

# ASTRONOMY



## Our 100<sup>th</sup> year!

**T**his August, we celebrate our 100th anniversary as the Department of Astronomy.

Astronomy was first taught at the Illinois Industrial University (our university's original name) in 1868, its very first year, by a professor in the Mathematics Department. By 1872, the university's first observatory had been built. In 1895, the University of Illinois received approval from the state legislature for a new and permanent observatory to be constructed just north of the Morrow Plots with a 12-inch refractor. The observatory was completed in 1896 and is still in use for educational purposes today—125 years later.

In August 1921, the Board of Trustees authorized the Division of Astronomy in the Department of Mathematics to be organized as a separate Department of Astronomy with Professor Joel Stebbins as the department head. The following year, Charles Wylie earned the first University of Illinois PhD in astronomy. The modern astronomy department started in 1951 with the astronomer George McVittie recruited as the new department head, expanding to nine faculty. By 1972, the department expanded to 15 faculty and the department had to move out of the Observatory in search of more space. In 1989, the Observatory was declared a National Historic Landmark. Soon after, the new Astronomy Building opened on Green Street and is still the home of Illinois Astronomy. Today, the department has award-winning faculty, students, and staff who continue Illinois Astronomy's century-long tradition of excellence, innovation, and curiosity.

The department has had a long and still developing history of engagement with telescopes that ranges from the 12-inch refractor in the dome (with Stebbins' groundbreaking work on electronical detection of light), to Mt. Laguna (our first meter class telescope led by Ken Yoss), to the early radio telescopes (i.e. 120 ft and 400 ft led by George Swenson Jr.), to radio interferometers (BIMA and CARMA), to the South Pole Telescope. In recent years, department faculty have become deeply involved in surveys, such as the Sloan Surveys, the Dark Energy Survey, the Legacy Survey of Space and Time, and many others. See the article about the new Center for Astrophysical Surveys. These telescopes help give Illinois its distinctive place in modern astrophysics.

The department also has a proud history of pioneering work in theoretical and computational astronomy. The department played a key role in the founding and development of the campus National Center for Supercomputing Applications (NCSA), motivated by simulations of colliding black holes by founding director and astronomy faculty member Larry Smarr and his students and collaborators, as well as foundational work in stellar evolution by Icko Iben and Ron Webbink. Cutting edge computation and data analysis remains a core interest of the astronomy faculty. In pure theory, McVittie was a well-known cosmological theorist, and his effort to understand the origin and evolution of the universe continues today.

## Join Us in Celebrating 100 Years Virtually!

**A**lthough we would have loved to invite everyone back to campus to celebrate our 100th anniversary, with the pandemic it is not possible. Even with the campus reopening in the fall, we think that most of you have other ideas for travel plans, and we understand.

Thus, we cordially invite all of our alums and friends to attend a virtual celebration of the Department of Astronomy's 100th year on August 21 at 11 a.m. (Central time). See [go.illinois.edu/astro100years](https://go.illinois.edu/astro100years) for more information and registration. We plan on some history, some stories of our graduates, and some ideas for our future. We will leave some time for reminiscing by attendees. Please join us for this celebration. We want to see as many of our alums and friends as possible.



# From the department chair



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**I am excited to represent** the Department of Astronomy during our 100th anniversary. Astronomy is one of the four original liberal arts quadrivium, and modern astronomy allows for students to learn more about the origin of the universe and our place in it. Astronomy is also a great “gateway science,” providing students a pathway to STEM. The department has a long and amazing history of education and cutting-edge research, and our faculty are proud to represent that long astronomy history.

It is also somewhat fitting that with this 100th anniversary, we are also planning the reopening of our department after nearly 18 months of COVID-19 and closed classrooms, labs, and offices. With vaccinations and the continuation of testing on campus, we think that in August 2021 we can safely resume our in-person education and research mission, which we have upheld for the last 100 years, and prepare our vision for the next 100 years.

As the COVID-19 pandemic stretches on, it continues to majorly impact our students and faculty. The delays of projects and the difficulties of Zoom meetings has created problems that no one could have foreseen. We have students (both undergraduate and graduate) moving into their second year who have never even set foot in the building. Faculty have graduate students whom they have never met in person. Nonetheless, Illinois Astronomy has continued to teach, reach the community, and perform outstanding cutting-edge research. We appreciate how everyone in our department rose to the challenge with amazing flexibility and extreme concern for students, faculty, staff, campus, and our communities.

