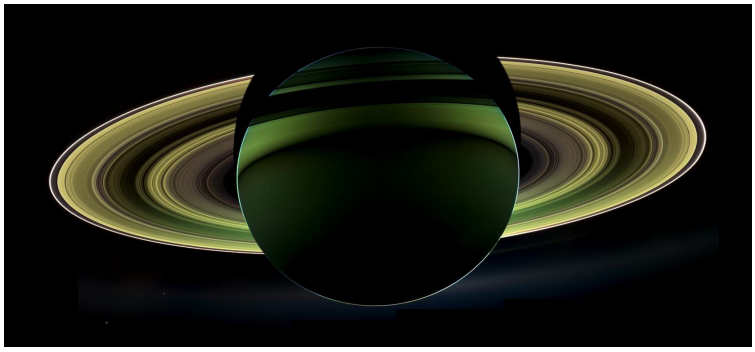
UA SCIENCE
LUNAR & PLANETARY LABORATORY
Department of Planetary Sciences

LUNAR AND PLANETARY LABORATORY NEWSLETTER FALL 2017

After Farewell Kiss, Cassini Takes the Plunge

by Daniel Stolte, UA Communications

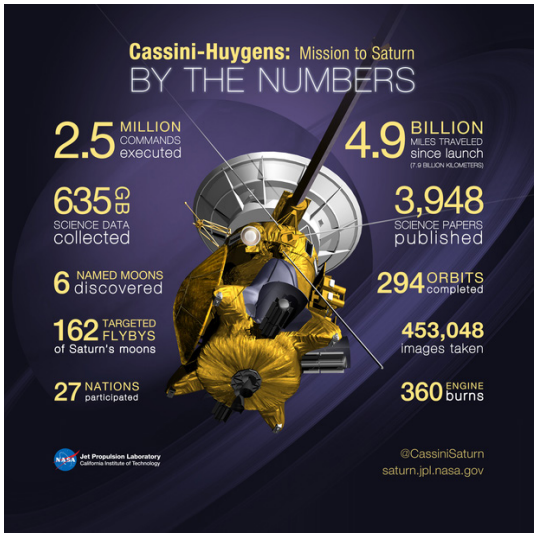


On September 15, 2017, NASA's Cassini spacecraft made its final dive into Saturn's upper atmosphere, ending its 23-year voyage to Saturn. Cassini launched in 1997 and arrived at Saturn in 2004; it was the most complex interplanetary spacecraft ever flown. LPL scientists played major roles in the mission instrumentation.

Led by retired Research Professor Martin Tomasko, LPL designed and built the Descent Imager/Spectral Radiometer (DISR), which rode the Cassini Huygens probe as it touched down on Titan. The DISR images were used by LPL staff scientist Erich Karkoschka to gather surprising clues about Titan's surface many years after the event.

LPL's Professor Robert Brown led the Visual and Infrared Mapping Spectrometer (VIMS) instrument operation. VIMS observations of spectra from Saturn and its rings and moons have led to discoveries about their compositions and have revealed details about the cycle of methane, which on Titan takes the role of water on Earth—forming clouds, raining down and forming lakes, as well as freezing into ice.

In all those observations, Cassini's cameras played an important role and have created some of the most visually beautiful images of the solar system. LPL's Professor Alfred McEwen was a member of Cassini's imaging science subsystem. Cassini's imaging team leader Carolyn Porco was appointed to the mission while on the faculty at LPL, where she had been working on NASA's Voyager mission; she was a co-originator of the idea to use Voyager-1 to take portraits of the planets, including the famous Pale Blue Dot image of Earth. Surface observations on Titan were planned at LPL, and then sent to the Cassini Imaging Central Laboratory for Operations in Boulder, which Porco heads as director.



For the LPL scientists who contributed to the Cassini mission, the Grand Finale tour of the Saturn system is truly the end of an era.

