KIPAC

KAVLI INSTITUTE FOR PARTICLE ASTROPHYSICS & COSMOLOGY

YEAR IN REVIEW 2024-2025

SLAC

LELAND STANFORD JUNIOR UNIVERSITY
DIE LUFT DER FREIHEIT WEHT
1891

DEAR FRIENDS OF KIPAC,

Thank you for your continued support of KIPAC. I'm pleased to share this review of the 2024-2025 academic year, which highlights new discoveries, details new tools to map and decode the cosmos, and highlights our wonderful community.

A centerpiece of this year was the **First Look** for the NSF–DOE Vera C. Rubin Observatory. On June 23, 2025, we watched as the 3.2-gigapixel SLAC-led LSST Camera—an unprecedented engineering marvel—streamed its inaugural science imagery to the world. Featured on our cover, these images represent more than two decades of collaboration between Stanford and SLAC to launch this incredible project. Rubin has already begun making discoveries—from asteroids and interstellar objects in our cosmic backyard to echoes of light from billions of years ago.

As we enter this data-rich era, we are building new collaborations to catalyze discovery. In late 2024, we launched the **Center for Decoding the Universe (C4DU)** in partnership with Stanford Data Science. This initiative is already a hub of interdisciplinary expertise—leveraging new AI and data science tools to untangle the next generation of astronomical data, and pushing new methodologies forward to enable discoveries across fields.

Our portfolio continues to push boundaries across every scale, for example:

- From world-leading constraints on WIMP dark matter with **LUX-ZEPLIN** to the trillionth trigger recorded by **Fermi LAT**, we are interrogating the fundamental particles of our universe and building new quantum detectors to do so even better in the future.
- We used KIPAC's new guaranteed time on the **Magellan telescopes** to investigate black holes, the first stars, and the chemical evolution of galaxies. Starting in 2027, the twin **Via spectrographs** on Magellan and MMT will map millions of stars, allowing us to hunt for the "missing" clumps of dark matter in our own galactic backyard.
- **DES** and **DESI** made newly precise measurements of the evolution of structure this year. **Simons Observatory's** first light in early 2025 will enable us to use the CMB as a "backlight" to study this even more precisely.

Finally, our science is only as strong as the community it inspires. This year's KIPAC and Friends Community Day welcomed nearly 7,000 people to the Science and Engineering Quad. Watching hundreds of children's eyes light up with new ideas reminds us why we do this work—to share the awe of a universe that is becoming a little more fathomable every day.

With gratitude,

Risa Wechsler
Director, Kavli Institute for Particle Astrophysics and Cosmology

CONTENTS

Front cover: A small section of NSF–DOE Vera C. Rubin Observatory's view of the Virgo Cluster. (Credit: NSF–DOE Vera C. Rubin Observatory)

Back cover: A high-resolution simulation of a spiral galaxy forming in the Universe, with gas and stars swirling together into a disk, dotted with glowing regions ionized by nascent stars. (Credit: Sergio Martin-Alvarez)

Right: The NIRCam image of the Southern Ring Nebula captured by the James Webb Space Telescope. (Credit: NASA, ESA, CSA, STScI)

NSF-DOE VERA C. RUBIN OBSERVATORY

First Look, Then See

Rubin image of the Trifid Nebula (blue) and Lagoon Nebula (red). (Credit: NSF-DOE Vera C. Rubin Observatory)

On June 23, 2025, researchers and the public across the globe gathered to see the universe as the NSF-DOE Vera C. Rubin Observatory does: vast, dynamic, and brimming with hidden detail. Its SUV-sized, 3200-megapixel CCD camera with a massive 8.4-meter telescope mirror is an unprecedented fusion, and everyone watched eagerly as its inaugural science imagery — known as its First Look — streamed live from the National Academy of Sciences in Washington, DC.

Rubin is one of the reasons KIPAC was founded in 2003. KIPAC's members have supported the construction and integration of the Legacy Survey of Space and Time (LSST) Camera, and now lead the LSST Dark Energy Science Collaboration, manage the Rubin US Data Facility, and help operate the Rubin Observatory system. So when a First Look watch party was hosted at SLAC, it was no surprise that over 100 project leads and scientists joined together to celebrate more than 20 years of hard work and anticipation.

"From the beginning, the partnership between Stanford and SLAC has always been a deep intellectual collaboration that helped shape the vision and technical roadmap for LSST," said Risa Wechsler, Director of KIPAC. "Now with First Look, we are marking the beginning of a new era in the study of the cosmos, with Stanford, SLAC, and KIPAC at the forefront."

A special event was also held for the public on the Stanford campus to celebrate the First Look, where nearly 1,000 participants both in person and online marveled at Rubin's first images and learned about the observatory's unique potential for research in cosmology, Milky Way science, and transient astronomy.

Data from the Rubin Commissioning Camera (Data Preview 1, DP1) released shortly after the First Look celebration has already enabled remarkable preliminary science. Eager researchers can mark their calendars for the upcoming start of the Rubin alert stream in early 2026, the anticipated release of Rubin Data Preview 2 later this year, followed by Data Release 1 (DR1) in 2028. The last of these will contain a year's worth of processed, science-grade data from the LSST survey.