Astronomers are very lucky for the most part in that most of our observations or simulations today can be done from home with data streaming in from distant locales. We hope you and your families were able to stay safe too.

I’m honored to have the opportunity to be the chair of the department as we enter our 100th year, and I look forward to our 101st year as we pursue our shared goals of Illinois Astronomy excellence and impact on all aspects of our land grant mission.

Thank you for your support. It is needed more than ever.

## Faculty Highlights

### New Books



**T**his year, three of our faculty published educational, interesting books. Professor Paul Ricker co-authored a book entitled “Common Envelope Evolution” that introduces students and researchers to our current understanding of a critical process in the lives of interacting binary stars (when they temporarily share the same outer layers and the

stellar cores of both stars are orbiting inside). Emeritus professor Laird Thompson authored a book entitled “The Discovery of Cosmic Voids” that reflects on cosmic voids and supercluster structures and his journey to have his findings accepted. Professor Stu Shapiro co-authored a book entitled “Numerical Relativity: Starting From Scratch” that is designed for students and researchers without backgrounds in general relativity who want to understand and use the tools of numerical relativity and run community codes that use these tools.

# New Astronomy Center on Campus

## The Center for Astrophysical Surveys

**The Center for Astrophysical Surveys (CAPS)** is a new research unit housed within the National Center for Supercomputing Applications (NCSA) dedicated to conducting, building, and analyzing data from astrophysical surveys.

CAPS strives to create a diverse, inclusive environment that facilitates collaboration between researchers involved in astrophysical surveys. The center also seeks to increase accessibility to advanced resources for astrophysical surveys such as high-performance computing, data processing, software development, user experience design, AI solutions, and consultation.

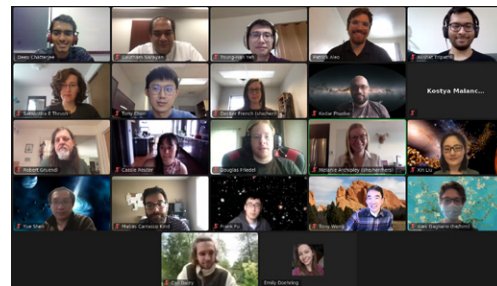
To that end, CAPS is involved in several surveys, including the Dark Energy Survey (DES), producing the most extensive and accurate dark matter map, the Vera C. Rubin Observatory's (VRO) Legacy Survey of Space and Time (LSST), the South Pole Telescope (SPT), and CMB-S4 (the next generation ground-based cosmic microwave background experiment). CAPS also works with teams that are enabling next-generation surveys such as searches for kilonovae as the Scalable Cyberinfrastructure for Multi-Messenger Astrophysics (SCiMMA) group.

CAPS has been active since 2019, and we have had two years of graduate and postdoctoral fellows. For 2019: Monika Soraisam (postdoctoral fellow); Melanie Archipley, Colin Burke, Cail Daley, Alex Gagliano (Grads). For 2020: Deep Chatterjee (postdoctoral fellow); Patrick Aleo, Melanie Archipley, Colin Burke, Yu-Ching (Tony) Chen (Grads).

The CAPS faculty and fellows have been busy doing lots of exciting cutting-edge research. You can hear about research going on in CAPS and the projects the center is involved in at our bi-weekly Friday noon lunch seminars. These are currently happening on Zoom, and if you are interested in joining, send us an email at [caps@ncsa.illinois.edu](mailto:caps@ncsa.illinois.edu) for connection information.

This year, we're delighted to welcome Dr. Srinivasan Raghunathan as our 2021 CAPS Postdoctoral Fellow. "Srini" will work with professors Joaquin Vieira and Gil Holder on the SPT-3G survey and CMB-S4, and we look forward to announcing a new slate of CAPS graduate fellows very soon!

The center is a collaborative effort between NCSA, the Office of the Vice Chancellor for Research and Innovation, the Department of Astronomy, and the Department of Physics at Illinois. CAPS seeks to bring cohesion and facilitate research for astrophysical survey science efforts, both across campus and with external partners.



A recent CAPS Zoom seminar.