Welcome from the Director

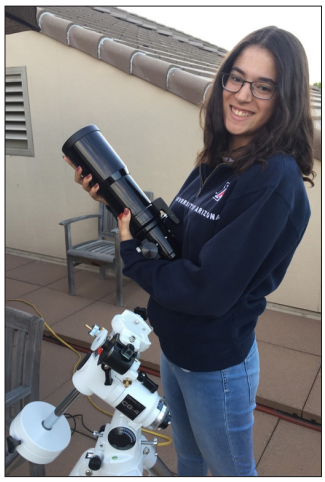
Welcome to the Fall 2017 version of the "LPL family" newsletter. If you think that you've been receiving news from LPL more often recently, it's because you have been. We realized that one of the things we weren't doing well at was conveying all of the great science that gets done here. So we started with a short monthly newsletter that is mostly limited to news items from the media about the science and the people here. However, we will continue to have a newsletter twice a year that is focused more on the LPL family, highlighting the comings and goings of faculty, staff, and students, honors, field trips, alumni notes, etc.

It has been an exciting few months, with the Grand Finale of Cassini, the Earth Gravity Assist of OSIRIS-REx, many of us traveling around the country to view the Great American Eclipse, 3 new faculty, and 12 new graduate students. I hope you enjoy reading about all the things that have been happening at LPL, and I also hope that you'll let us know when there's something about you that we could include in the newsletter.

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

Bright Future for PTYS Undergraduate Minor

by Daniel Stolte, UA Communications



PTYS undergraduate minor Adriana Mitchell (majors in Optical Sciences and Engineering) has been busy for more than a year readying science equipment for observing the August 21 solar eclipse with Citizen CATE (Continental-America Telescopic Eclipse Experiment). In an attempt to produce the first dataset of high-resolution, rapid-sequence, white-light images of the sun's inner corona, 68 telescopes, lined up like beads on a string along the path of totality, will be linked together to generate the longest movie of a solar eclipse ever made, resulting in 90 minutes of totality. CATE brings together volunteers from high schools, universities, informal education groups, astronomy clubs across the country, national science research labs and 5 corporate sponsors.

With the string of telescopes operated by CATE volunteers, scientists hope to measure the solar wind streaming out from the sun. Mitchell will perform a special and critical role during these observations, as she will operate one of only two sites where telescopes are outfitted with polarimeters, specialized filters that see only light waves that are synchronized in one plane. This allows them to track the so-called polar plumes, blobs of gas hurled from the sun's surface into space.

"One of the big questions in solar physics is: Why is the sun's corona hotter than the surface?" Mitchell says. "Or: Why does the solar wind accelerate dramatically as it streams out, going from one mile per second to a hundred?"

By the time of the next solar eclipse in 2024, Adriana Mitchell may already have a Ph.D. "I'm definitely going to grad school," she says. "Since I'm mostly interested in planetary science, I'd like to build instruments. Like an infrared imager or some type of spectrometer that could someday fly through the geysers on Saturn's moon Enceladus. That would be really cool."

The way Adriana Mitchell says that, somehow, leaves no room for doubt.

Department

New Faculty at LPL

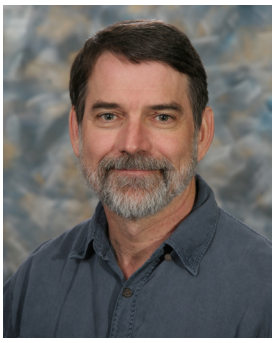
In August, Dr. Erik Asphaug joined LPL as a Professor. Erik obtained his Ph.D. from LPL in 1993; since then he has had a distinguished career studying the formation and evolution of comets, asteroids and planets. After his postgraduate work at NASA Ames, he became a Professor of Earth Sciences at U.C. Santa Cruz, where he helped start their degree program in Planetary Science, worked on problems of planet formation, and participated in the LCROSS mission detecting water on the Moon. In 2012, he joined the School of Earth and Space Exploration at ASU, where his work on planetary physics contributed to the selection of the NASA Discovery mission, Psyche. He leads the Comet Radar Explorer team, who aspire to use reflection radar to image the global interior structure of a comet nucleus. In his new appointment he also plans to work closely with students and faculty to make progress in low cost, high cadence missions of exploration to near-Earth asteroids, and to develop methodologies to extract resources and developing technologies for robotic exploration of these very low gravity worlds. But his scientific passion is to understand how the terrestrial planets, especially the Earth, got to be the way they are, and why they are so diverse.