The unprecedented LSST Camera on Rubin does two things exceptionally well. First, it takes really good pictures. “Its images are so detailed that it could resolve a golf ball from around 15 miles away, while covering a swath of the sky seven times wider than the full moon,” says Aaron Roodman, KIPAC senior member, professor of particle physics and astrophysics at SLAC, and program lead for Rubin’s LSST Camera.

But beneath these exquisite pictures lay important scientific discoveries waiting to be untapped. And that’s where Rubin’s second superpower comes in: it provides the specialized technical capabilities to examine the universe with a laser-sharp precision to see the physics that’s been hiding in plain sight for billions of years.

Deep in the swirling blue and yellow structure of the mind-bogglingly beautiful Swelling Spiral Galaxy (M61), Rubin confirmed the presence of a stellar stream — a remnant of a smaller galaxy pulled into the gravitational well of a larger galaxy and torn apart by its tidal forces, leaving behind only a stream of stars orbiting the host galaxy. The physical characteristics of these streams, such as the progenitor’s 200 million solar masses and 160,000-lightyear stream length, can be used to test theories of galaxy formation and dark matter.

“The M61 stream length is 1.5 times the diameter of the Milky Way, as it appears in visible light — and yet, other telescopes couldn’t get a clear picture of it,” says Christian Aganze, a KIPAC postdoctoral scholar and Stanford Science Fellow who specializes in stellar streams research. “We’re hoping this is just the beginning of Rubin’s contributions that will provide high-resolution data to refine models of tidal disruption within dark matter halos.”

While some galaxies are pulling matter in, others are ejecting it right back out. Most observed transient events are low-energy phenomena — like the 2,104 asteroids discovered during Rubin’s First Look. But extragalactic transients also include high-energy astrophysical phenomena. In a brief initial commissioning (DP1), Rubin observed 11 supernova explosions, including the discovery of eight never seen before.

Using a newly developed pipeline for DP1 data, researchers have found 18 possible nuclear transients, sudden brightenings at the center of galaxies. These could be previously undiscovered active galactic nuclei (steady brightenings powered by supermassive black holes), tidal disruption events (one-off flares from stars torn apart by black holes), or a new class entirely, called ambiguous nuclear transients (extreme flares that are brighter than active galactic nuclei, but longer-lasting than tidal disruption events). Not much is known about ambiguous nuclear transients, and researchers hope data from Rubin will catalyze their investigations.

“Rubin will help us find precursor emissions — before supernovae actually occur,” says Yijung Kang, KIPAC member and LSST Research Associate at SLAC. “Early identification of transient events provides more precise physical interpretations to help us narrow down what we think we’re observing and how they might evolve.”

Another field where Rubin shows promise is in the study of dark energy, a concept proposed to explain the accelerated expansion of the universe. The unprecedented depth and breadth of the LSST will provide the most comprehensive view of the growth and distribution of large-scale structure in the universe, across nearly all of cosmic time. Rubin will be an exquisite instrument for measuring phenomena like gravitational lensing, where matter distorts the fabric of space and time, bending light as it travels from cosmic distances to Earth. It will help us map the distances of billions of galaxies and how fast they are receding from Earth due to the universe’s expansion. And it will illuminate how structures from galaxies to galaxy clusters and filaments of dark matter have grown and evolved. These are all critical pieces to solving the puzzle of dark energy and the true nature of the cosmos.

Rubin will be unparalleled in its contributions to our understanding of the universe, but even more than that, it’s also a profoundly humanizing reminder to stop and smell the roses — even if they’re millions of light-years away.

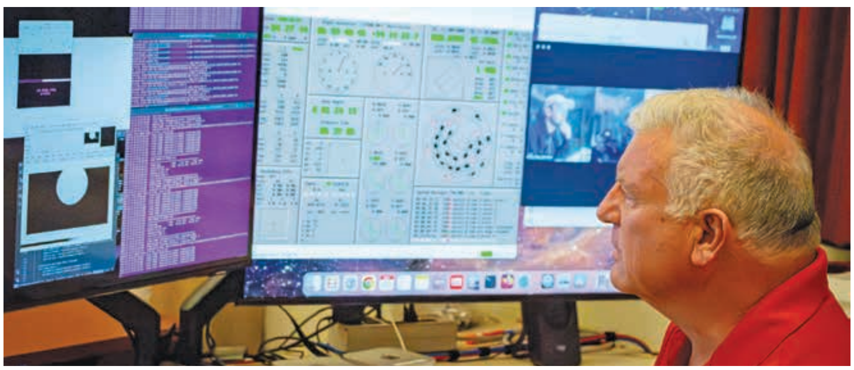
Press conference of Rubin’s First Look at the National Academy of Sciences in Washington, DC. KIPAC Senior Member Aaron Roodman – Professor of Particle Physics and Astrophysics at SLAC, Deputy Director of Rubin Construction, and LSST Camera Program Lead for SLAC/DOE – was part of the panel (far right). (Credit: NSF-DOE Vera C. Rubin Observatory)

Seeing Farther
Through Giant Eyes

KIPAC Secures Time on the Magellan Telescopes

With support from Stanford and SLAC, KIPAC now has guaranteed access to one of the world's most powerful optical observatories: the twin Magellan telescopes at Las Campanas in Chile.