## Alumni Spotlight

### From Galaxy Clusters to Clean Energy Innovation



**Alumna Rukmani Vijayaraghavan (PhD 2015)**

simulated the evolution of galaxies in harsh cluster environments as a graduate student and is now working on clean energy innovation in the federal government. After an NSF Astronomy & Astrophysics Postdoctoral Fellowship, during which she also ran the Girls

Exploring the Universe camp, Rukmani served as an American Institute of Physics Congressional Science Fellow. She worked in a U.S. Congressional office on issues ranging from science funding, computer science education, clean energy and climate, to civil aviation and housing. She helped write and introduce legislation, prepared for hearings, and worked on the federal

appropriations process.

Rukmani's time in the nation's capital inspired her to continue a career in public service and in solving the climate crisis. To avoid the worst effects of climate change, we as a society need to decarbonize the economy by 2050, which requires deploying existing clean energy solutions and supporting clean energy innovation; making these solutions sustainable requires that the energy transition must be just and inclusive. To work on these issues, Rukmani served as an AAAS Science and Technology Policy Fellow in the U.S. Department of Energy's (DOE) Water Power Technologies Office, where she is now a federal employee. She works with DOE programs and the National Labs to enable sustainable and equitable clean energy innovation and commercialization activities.



# Graduate Student Spotlights

## Young Protostars in Ophiuchus

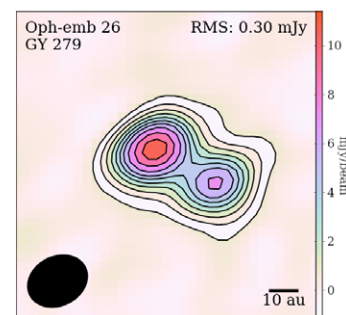


**Frankie Encalada**

Stars are birthed from within the densest regions of molecular clouds. The gas and dust composition of these clouds ends up not only within the protostars as fuel for future thermonuclear fusion, but also during the collapse process as a circumstellar disk from which the protostar accretes and in which planets may form. For our solar system, we understand the ends, but what of the means? How do we study something that has already happened? We point powerful telescopes at nearby molecular clouds and observe the stellar systems that are still in their infancy. This is what fifth-year graduate student Frankie Encalada and professor Leslie Looney are doing. They used the Atacama Large Millimeter Array (ALMA) telescope in Chile to look at the youngest protostars in

one of the closest molecular clouds at 140 parsecs, Ophiuchus. Their results, when compared to the research done in other nearby molecular clouds, namely Perseus and Orion, showed that Ophiuchus protostars formed with lower disk masses and disk radii, but with similar stellar multiplicity. This points towards different fundamental initial conditions for the star formation process in different regions yet result in similar outcomes.

A false color sub-millimeter ALMA dust emission image of a young protostellar system with two protostars surrounded by a disk of gas and dust. One of the many young systems in Ophiuchus that may go on to host planets in a few tens of millions of years.



## The Study of Early Galaxies after the Big Bang

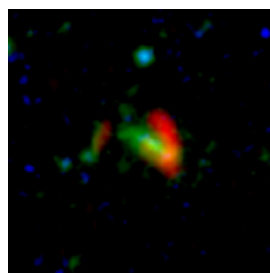


**Sreevani Jarugula**

In the cosmic history of the universe, the earliest stars and galaxies formed a few hundred million years after the Big Bang, in the Epoch of Reionization. These are the precursors of the galaxies and galaxy clusters we observe in the present universe. It is important to study these first galaxies to understand how galaxies formed and evolved over cosmic time. The Atacama Large Millimeter/submillimeter Array (ALMA) in Chile has the sensitivity and resolution to study the properties of these early galaxies through observations of atoms, molecules, and dust.

Graduate student Sreevani Jarugula, in collaboration with professor Joaquin Vieira and the South Pole Telescope Submillimeter Galaxy (SPT-SMG) group,

observed SPT0311-58, a pair of galaxies present at a redshift of 6.9 (only about 800 million years after the Big Bang) with ALMA. It is one of the most massive infrared luminous systems detected in the Epoch of Reionization. The team analyzed multiple carbon monoxide molecular transitions in the pair of galaxies, in addition to neutral carbon and water, which is one of the most distant detections of water in the universe. Using modelling, they estimate the properties of the galaxies such as the temperature, star formation rate, and gas mass. It is expected that more such galaxies will be discovered in the upcoming SPT survey.