Long-time LPL adjunct instructor Dr. Steve Kortenkamp moved into a new role as an Associate Professor of Practice. Steve's background is in planet formation and the orbital dynamics of interplanetary dust, asteroids, and the moon-forming impactor. He was previously a research scientist at the Planetary Science Institute in Tucson. Steve's current research includes an emphasis in science education, with a new NSF project that seeks to use 3D printed planetary terrains to address deficiencies in STEM involvement among students who are blind or visually impaired. At LPL, Steve uses an experimental curriculum to conduct human-subjects research into the effects of student choice on performance and engagement in science education. He is also an accomplished author of children's science books, recently publishing an interactive "You Choose" book about Mars exploration based on many of the missions that LPL has been a part of over the last few decades.

Dr. Tommi Koskinen joined the faculty at LPL this fall as an Assistant Professor. Tommi is a planetary scientist who specializes in the dynamics, chemistry, escape and evolution of the atmospheres of the planets and satellites in the solar system and extrasolar planets. He earned his Ph.D. in Astrophysics at University College London, U.K. He came to LPL in the fall of 2009 to pursue a post-doctoral associate position and decided to stay on as a Staff Scientist (2014), attracted by the vibrant planetary science and astronomy community at the University of Arizona. Tommi develops numerical models and data analysis techniques to interpret observations of planetary atmospheres, with a current focus on the physics and chemistry of the middle and upper atmosphere. He works on atmospheric models and observations of a diverse array of objects including extrasolar planets, Saturn, Titan, and Pluto. He was a participating scientist on the Cassini mission to the Saturn system and will continue to work on the large archive of observations that remain to be analyzed after the Grand Finale tour. He is also working on developing new models that are required to understand upcoming observations of extrasolar planet atmospheres.

Department

Recent Faculty Awards



Professor Roger V. Yelle was named a 2017 Fellow of the American Geophysical Union (AGU). Professor Yelle was awarded "for significant advances in understanding the upper atmospheres of planets and implications for planetary evolution." The Fellows program "recognizes AGU members who have made exceptional contributions to Earth and space sciences as valued by their peers and vetted by a committee of Fellows." Professor Yelle will be recognized at the AGU fall meeting in New Orleans on December 13.

Professor Adam Showman has been named a 2018 Galileo Circle Fellow, one of the highest honors for faculty in the University of Arizona College of Science.

This award recognizes scholars with "a deep understanding over a broad range of science, a willingness to think in a truly interdisciplinary way, and an ability to inspire colleagues and students." Galileo Fellows receive $5,000 and lifetime membership in the Galileo Circle.

LPL professors Renu Malhotra and Alfred McEwen are previous recipients of the Galileo Fellows Award. Congratulations to Adam on this well deserved honor!

Kudos and congratulations to Daniel Apai and Isamu Matsuyama on moving into the Associate Professor rank, and to Walter Harris on obtaining tenure!

LPL Alumni at DPS

The 49th meeting of the Division of Planetary Sciences of the American Astronomical Society ("DPS" for short) had a strong LPL flavor to it, as it often does. The meeting, October 15-20, was organized by LPL alum (and member of the LPL External Advisory Board) Jani Radebaugh (2005) in Provo, Utah, where she is an Associate Professor of Geological Sciences at Brigham Young University. LPL alumni Sarah Hörst (2011) and Matt Tiscareno (2004) gave plenary talks, and many LPL faculty, staff, students, and alumni presented posters and oral presentations. LPL alum Jamie Molaro (2015) again organized an Art of Planetary Science exhibition for the conference, modeled after the successful version that she developed as a grad student in Tucson, and LPL sponsored the show. Finally, the DPS leadership continues to have a strong LPL influence, with eight LPL alumni and an LPL faculty member in leadership roles, along with several others with LPL ties (such as former students from other UA departments and postdocs). And next year's meeting in Knoxville, Tennessee is being organized by alum Josh Emery (2002) and UA Geosciences alum Devon Burr (2003).