Each 6.5-meter optical telescope is equipped with instruments for studying a wide range of astrophysical topics, including dark matter, dark energy, galaxy formation, star-forming regions, and compact objects — a laundry list of KIPAC projects and priorities. Researchers at KIPAC have 20 nights per year, split into two six-month "semesters," to observe remotely from a dedicated control room in the Physics and Astrophysics Building on the Stanford campus.

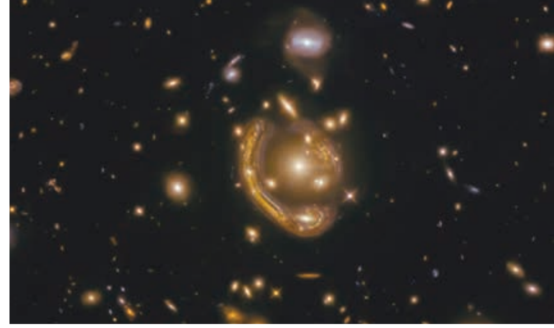


"Magellan is one of the premier ground-based telescope facilities in the world," says former staff scientist Dan Wilkins, who just started a faculty position at The Ohio State University in September 2025. Wilkins was a founding member of the committee that manages KIPAC's time on Magellan. "Becoming a partner gives KIPAC scientists the ability to pursue a broad range of scientific programs that will advance all of our major research themes."

Access to Magellan means access to the many instruments used to capture and analyze Magellan data. KIPAC researchers can even build their own instruments to mount on one of the telescopes, an opportunity that KIPAC Professor Roger Romani couldn't pass up. He studies neutron stars, and he collaborated with Kevin Burdge of MIT to develop an ultra-fast, extremely low-noise camera called Lightspeed that can catch objects which vary on extremely short timelines, such as pulsars, in the act.

"We'll be able to make photon-by-photon movies instead of taking stills," Romani says.

KIPAC Senior Scientist Phil Marshall is getting a jump on planned observations of gravitationally lensed quasars from the Legacy Survey of Space and Time (LSST), the 10-year survey of the southern sky that began this year. The Magellan telescopes capture different data about these "strongly lensed" quasars than LSST will (such as spectra), and Marshall says combining the data will help resolve questions about the Hubble Constant and give insights into the



expansion history of the Universe. According to Marshall, a fascinating line of research will only get better. "It'll be extra-specially fun when new lenses are discovered by Rubin," he says.

Another benefit of observing time on Magellan is educational. "It gives our students, post-docs and early career researchers hands-on experience with some of the best observing facilities in the world," says Wilkins.

Newly minted PhD Anthony Flores is one graduate student who was able to take advantage of the opportunity to observe using Magellan.

For his PhD work, Flores studied some of the most distant galaxy clusters in the Universe using X-rays. He's headed to Rutgers University to continue his work on galaxy clusters, but in multiple wavelengths.

"I hope that the work that I've done here with X-rays and what I'm doing with Magellan will enable me to shift seamlessly to my work at Rutgers."

The observational programs awarded telescope time in 2024–2025 include studies of:

- **The most massive galaxy clusters**
- **Gravitationally lensed quasars**
- **Heavy element production**
- **Neutron stars**
- **Dwarf galaxies and the outer halo of the Milky Way**
- **Elemental abundances within stellar streams**
- **Stellar velocities around the center of the Large Magellanic Cloud**

Stanford is collaborating with a consortium of institutions that operate the telescopes, including Carnegie Institution for Science, the Harvard Smithsonian Center for Astrophysics, University of Arizona, University of Michigan, and Massachusetts Institute of Technology.

Left: *The Milky Way in the skies over the twin Magellan Telescopes, located at Las Campanas Observatory in Chile. (Credit: Yuri Beletsky)* ***Above:*** *KIPAC Professor Roger Romani in the Magellan control room on the Stanford campus. He and KIPAC graduate student Jack Dinsmore, onsite in Chile, are testing a new instrument on the telescope. (Credit: KIPAC)* ***Top right:*** *This example of strong lensing is GAL-CLUS-022058s, located in the southern hemisphere constellation of Fornax (The Furnace). GAL-CLUS-022058s is the largest and one of the most complete Einstein rings ever discovered in our Universe. (Credit: NASA/ESA)*

NEW KIPAC FACULTY

Zeeshan Ahmed

Associate Professor of Particle Physics and Astrophysics

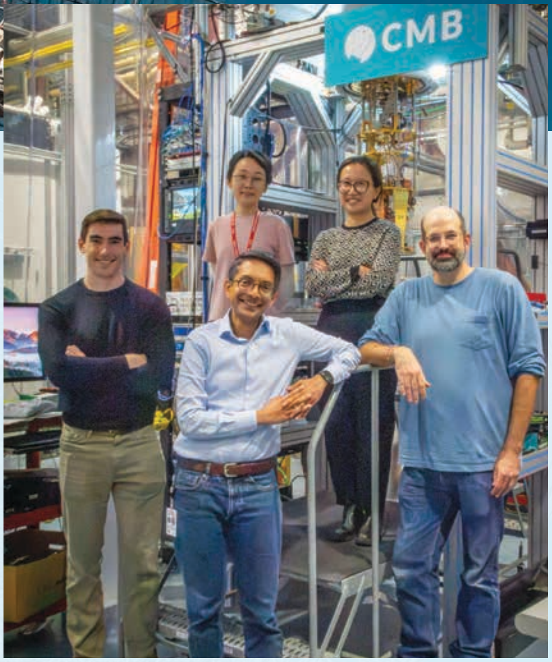
When newly-minted PhD Zeeshan Ahmed arrived at Stanford in 2011 for his first post-doctoral research position, he joined BICEP, a cosmic microwave background (CMB) telescope located at the South Pole. Ahmed previously looked for dark matter at Caltech, but made the switch at the urging of his mentors. "They recommended we all look around at what's out there," he says.

