx Scientists: Taking Asteroid Sample was Like Punching a Ball Pit. Before-and-after images and measurements revealed a treasure trove of data from the few seconds that it took for the OSIRIS-REx spacecraft to collect an asteroid sample, which is currently en route to Earth. (Lauretta)

More Than One Asteroid Could Have Spelled Doom for the Dinosaurs. A newly discovered impact crater below the seafloor hints at the possibility that more than one asteroid hit Earth during the time when dinosaurs went extinct. (Bray)



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