LPL Alums took some time during this year's October DPS meeting to catch-up and relax. Photo: Alessondra Springmann

Department

Meet LPL Postdocs: Alex Evans and Gijs Mulders

Alex Evans joined LPL in January 2017 as a Postdoctoral Research Associate with Associate Professor Jeff Andrews-Hanna. Before staring at LPL, Alex held postdoctoral research positions at the Southwest Research Institute and at the Lamont-Doherty Earth Observatory (LDEO) of Columbia University. Alex is interested in understanding the evolutionary, tectonic, geodynamic, and geophysical processes of rocky planets. His work includes analyses of altimetry, gravity, geomorphology, and tectonics to determine the structure, surface, and internal evolution of these rocky bodies. Thus far, his research has focused on the investigation of the Earth, Moon, Mercury and Mars. Additionally, he has also been involved in the design, development, and implementation of planetary exploration missions.

Alex is originally from the midwest region of the United States. He earned his B.S.E. in Aerospace Engineering from the University of Michigan in 2006 and subsequently a M.S. in Geobiology and a Ph.D. in Planetary Geophysics from the Massachusetts Institute of Technology in 2013. His thesis research covered investigations of Martian crustal evolution, lava-flooded craters on the Moon, and the influence of water in the early thermal history of the Moon using data from past and current NASA missions. Prior to pursuing his Ph.D., Alex worked for NASA's Jet Propulsion Laboratory on mission concept design and analyses at the Moon and Mars.

In addition to his research, Alex has demonstrated a strong commitment to public service and legislative advocacy. He has held leadership roles in student government and non-profit organizations, including as the President and CEO of the National Association of Graduate-Professional Students. Through these roles, Alex has garnered significant experience in non-profit management as well as legislative policy and advocacy at the state and federal levels.

Gijs Mulders joined LPL in August 2013 to work with Ilaria Pascucci and Daniel Apai. He specializes in statistical studies of exoplanets discovered with Kepler, numerical simulations of terrestrial planet formation, and the structure of protoplanetary disks. In 2015, he also joined the Earth in Other Solar Systems team (EOS) to further study how exoplanets could obtain biocritical ingredients. Gijs was born in the Netherlands, growing up near the city of Utrecht. He studied at the University of Amsterdam, where he obtained a Ph.D. on radiative transfer modeling of protoplanetary disks. True to his Dutch genes, he is an avid cyclist ("who needs a car in Tucson?"). He enjoys running, listening to obscure music, and growing his collection of festival wrist bands.

Thank You LPL Donors

We would like to thank all those who have donated to LPL in 2016 and 2017. Individual donors are David Acklam, Gordon Bjoraker, Dan Cavanagh, David Choi, Betty Fink, Barbara Gray/Sun City Oro Valley Astronomy Club, Fan Guo, Bradley Hauert, Guy Jette, Mark Kelly, Xenia King, Norm Komar, Robert Logan, Alfred McEwen, Laura McGill, Bob & Gloria McMillan, Jamie Molaro, Kelly Nolan, Dan Petrocelli, Jani Radebaugh, Timothy Reckart, Justin Rennilson, Michelle Rouch, Tim Swindle, and Ewen Whitaker. Corporate donors are Borderlands Brewery, Trimble, Matrox Imaging, and Tap and Bottle. Thanks to everyone for helping LPL accomplish things we would not be able to without you.

Outreach

LPL Outreach Update

LPL students, faculty, and staff were busy organizing, hosting, and participating in events around Arizona over the summer and early fall, including Nightwings at the Pima Air & Space Museum and SpaceFest.

Space Drafts, Tucson's flavor of Astronomy on Tap, continues to be very popular with the Tucson community. It is a free monthly science talk series held at Borderlands Brewing Company and coordinated by LPL and Steward Observatory. Space Drafts gives local scientists a venue to connect with an interested public audience. You can follow Space Drafts on Facebook or Twitter for more information about upcoming events!

This year's Summer Science Saturday (July 15) was themed around HiRISE and Mars. Professor Alfred McEwen gave the day's science lecture, describing what scientists have learned from the HiRISE images. The University of Arizona Press made available copies of *Mars: The Pristine Beauty of the Red Planet*. As always, there were lots of Mars-focused exhibits and hands-on activities for kids, as well as an entertaining chemistry science show by Brain S.T.E.M., which played to a packed house.