He's never looked back.

Ahmed's dark matter-hunting days had given him plenty of experience using supercooled, superconducting detectors. During his first postdoc, Ahmed leveraged that knowledge to lead the design, construction, testing and deployment of BICEP's third generation receiver, BICEP3. The BICEP telescopes pick up the faint signal of CMB photons, the oldest light in the Universe.

Ahmed remembers the wonder he felt as a child when he realized how unfathomably huge the Universe is. "The thing that blew my mind was realizing that every object in the first Hubble Deep Field pictures was not a star — it was a galaxy," Ahmed said. The CMB is a treasure trove of information regarding the birth and development of the Universe, and Ahmed's time at KIPAC has been spent finding ways to use that information to make the Universe a little more fathomable. His work on BICEP led to a Panofsky fellowship in 2015; the fellowships, named after Wolfgang K. H. "Pief" Panofsky, the founding director of SLAC National Accelerator Laboratory (SLAC), are awarded to early-career doctoral researchers who demonstrate creativity and innovative thinking. This recognition was followed in 2016 by a Department of Energy Early Career Award and appointment as an associate professor in the department of particle physics and astrophysics at SLAC in 2023.

Ahmed's detector readout schemes have been adopted by several microwave telescopes. Among them are the four telescopes at the Simons Observatory (SO), located in the high, dry air of the Atacama Desert in northern Chile. With the largest of these telescopes having seen first light in Spring 2025, the SO is almost ready to join the Rubin Observatory (see pages 4 and 5) with its own survey of the southern sky — but in microwaves instead of visible light.



Ahmed and team in the lab. Front row, left to right: graduate student Toby Satterthwaite; Ahmed; staff scientist Shawn Henderson. Top row, left to right: postdoctoral scholars Rui Shi and Cheng Zhang. (Credit: KIPAC)

According to Ahmed, the SO is beginning to collect data for a process called weak lensing reconstruction, which is a statistical method for untangling the subtle effects the gravity of a massive foreground object can have on the appearance of background objects. "The CMB, since it was emitted so early in the Universe, provides a backlight for the Universe's structure as it grew," he explains. "But the map it shows us is distorted by gravitational lensing by foreground objects, just as for visible light. Reconstruction maps how everything has been distorted."

Early commissioning data from SO has already been used to produce CMB maps that show great promise for future work.

"The Simons Observatory has about 60,000 detectors now and will go up to 100,000," says Ahmed. "And what's cool is that it works!"

Prior to his leadership roles at national labs, Josh Frieman cofounded and directed the Dark Energy Survey with the aim of learning about this mysterious energy accelerating the expansion of the universe. (Credit: Fermilab, Reidar Hahn)

Josh Frieman

Professor of Particle Physics and Astrophysics

When he was younger, Josh Frieman was more drawn to history than science. That was until his junior year of college at Stanford University, when he heard cosmologist Dennis Sciama present a colloquium that traveled from the present back to a tiny fraction of a second after the Big Bang. It was then that Frieman realized he could become a historian of the universe as a whole.

"Because I had this particular interest in history, this really struck a chord with me. Cosmology is like archaeology on the grand scale," says Frieman, associate lab director of the Fundamental Physics Directorate at SLAC. "In the case of archaeology, it's reconstructing some earlier civilization or culture. For us, the billions of galaxies in the universe are like pottery shards that we use to try to understand the first moments of cosmic history."

Since then, Frieman has sought to understand how the universe began and evolved. A primary focus of his work is dark energy, the mysterious force driving the accelerated expansion of the universe. "We don't know what 70% of the universe is. That seems kind of important," he says.

When Frieman first began pursuing astrophysics, his work was purely theoretical. But with advancements in telescopes and computing in the past 40 years, the field has become more experimental, allowing Frieman to test his ideas about the early universe with measurements.

Wanting to play a part in the data collection too, Frieman helped form new experimental projects and teams, and his involvement expanded to leadership roles. First, he led the Sloan Digital Sky Survey's Supernova Survey, which discovered over 500 supernovae, exploding stars whose brightness can be used to figure out how fast the universe has expanded over time. He then cofounded, and eventually directed, the Dark Energy Survey, which will soon publish cosmological studies based on six years of data for over 300 million distant galaxies.

Frieman went on to use his experience in large-scale collaboration and management to lead in other contexts, including as a professor and department chair at the University of Chicago, the head of Fermilab's Particle Physics Division from 2018 to 2021, and president of the Aspen Center for Physics (ACP) from in 2019 to 2022. He currently serves as chair of the Board of Trustees of the ACP.

Now, at SLAC, Frieman hopes his leadership will enable others to make discoveries: "I see a significant part of my role as helping enable other people to do exciting science, either through obtaining research funding, building facilities, or operating experiments. I want to create the conditions for them to do great work," he says.