The pair of galaxies in SPT0311-58. The millimeter continuum emission observed with ALMA is shown in red and the optical and infrared emission from the Hubble Space Telescope is shown in blue and green. Image credit: Marrone et al. (2018)

## Detecting Transient Sources with SPT



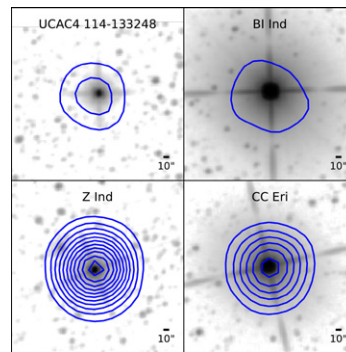
**Cail Daley**

**T**he South Pole Telescope (SPT) collaboration has recently begun to use data from its currently-operating SPT-3G camera to venture into the field of time-domain astronomy at millimeter wavelengths. Though primarily operating as a cosmology

telescope, SPT-3G's daily cadence, arcminute resolution, and instrumental noise levels give excellent sensitivity to transients over 1,500 square degrees of sky going back to 2018.

Graduate student Cail Daley, in collaboration with other SPT graduate students, recently published a paper with 15 transient detections. The untriggered transient search has revealed several exciting transient candidates, including flaring variable stars and extragalactic sources, and an Active Galactic Nuclei (AGN) monitoring program is

currently being developed. The stellar flares are bright with durations from a few minutes to several hours, while the extragalactic sources have durations of two to three weeks. Many members of the Illinois astronomy community, including undergraduates, graduates, and faculty, have contributed in various ways to the ongoing SPT transients effort, and our friends at NCSA are setting up a lightcurve server to make the SPT lightcurves more accessible.



Mid-infrared images of SPT-3G flare stars from the Wide-field Infrared Survey Explorer (WISE) satellite (Lang 2014) with SPT-3G flux contours overlaid in blue. The extended cross-like features are telescope diffraction spikes.

## Analyzing the Strange Death of a Star

**At the end of its life**, a massive star collapses and explodes in a brilliant event known as a supernova. Technological advancements in the past decade have allowed us to discover thousands of these explosions each year and study what conditions lead a star to explode in different ways. Fourth-year graduate student Alex Gagliano, in collaboration with professor Gautham Narayan and a team of researchers within the Young Supernova Experiment, found evidence of bizarre behavior from nearby supernova 2020oi at the heart of the spiral galaxy NGC 4321. In the first few days of a supernova, the light from the explosion typically gets brighter over time as radioactive elements produced in the blast decay and release a bright glow.

Using a combination of state-of-the-art ground-based and space-based telescopes, however, Alex and his team found that 2020oi unexpectedly brightened and then dimmed again for a short period of time. Alex combined this data with Hubble Space Telescope images of the region before the explosion. He

discovered that this supernova marked the death of a star in a binary system. The expanding material from the explosion most likely crashed into surrounding gas that had been pulled off of the star by its companion, causing a brief flash of light as this envelope was heated. This is only the third time this kind of brightening event has ever been observed, and future discoveries from large-scale surveys will tell us even more about how these energetic and enigmatic explosions take place.



**Alex Gagliano**



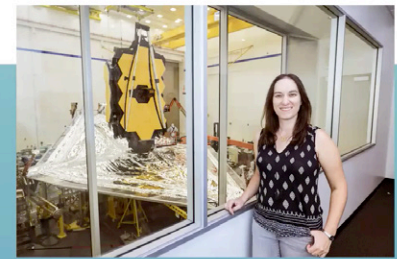
# Astrofest 2021

**The second Illinois Astrofest** occurred as a virtual meeting on April 23, 2021, due to the pandemic. We had an enthusiastic response to our call for presentations from all over campus and ultimately selected five local speakers for the oral session, in addition to our featured speaker, Dr. Stacey Alberts (astronomy 2007), a research professor at the University of Arizona. Stacey presented her exciting career path leading up to her involvement in the NASA James Webb Space Telescope (JWST) — even more Illinois engagement in JWST. Stacey also was the colloquium speaker earlier that week, presenting her research in extragalactic astronomy.