The solar eclipse on August 21 was a busy day on the UA campus. In addition to being the first day of classes, an estimated 1,000 eclipse watchers converged on the UA mall to take part in viewing events, including those organized by LPL, Steward Observatory, the Department of Optical Sciences, and Flandrau Science Center. Guests had the opportunity to talk with scientists, watch the eclipse through solar telescopes, and learn about how and why solar eclipses occur.

LPL graduate students demonstrate stable Lagrange points at a recent Space Drafts talk.

LPL graduate student Cassandra Lejoly talks Mars at Summer Science Saturday.

Eclipse watchers gathered in front of the Kuiper Building on August 21.

LPL graduate student volunteer Maria Steinrueck and three eclipse observers.

Department

LPL Field Trip PTYS 594A

by Christopher Hamilton

For fall 2017, LPL field trip students traveled to the Page region of northern Arizona to obtain a closer look at the Navajo Sandstone Formation, to learn more about their origin, and to discover how they have been modified since the break-up on Pangaea. On October 6, the LPL group drove to Page, via Flagstaff, stopping at the Sunset Crater National Monument and hiking to the top of Lenox Crater to view the San Francisco Peaks. The region includes over 600 volcanoes emplaced over the past 6 million years; the youngest of these volcanoes, Sunset Crater, formed less than 1000 years ago. From there, the group continued on to Page and the field trip focused mainly on exploring the Navajo Sandstone Formation within two cross-sections provided by the Colorado River Gorge and the Water Holes Canyon.

On the Colorado River at Lees Ferry. (Photo: Christopher Hamilton)

The next day, the LPL group had an opportunity to travel from the Glen Canyon Dam to Lees Ferry by taking a river raft along the Colorado River. From the water, the towering walls of the gorge rose up over 300 m, provided an exceptional view into the stratigraphy as well as tectonic history of the Navajo Sandstone Formation. The rafting trip also enabled students to stop along the way to see Native American petroglyphs carved thousands of years ago into dark "desert varnish" on the rocks. On the drive back to Page, the group stopped at the Horseshoe Bend overlook to present their research on the geologic history of the region and the processes that lead to the formation of the Navajo Sandstone Formation and more recent Colorado River.

With this perspective, students were able to spend the following day exploring the Water Holes Canyon, which serves as an ephemeral tributary to the Colorado River. Much like the famous Antelope Canyon, the Water Holes Canyon trail winds its way through impressive slot canyons carved into the Navajo Sandstone Formation. In this setting, students shared their presentations related to the geological and ecological characteristics of the region as well as eolian and aqueous processes. The group also developed their observational skills by making geological sketches in their field books and measuring the orientations of bedding planes, unconformities, and faults. On the way back to Tucson, late in the afternoon on October 9, the group stopped outside Cameron to see the remains of a reclaimed uranium mine and discuss aspects of economic geology and its effects on the region.

Overall, this focused field trip provided a deeper look at the Navajo Sandstone Formation and its place within the "Grand Staircase," which is an exceptional stratigraphic succession exposed through the southwest United States. Additionally, students drew connections to other Earth-like and exotic planetary bodies like Mars and Titan, connecting the processes they observed to those operating on other worlds.

PTYS 554 Field Trip

The PTYS 554 class (Evolution of Planetary Surfaces) explored the geology of northern Arizona. At right is a photo of the class conqurering S P Crater, a 50,000 year old cinder cone north of Flagstaff. (Photo: Shane Byrne)

Graduate

Recent PTYS Graduates

James Keane is currently a postdoctoral associate at the Joint Center for Planetary Astronomy at CalTech. He defended his dissertation (*Tidal-Rotational Dynamics of Solar System Worlds, from Mercury to Pluto*) on May 12. Isamu Matsuyama was his advisor.

Sarah Morrison defended *The Dynamics and Implications of Gap Clearing via Planets in Planetesimal (Debris)* Disks on May 10, and is now a postdoctoral associate in the Department of Astronomy and Astrophysics, University of Pennsylvania. Sarah was advised by Kaitlin Kratter.