NEW KIPAC FACULTY

Brian Lantz

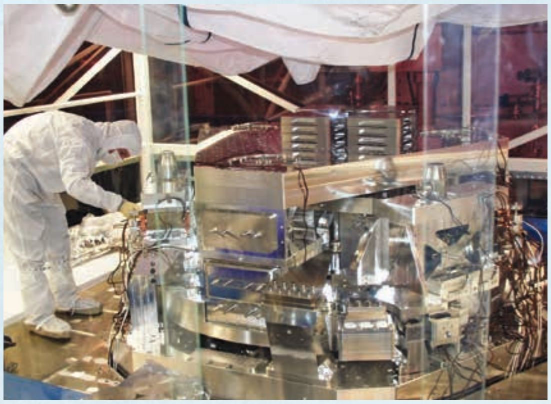
Professor (Research) of Applied Physics

Brian Lantz is not your typical KIPAC member. Instead of looking at light from the stars, he works on the Laser Interferometer Gravitational-wave Observatory (LIGO), measuring the tiny ripples in space-time from passing gravitational waves. These ripples occur when extremely massive objects (such as black holes) collide. But it's not the vibrations in space-time that keep him busy, it's the vibrations of the ground the detectors sit on. Lantz is the lead scientist for the seismic isolation system that protects LIGO from random Earth-based tremors that can mask gravitational wave signals.

Lantz and his team have developed methods to dampen vibrations from sources as obvious as actual earthquakes and as banal as the rumble of nearby traffic. Strong winds on the high-desert plateau site of Hanford, Washington, and storms over the ocean near the Livingston, Louisiana site can affect the delicately balanced lasers and mirrors that comprise LIGO's interferometers.

"I'm an instrumentation guy," says Lantz. "Precision measurement, precision instrumentation. That's where I fit into the world."

Precision measurement and precision instrumentation are a must for LIGO. The signal the observatory is looking for is a distortion of space-time that is less than one ten-thousandth the width of a proton. To have even a chance at detecting such a tiny signal, the delicately balanced optics of the interferometers at the two sites must be swaddled in a blanket of absolute stillness. Otherwise, the myriad rumblings and grumblings — both natural and man-made — of our planet would simply drown them out.



One of LIGO's multi-stage optic suspensions with attached internal seismic isolation platforms, which Lantz was instrumental in designing and building. These subsystems produce a significant improvement on the low-frequency side of LIGO's noise spectrum. (Credit: LIGO Collaboration/MIT)

To ensure that LIGO gets its moments of zen, the optics are mounted on isolation tables supported by springs that passively dampen stray vibrations. Very low frequency motions for which the springs can't compensate are detected by sensors, and the instruments nudged back into place by actuators.

The latest upgrade Lantz and his group have been working on is a seismic platform interferometer (SPI), which was recently installed at the LIGO Observatory sites. In essence, the SPI equips the seismic isolation system with its own interferometer to detect relative motions between different sets of optics.

Lantz has spent his entire academic career with LIGO, working with LIGO founding father Rainer Weiss during his undergraduate and graduate years at MIT. Following his PhD in 1998, Lantz came to Stanford for a post-doctoral position and never left. He joined the Stanford LIGO group in 2001, and in September 2024, he was elevated from senior science staff to research professor.

Despite Lantz's protestations to the contrary — "I don't try to explain the ground motion. I just try to fix it." — his speech is peppered with references to geological and seismic phenomena such as "microseismic peaks" and "teleseismic earthquakes," belying a deep understanding of the forces he's charged with taming. He can also wax enthusiastic about black hole mergers, the birth of the Universe, and multimessenger astronomy. This wide-ranging intellectual curiosity, coupled with his technical acumen, has resulted in the American Physical Society naming him a 2025 APS Fellow.

You can count on Lantz to be a stabilizing influence in the search for gravitational waves for a long time to come.

NEW SENIOR MEMBER

Growing up in the San Francisco Bay Area, Adam Bolton expected to return here promptly after leaving to obtain his PhD at the Massachusetts Institute of Technology. In the end, it took 25 years, four states, two kids, two dogs, and a cat. He and his wife (also a native Californian) are happy to be back, and looking forward to once again hiking the area's many trails and shorelines.

No matter where he lives, be it Massachusetts, Hawaii, Utah, or Arizona, Bolton gets involved in big data astronomy experiments. This began during his graduate thesis, when he was hunting for a type of strong gravitational lens within the Sloan Digital Sky Survey database. By combining Sloan's data with observations from the Hubble Space Telescope, he was able to identify and characterize a large number of these rare lenses, in which the strong gravity of one galaxy is distorting the light of a galaxy behind it. (see figure below).

"That really got me hooked on the excitement of data-intensive astronomy," Bolton says. "I got interested both in the scientific opportunity of that mode of astronomy and the mechanics of how the software and the data systems all fit together to make that kind of research possible."

He went on to direct the Community Science and Data Center at the National Optical Astronomy Observatory (today part of NSF NOIRLab) in Tucson. Now, he'll help manage the unprecedented amount of data the Vera C. Rubin Observatory will collect as Rubin Operations' US Data Facility lead.