Although the oral session unites the attendees, Astrofest is really centered on the poster session, which offers Illinois astronomers a wonderful opportunity to socialize while learning about each others' research. Since it is much more challenging to conduct a poster session virtually, we made use of the "Gather.town" platform to place the approximately 50 participants into a virtual world where their "avatar" could move around a "poster room" and interact with nearby participants via audio and/or video chat. We placed the 17 posters into two virtual rooms on either side of a virtual "lobby." This proved to be a great success, though we do plan to return to a more traditional format (including food and drink!) once the pandemic has subsided. We also plan to redouble our efforts to involve researchers at Illinois outside



Stacey Alberts - University of Arizona



## THE JAMES WEBB SPACE TELESCOPE: HOW IT STARTED AND HOW ITS GOING (AND HOW I GOT TO HELP)

Astrofest @ UIUC  
April 23, 2021

the Department of Astronomy who are doing research in astronomy or with astronomical applications.

The organizing committee (Tony Wong, Sreevani Jarugula, Colin Burke, and Deep Chatterjee) are grateful for the assistance of Rebecca Bare on logistics and our eight poster judges who helped to select our student poster winners, Sneh Pandya (undergraduate prize) and Jennifer Li and Jesse Miller (graduate prizes). We would also like to acknowledge the financial support of the Vermilion River Fund for Astronomical Research.

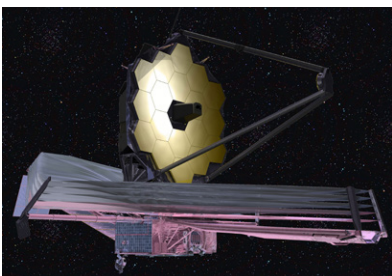
## Department News

### Preparing for Future Space Telescope Observations

**The NASA James Webb Space Telescope (JWST)** announced their accepted proposals for Cycle 1. JWST will provide an unprecedented view of astrophysics so there was significant competition for time, but Illinois astronomers were involved on many successful proposals:

Professor Looney (co-I on two projects), professor Narayan, postdoc Chatterjee, and grads Aleo and Gagliano (co-Is on three projects), graduate student Phadke was PI on one project (with professor Vieira, research scientist Reuter, and grad Jarugula), professor Shen

(PI on one project with graduate student Li and co-I on two projects), and professor Vieira and graduate student Phadke (co-Is on one project). We look forward to their exciting observations after JWST launches later this year.



### Staff News

We are happy to welcome a new astronomy staff member. Rose Smith joined astronomy in June as our new office manager.

### Faculty News

We are excited to announce the promotion of assistant professor Xin Liu to associate professor. The following were recognized on the campus Excellent Teacher list: Professors Leslie Looney (Sp20), Bryan Dunne (Sp20), Brian Fields (Sp20), Leslie Looney (W20), Gautham Narayan (Sp20), Amanda Winans (Sp20), and Tony Wong (F20).

### Observatory News

We are happy to work closely with the Friends of the Observatory (make sure to check out their newsletters) to keep the Observatory an important part of the department. This year, we raised enough to remove the partition wall on the west side of the building. This will allow us to better utilize the space by increasing the size of the classroom used for outreach presentations, some classes, and for the University of Illinois Astronomy Society (UIAS) meetings.

## Undergraduate Student News

In this difficult year, we have had some truly amazing undergraduate students doing classwork, getting involved in research, and making a difference. With the pandemic, we had a very successful online convocation. We are proud of our 2021 graduates! Congratulations to the Astronomy Class of 2021: Alexander Basler, Kunal Bhatia, Kelley Chau, Kaiyuan Dou, Jorge Espinoza, Justin Gaetz, Alex Garcia, Kameron Gausling, Archit Gupta, Jake Hawkins, Matthew Hoyle, Zhenghai Liu, Bashitha Mandava, Daniel Milgram, Daniel Montoya, Peyton Pielet, Sahaj Putcha, Japneet Singh, Yuchen Wang, and Zhengyuan Yu. And congratulations to our graduating minors: Thao-Vien Bui, Justin Gruber, Reka Manton, Sneha Pandya, Raghava Ravi, Daniel Rymut, and Zhaoyu Yang.

The Layla Suzanne Ryan Memorial Scholarship was established to recognize outstanding undergraduates who also exhibit community service. The winner of the 2021 award is astronomy major Holly Lee. The Stanley Wyatt Memorial Award is awarded annually to the graduating astronomy major or minor with the most outstanding GPA and track record of undergraduate research. The 2021 award recipient is graduating astronomy major Jake Hawkins.