Donna Viola defended her Ph.D. dissertation titled, *Expanded Craters on Mars: Implications for Shallow, Mid-Latitude Excess Ice*, on July 10. Shane Byrne served as Donna's advisor. Donna is currently working with Professor Byrne as a Research Specialist at LPL.

Welcome 2017/2018 Graduate Students



Left to right:
Zarah Brown - B.S. Astrobiology, Univ. of Colorado, Boulder
Rachel Fernandes - B.S. Astrophysics & Physics, Univ. of Cincinnati
Indujaa Ganesh - M.S. Geoinformatics/Natural Resources Engineering, Indian Inst. of Technology



Left to right:
Theodore Kareta - B.S. Physics & Astronomy, Univ. of Mass., Amherst
Allison McGraw - B.S. Geosciences, Univ. of Arizona
John Noonan - B.A. Astrophysics, Univ. of Colorado, Boulder



Left to right:
Patrick O'Brien - B.S. Physics/Astrophysics, Univ. of N. Carolina, Chapel Hill
Luke Ranieri - M.S. Geological Sciences, San Diego State University
Lindsay Rhoades - B.S. Physics & Astronomy, Emory University



Left to right:
Laura Seifert - B.S. Geosciences, Univ. of Arizona
Benjamin Sharkey - B.S. Physics/Astrophysics, Univ. of Minnesota
Joana Voigt - M.S. Geological Sciences, Freie Universität Berlin

Graduate

Spring 2017 GTA Award to Kyle Pearson

Kyle Pearson is the recipient of the PTYS Outstanding Graduate Teaching Assistant Award for Spring 2017. Kyle worked with Dr. Vishnu Reddy in the PTYS/ASTR 170B2 General Education course (Natural Sciences Tier I).

Recipients of the Outstanding GTA Award receive funds of up to $1,000 to support travel to a professional meeting of their choice.

Invest in LPL

2017 Cavanagh Travel Funds

With support from LPL External Board Chair Dan Cavanagh, Molly Simon had the opportunity to travel to Utrecht (Netherlands) to attend the International Symposium on Astronomy and Astrobiology Education (July 3-7, 2017). Molly's dissertation work is a science/science-education hybrid with Dr. Ilaria Pascucci and Dr. Chris Impey.

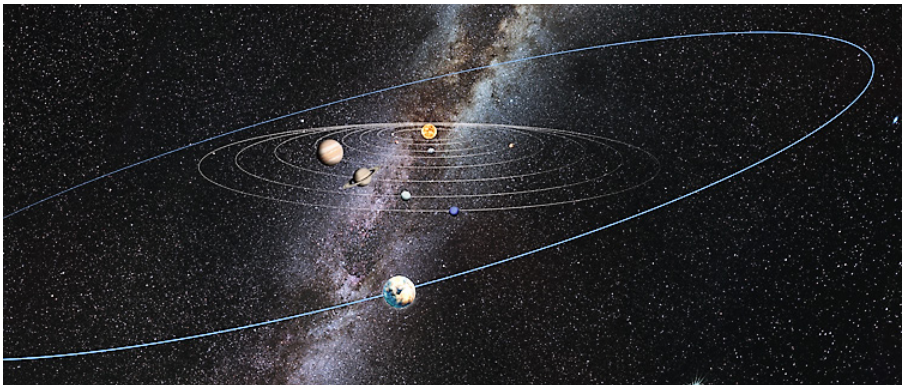
At the ISE2A conference, she gave a talk about research, specifically discussing college students' preinstructional ideas on the topic of planet formation. For the presentation in Utrecht, Molly synthesized the results from short-answer questions administered to over 1,500 introductory astronomy and planetary science students during the 2016-2017 academic year. These questions covered the topics of planet formation, planetary composition, migration, basic definitions of planets, exoplanets, and the structure of planetary systems.

This travel opportunity allowed Molly to interact with fellow scientists and astronomy educators alike; "I learned about up-to-date research being conducted in the field and also gained insight into how best to design astrobiology courses. Overall, it was great to see that astronomy education is an important topic all over the world!"