Every night, from a mountaintop in Chile, the LSST camera of the Simonyi Survey Telescope at the Rubin Observatory will capture about 2,000 digital images as it maps the southern sky. The observatory will transmit these images, amounting to 20 terabytes of data, to servers at Rubin's US Data Facility located at SLAC National Accelerator Laboratory. Over 10 years of operation, the survey will amass a total of 5.5 million images and 300 million gigabytes of data.

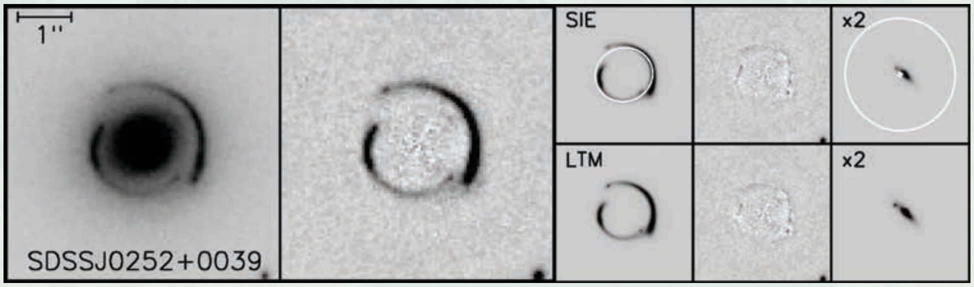
"It was realized very early on that Rubin's data management would be just as large a challenge as building the telescope and the camera," says Bolton, who will oversee a major part of this challenge at SLAC. He and the USDF team will ensure the data facility is properly processing, storing, and sharing the data.

As a senior staff scientist at SLAC, Bolton will also use Rubin's data, including the detection of a tremendous number of gravitational lenses, to study dark matter, dark energy, and the evolution of galaxies.

"I've generally been looking for places where I can have the impact at the largest scales in this kind of work," Bolton says. "That's why I was drawn to Rubin, the current center of action in big data astronomy."

Adam Bolton

Senior Scientist



A Hubble Space Telescope image (left) and mathematical models (middle) of a strong gravitational lens that Adam discovered in the Sloan Lens ACS (SLACS) Survey. The six smaller panels on the right show models of the lensing effect for two different kinds of lensing mass model. Adam's work on data-mining within the Sloan Digital Sky Survey to find objects like this launched him on the big-data astronomy journey that has led to his role in Rubin today. (Credit: Adam Bolton)

CONGRATS TO KIPAC

Risa Wechsler was elected to the National Academy of Sciences in recognition of her distinguished and continuing achievements in original research in astrophysics and cosmology.

Susan Clark was awarded the Helen B. Warner Prize by the American Astronomical Society for her seminal contributions to our knowledge of cosmic magnetism and the development of innovative observational techniques for studying the interstellar medium. She was also honored with the Stanford Faculty Women's Forum Inspiring Early Academic Career Award for creating a culture of inclusion and belonging for students and trainees at all levels. Susan further received an NSF CAREER Award for studying the interstellar medium and astrophysical magnetism, and developing new educational materials in astrophysics. Lastly, she received the 2024/25 H&S Dean's Award for Achievements in First Years of Teaching.

Dan Akerib was named co-spokesperson for the XLZD collaboration, which unites three world-leading efforts to expand the search for WIMP dark matter.

The Fermi/LAT team, led by **Peter Michelson**, was honored with the Giuseppe and Vanna Cocconi Prize by the European Physical Society for revolutionizing the field of gamma-ray astronomy.

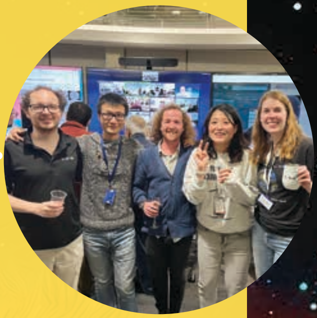
Noah Kurinsky was promoted to Senior Scientist at SLAC.

Xinnan Du was awarded the Stanford IDEAL Honor Roll for her demonstrated commitment to advancing diversity, equity, inclusion, and belonging efforts at the university.

Andrés Plazas Malagón was named a distinguished alumnus by the Physics Department at Universidad de Los Andes.

Peter Marinos won first prize in Action and Impact on Campus in the Stanford Doerr School of Sustainability photo contest with his photo "Star Trails at the Stanford Student Observatory."

Lukas Eisert, Kevin Fanning, Minhee Hyun, Yijung Kang, Shuang Liang, and **Kate Napier** were awarded the AURA Team Award by the Rubin Construction Team.



NEW APPOINTMENTS:

Enrique Lopez Rodriguez has joined the University of South Carolina as an Associate Professor.

Kimmy Wu has joined the California Institute of Technology as an Assistant Professor.

Mehrnoosh Tahani has joined the University of South Carolina as an Assistant Professor.

Kirit Karkare has joined Boston University as an Assistant Professor.

Dan Wilkins has joined the Ohio State University as an Assistant Professor.

Former KIPAC Fellow **Ann Wang** was appointed to a Panofsky Fellowship at SLAC to pursue dark matter searches with LZ and the development of XLZD.

Former KIPAC Fellow **Chiara Salemi** has joined the University of California, Berkeley as an Assistant Professor.