## Graduate Student News

With the pandemic, it has been a hard time for graduate students. They are students, researchers, teachers, mentors, and leaders and all of that has been deeply impacted by the pandemic.

One of the first steps for our graduate students is the preliminary exam in which they outline their PhD research. The graduate students who have passed their prelims this academic year are (ordered by date): Yu-Ching (Tony) Chen and Rachel Harrison.

We are happy to announce our graduate students who have graduated with a PhD this academic year (ordered by date): Di Wen, Monica Huang, Wei-Ting Liao, Jennifer Li, and Patrick Mullen.

The Mr. and Mrs. Hsiang-Pai and Wen-Hua Chu Department of Astronomy Excellence in Research Graduate Student Award was founded by professor emeritus and former Department of Astronomy chair You-Hua Chu, named in honor of her parents. The 2021 winners of the award are Observation: Sreevani Jarugula and Theory: Patrick Mullen. Sreevani's work, highlighted in this newsletter, focuses on high redshift galaxies, and Patrick's work, highlighted in last year's newsletter, focuses on simulations of the impact that created our Moon.

In addition to these departmental awards and milestones, our students are winning university-wide and external recognition. Some selected highlights: Lilly Bralts-Kelly (Excellent Teacher List, F20) and Alex Gagliano (finalist for the American Statistical Association's Astrostatistics Best Student Paper Award).

## Lew Snyder



Astronomy is sad to announce the passing of professor emeritus Lew Snyder in February. He will be most remembered for leading the detection of the formaldehyde molecule ( $\text{H}_2\text{CO}$ ) in the interstellar medium using the Green Bank 140 Foot Radio Telescope in 1969. This was the first polyatomic molecule detected in space that contained more than a single heavy atom, and demonstrated that complex molecules (including organic molecules) could form and persist in space. The widespread abundance of formaldehyde suggested that interstellar organic chemistry would be a rich field of research. Lew was a pioneer in the field of molecular astrochemistry and provided scientific motivation for the modern generation radio observatories such as the Atacama Large Millimeter/submillimeter Array (ALMA). He was also a big influence on the department for 30 years, serving as the director of the Laboratory for Astronomical Imaging for many years and as the chair of the department. His family has established the Lew Snyder Memorial Fund that will be used to support graduate students. You can donate to the fund by going to [giving.illinois.edu](https://giving.illinois.edu) and typing in the fund name.



**DEPARTMENT OF ASTRONOMY**  
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**We count on the generosity of alumni and friends to support students** as they embark on earning a world-class education and to fund faculty members as they conduct world changing research and train students. Your investment makes a big difference!

**Yes! I believe in the importance of excellence in astronomy and wish to show my support!**

\$\_\_\_\_\_ **Department of Astronomy Annual Fund.** (11334898) Your gift to our department fund will have the widest impact as it supports the full range of our key missions, including undergraduate and graduate student support, distinguished lecturers, the recruitment of excellent faculty, and alumni and outreach events.

\$\_\_\_\_\_ **Low Snyder Graduate Fund.** (11336905) Support graduate students by providing travel grants for them to present their research at conferences. This is a new fund, and we are hoping to raise enough to make it a permanent addition.

\$\_\_\_\_\_ **James Kaler Astronomy Classroom Fund.** (11341988) Continue to support our newly dedicated Department classroom, named after one of our most beloved faculty members.

\$\_\_\_\_\_ **Stanley Wyatt Memorial Award Fund.** (11775123) Support graduating Astronomy majors/minors with outstanding GPAs and track records of undergraduate research. Help us increase the monetary award, which has not increased in the last 10 years.

\$\_\_\_\_\_ **Layla Suzanne Ryan Scholarship Fund.** (11773536) Support junior or senior majors/minors in Astronomy who exhibit outstanding community service or outreach.

\$\_\_\_\_\_ **Mr. & Mrs. Hsiang Pai & Wen-Hua Chu Department of Astronomy Excellence in Research Graduate Student Award Fund.** (11774227) Support graduate students who exhibit excellence in research. We want to continue having a theory and observational award each year. Your gift can help achieve this.

\$\_\_\_\_\_ **Icko Iben Jr. Distinguished Lectureship Series Fund.** (11772338) Support the Iben Lecture series that brings top researchers to campus to give public talks on their work.

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