Department

LPL Scientists and the Curious Case of the Warped Kuiper Belt

by Daniel Stolte, UA Communications



A yet to be discovered, unseen "planetary mass object" makes its existence known by ruffling the orbital plane of distant Kuiper Belt objects, according to research by Kat Volk and Renu Malhotra of the UA's Lunar and Planetary Laboratory. The object is pictured on a wide orbit far beyond Pluto in this artist's illustration. (Image: Heather Roper/LPL)

LPL Postdoctoral Research Associate Dr. Kat Volk and Regents' Professor Renu Malhotra present compelling evidence of a yet undiscovered planetary body with a mass somewhere between that of Mars and Earth. The mass has given away its presence only by controlling the orbital planes of a population of space rocks known as Kuiper Belt objects (KBOs) in the icy outskirts of the solar system.

Most KBOs orbit the sun with inclinations that average out to the invariable plane of the solar system, but the most distant KBOs do not. Their average plane, Volk and Malhotra discovered, is tilted away from the invariable plane by about 8 deg—something unknown is warping the average orbital plane of the outer solar system. "The most likely explanation for our results is that there is some unseen mass," says Volk. "According to our calculations, something as massive as Mars would be needed to cause the warp that we measured."

Volk and Malhotra analyzed the tilt angles of the orbital planes of more than 600 KBOs to determine the common direction about which these orbital planes all precess. "We expect each of the KBOs' orbital tilt angle to be at a different orientation, but on average, they will be pointing perpendicular to the plane determined by the sun and the big planets." If the average orbital plane of objects in the outer solar system were a sheet, it should be quite flat past 50 AU, according to Volk. "But going further out from 50-80 AU, we found that the average plane actually warps away from the invariable plane," she explains.

Because a planet, by definition, has to have cleared its orbit of minor planets such as KBOs, the hypothetical mass is termed a planetary mass object. The data do not rule out the possibility that the warp results from more than one planetary mass object. Why haven't we found it yet? Probably because we haven't yet searched the entire sky for distant solar system objects. The most likely hiding place for a planetary mass object would be in the galactic plane, an area so densely packed with stars that solar system surveys tend to avoid it. A possible alternative to an unseen object that could have ruffled the plane of outer KBOs could be a star that buzzed the solar system in recent history.

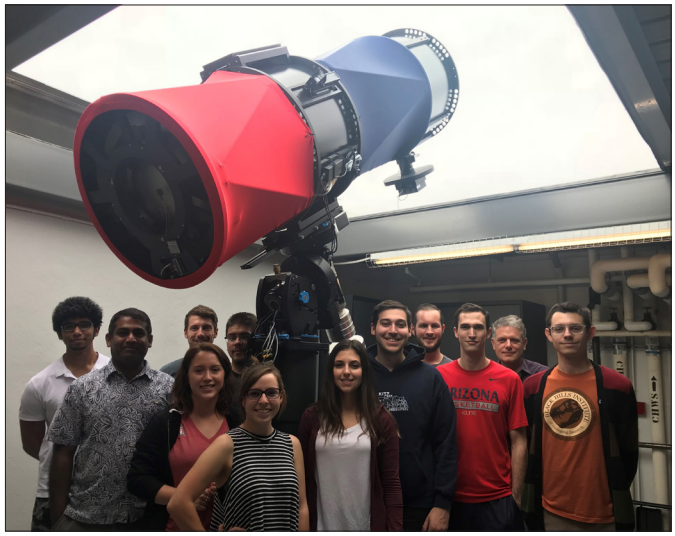
Humankind's chance to catch a glimpse of the mysterious object might come fairly soon once construction of the Large Synoptic Survey Telescope is completed. Run by a consortium that includes the UA and scheduled for first light in 2020, the instrument will take unprecedented, real-time surveys of the sky, night after night.

Invest in LPL

PTYS 416/516 and the TC4 Observational Campaign

Thanks in part to funding provided by the LPL External Board of Advisors, PTYS graduate students traveled to Hawaii to observe near-Earth object (NEO) 2012 TC4, a small asteroid predicted to have a close encounter with Earth on October 12, 2017. LPL Assistant Professor Vishnu Reddy, a member of the global consortium of astronomers tracking the asteroid 2012 TC4, teamed with Associate Professor Walt Harris, with whom he was co-teaching the 416/516 course, to put together a class project related to this event. Undergraduates in the course were given the task of following TC4 using the new RAPTORS telescope on the roof of the Kuiper Building; graduate students, accompanied by professors Harris and Reddy, would travel to the big Island of Hawaii, where they would be directly involved in the NASA Infrared Telescope Facility (IRTF) observations.