Dark Energy Spectroscopic Instrument (DESI)

DESI uses high-resolution spectroscopy to measure distances to galaxies for gaining valuable insight into dark energy, the hidden force driving the expansion of the universe. In April 2024, DESI released the largest 3D map of the Universe ever made — capturing 18.7 million celestial objects from as far back as 11 billion years ago.

In 2025, 270-terabytes of DESI's extensive dataset were released to the public to spur collaborative research. Analysis of DESI's data with other research provides interesting hints of a weakening impact of dark energy over time — a notion that could send our "standard model" of the universe back to the drawing board.

Dark Matter (DM) Radio

DM Radio is a multi-stage search for axions, theorized lightweight dark-matter particles that exhibit wavelike behavior and can convert into an electromagnetic signal (i.e., a photon) in a magnetic field, which can be picked up via an ultra-low-noise radio. The quantum chromodynamics (QCD) axion is an especially promising candidate to fit into the dark matter puzzle. To detect their very weak signal strength, DM Radio uses a high field magnet combined with quantum sensing techniques to improve its detection capabilities.

Building on the DM Radio Pathfinder (operational through 2022), the team is currently constructing DM Radio 50L, which will provide the first axion search results. At Stanford, Kent Irwin's group is developing Radiofrequency Quantum Upconverters, an ultra-low noise device that converts low frequencies to high frequencies, allowing the team to use off-the-shelf components. At SLAC, Chelsea Bartram's group is developing a concept called Bode-Fano evasion to search a wider range of frequencies without losing sensitivity to very faint signals. The final stage experiment, called DMRadio-GUT, would deploy these techniques to achieve sensitivity to the QCD axion over a wide range of frequencies, providing a promising near-term opportunity for axion discovery.

Fermi Gamma-ray Space Telescope's Large Area Telescope (Fermi LAT)

On April 12, 2025, Fermi LAT recorded its trillionth trigger since its launch in 2008. Incoming high-energy particles "trigger" the LAT to read out a detection about 2,000 times per second on average as it sweeps across the entire night's sky every three hours.

A small fraction of those triggers, about 2 per second, come from celestial gamma rays, which must be "filtered" from a large background of charged particles (cosmic rays). Initial filtering happens onboard to reduce the data volume for telemetry, but most of the work to produce clean gamma-ray data sets is done during telemetry processing at SLAC.

The sky glows in gamma rays from a variety of high-energy sources, a large fraction of which is essentially isotropic and originates from outside the Milky Way. A recent study found a correlation between Fermi LAT's deep map of the extragalactic high-energy cosmos with the large-scale cosmic structure inferred by the Dark Energy Survey.

NASA's 2025 Senior Review of Operation Missions cited Fermi as "an integral

Above: An interacting pair of nearby dwarf galaxies, roughly 40 Mpc (130 million light years) away, revealed in the first year data from DESI. (Credit: Legacy Surveys / D. Lang (Perimeter Institute); image generated by Viraj Manwadkar)

Below: KIPAC PhD student Nicholas Rapidis, postdoc Aya Keller, and collaborator Roman Kolevatov (Princeton) installing a magnetic shield onto the cryostat during the assembly of DMRadio-50L in the basement of the Physics and Astrophysics Building. The shield is designed to protect the sensors from background magnetic fields, thereby increasing their sensitivity to potential dark matter signals. (Credit: Chelsea Bartram)

part of NASA's multi-wavelength observatory portfolio," playing a "crucial role" in understanding stellar evolution, galactic jets, and high-energy radiation from accreting black holes.

R&D for Joint Analysis of the Kinetic Sunyaev-Zel'dovich Effect and Galaxy Lensing

Emmanuel Schaan's research was selected as a 2025 project for SLAC's Laboratory Directed Research & Development Program, which funds projects aimed at developing cross-disciplinary approaches to important scientific and technological challenges.

Schaan's project aims to set up the theoretical and software infrastructure at SLAC for joint analyses of CMB data from Simons Observatory and galaxy survey data from Rubin Observatory. Combining galaxy lensing data, which measure the total matter distribution (both ordinary and dark matter), with Sunyaev–Zel'dovich data, which probe ionized gas around galaxies through CMB photon scattering, would provide joint constraints on the dark matter and gas densities around the same galaxies. With this project, Schaan aims to solve the largest theoretical uncertainty in the analysis of Rubin data, while also lowering the barrier to entry for all subsequent joint analyses of CMB and large-scale structure at SLAC.

Satellites Around Galactic Analogs (SAGA) Survey

There are many properties that can only be measured in one system: that of our home galaxy, the Milky Way. In order to put the Milky Way into its broader cosmological context, it is essential to understand the properties of similar systems. The SAGA survey made a major dent in this project by identifying 101 nearby systems with similar luminosity to the Milky Way, and finding and measuring the properties of their bright satellites (smaller galaxies orbiting larger systems).

KIPAC PhD student Toby Satterthwaite with the SO LAT while it was under construction. (Credit: Toby Satterthwaite)

Over a decade-long program, Risa Wechsler and her collaborators combined public imaging data with 46,000 new spectra acquired using various ground-based telescopes to identify 378 satellites around these host galaxies. The final results from the survey were published in late 2024. One surprising finding from these results is that many small satellite galaxies are still forming stars in these external galaxies, while in the Milky Way, all satellites smaller than the Magellanic Clouds are no longer star forming.