The project achieved its goals of giving students the opportunity to be involved in a hands-on research project while also obtaining measurements to be used as part of the wider effort to characterize TC4. While the graduate student team was not able to obtain an IRTF spectrum on the night the students were present at the observatory, the data they obtained during remote observations 2 nights earlier meant that they did not return empty handed. They also gained new insight into the challenges and frustrations that come with groundbased observing, and their assistance during the power outage will be useful for optimizing the IRTF recovery process in the future. The undergraduate team had a successful observing run made possible through their own careful preparation, and provided the side benefit of obtaining observations that will prove useful for characterizing the RAPTORS telescope performance. As Haris Niazi, a member of the graduate student team, summed up the entire experience, "It was wonderful being part of something that takes you out of the familiar confines of a classroom and pits you against a real-world research problem. Observing was quite the experience."



Undergraduate students at the RAPTORS observatory at LPL. (Photo: Rachel Fernandes)

Graduate students at the NASA Infrared Telescope Facility on Mauna Kea, Hawaii. (Photo: Alessondra Springmann)

LPL in the News

Links to the news stories below and others are available at: http://www.lpl.arizona.edu/news/2017/fall

Recurring Martian Streaks: Flowing Sand, Not Water? - Seasonal dark streaks on Mars have been described as possible signs of flowing water, but a new study shows they are a better fit to dry flow processes.

OSIRIS-REx gets an Assist from Earth's Gravity - The OSIRIS-REx spacecraft did a close pass to Earth in September, taking spectacular images and getting the boost it needs to get to Bennu.

NASA Tests its Asteroid Defense System - Vishnu Reddy plays a major role in an exercise using the flyby of asteroid 2012 TC4 to see how quickly and how well Earth's telescopes can be used to characterize a threatening asteroid.

UA Scientists and the Curious Case of the Warped Kuiper Belt - Kat Volk and Renu Malhotra find that the orbits of Kuiper Belt Objects may indicate the existence of a distant planet-sized object.

When the Sun Goes Dark, UA Student's Skills Shine - PTYS undergraduate minor Adriana Mitchell worked with a project to monitor the Sun's corona during August's total solar eclipse.

Sorry, No Alien Megastructure Around Mysterious Star - Work by Huan Meng and George Rieke shows that "Tabby's Star" is dimming because of a dust cloud, not a vast artificial structure.

Asteroid-Comet Is New Type of Object - An object discovered by Catalina Sky Survey is a binary "main belt comet."

A Glacier in Interior Alaska is a Testing Ground for Equipment Intended for Use in Space - An LPL-led team works on developing seismology instruments for Europa.

LPL Faculty Profiled in Arizona Daily Star - Dante Lauretta and Vishnu Reddy are highlighted in separate stories.

Stellar Corpse Sheds Light on Cosmic Rays - A new study led by Federico Fraschetti suggests a different way to accelerate cosmic rays.

Scientists Solve Mystery of Blinking Brown Dwarfs - Atmospheric bands and waves, similar to those seen in the Solar System, are observed on brown dwarfs.

UA Trains Visually Impaired Youth for STEM - Steve Kortenkamp uses HiRISE images to motivate visually impaired students to consider STEM fields.

Earth's New Buddy Is Asteroid, Not Space Junk - Earth's "quasi-satellite," 2016 HO3, has a spectrum and light-curve that match near-Earth objects, not space debris.

Search for Life on the Solar System's Icy 'Ocean' Moons -"Tidal Heat is the Key" - Hamish Hay and Isamu Matsuyama show that tidal heating may be crucial if there is life in ocean worlds.

Amazonia's Future Will Be Jeopardized by Dams - Vic Baker and colleagues say that building hundreds of proposed hydroelectric dams will cause massive environmental damage.