Simons Observatory (SO)

The SO kicked off its wide, high-resolution survey of the cosmic microwave background (CMB) with the first light of its Large Aperture Telescope (LAT) in February 2025. Equipped with 30,000 quantum detectors operating at near absolute zero (-459.6 degrees Fahrenheit compared to absolute zero at -459.67 degrees Fahrenheit), the LAT has the largest cryogenic receiver ever deployed to a telescope.

The SO supersedes the Atacama Cosmology Telescope, located at the same site in Chile. The LAT provides 400% greater sensitivity compared to its predecessor — a capability that will double with the additional 30,000 detectors that have been recently deployed as part of the Advanced Simons Observatory (ASO) project. Early commissioning data has already been used to produce CMB maps that show great promise for future work.

XENON Lux-Zeplin Darwin (XLZD) Dark Matter Detection Collaboration

The LZ group at SLAC, led by KIPAC members Daniel Akerib and Thomas Shutt, has searched for heavy dark matter particles with their 10,000-kg liquid xenon detector since its formation in 2012. In particular, they're searching for Weakly Interacting Massive Particles (WIMPs), which exhibit particle-like behavior.

Heavy dark matter particles are theorized to produce detectable ionization and light when colliding with matter under the right conditions. Xenon has all the right attributes: it stays in a dense liquid state at a manageable temperature that can be highly purified with virtually no radioactivity. But it's expensive and rare — producing 1 kg requires straining other elements out of 2 million cubic meters of air and costs $1,000.

In September 2024, the LZ team jointly formed the XLZD collaboration to advance the concept of a next-generation xenon dark matter detector with significantly greater sensitivity to WIMPs. The team has high hopes of significant participation in such an international project in the coming decade.

PUBLICATION HIGHLIGHTS

FORMATTING OF NAMES
Gray bold italic: KIPAC members
Gray italic: KIPAC alumni

TOP 5 MOST CITED

1. DESI 2024 VI: Cosmological Constraints from the Measurements of Baryon Acoustic Oscillations

*Adame, Aguilar, Ahlen et al. (incl. **Alvarez, Fanning, Wechsler**), Journal of Cosmology and Astroparticle Physics, 2025*

Presents the first cosmological results from the Dark Energy Spectroscopic Instrument (DESI) using baryon acoustic oscillation (BAO) measurements from its first year of data, finding that the inferred cosmological parameters are consistent with the standard flat ΛCDM model, with dark energy behaving like a cosmological constant, though with a slight indication that it may evolve over time.

2. Euclid: I. Overview of the Euclid mission

*Mellier, Abdurro'uf, Acevedo Barroso et al. (incl. **Allen**), Astronomy & Astrophysics, 2025*

Provides a high-level overview of the Euclid mission, a major space telescope project designed to study dark matter and dark energy using high-resolution optical and near-infrared imaging and spectroscopy across 14,000 square degrees of the sky.

3. The Dark Energy Survey: Cosmology Results with 1,500 New High-redshift Type Ia Supernovae Using the Full 5 yr Data Set

*Dark Energy Survey (DES) Collaboration (incl. **Burke, Plazas Malagon, Roodman, Wechsler**), Astronomical Journal Letters, 2024*

Reports cosmological constraints with unprecedented precision using five years of DES supernova data, confirming the accelerated expansion of the universe and that dark energy is consistent with a cosmological constant.

The "Lighthouse" X-ray filament (blue) extending from pulsar PSR J1101-6101 as seen in the Chandra data. The pulsar's supersonic wake (white) points towards its parent supernova remnant in the upper left. (Credit: Jack Dinsmore)

4. UNCOVER: Candidate Red Active Galactic Nuclei at 3 < z < 7 with JWST and ALMA

*Labbe, Greene, Bezanson et al. (incl. **Suess**), Astrophysical Journal, 2025*

Reports the discovery of numerous "little red dots" – tiny, distant galaxies whose unusual colors are most consistently explained by the presence of hidden, actively accreting supermassive black holes in the early universe.

5. Dark Matter Search Results from 4.2 Tonne-Years of Exposure of the LUX-ZEPLIN (LZ) Experiment

*Aalbers, **Akerib**, Musalhi et al. (incl. **Ames, Anderson, Arthurs, Biesiadzinski, Coronel, Ghosh, Luitz, Shutt, Wang**), Physical Review Letters, 2025*

Reports the latest results from the LUX-ZEPLIN (LZ) Experiment in search for the weakly interacting massive particle (WIMP) dark matter, placing world-leading constraints on WIMP-nucleon interaction strength for a wide range of masses.

HIGHLIGHTS

1. Neutral Gas Phase Distribution from HI Morphology: Phase Separation with Scattering Spectra and Variational Autoencoders

*Lei, Clark, Rudy et al. (incl. **Butsky**), Astrophysical Journal, 2025*

Uses machine-learning techniques that extract the phase structure (e.g., cold, warm) of the neutral hydrogen gas (HI) solely from the spatial morphology of HI emission.

2. The SAGA Survey. III. A Census of 101 Satellite Systems around Milky Way–Mass Galaxies

*Mao, Geha, **Wechsler** et al. (incl. Wang & Nadler), Astrophysical Journal, 2025*

Presents Data Release 3 of the Satellites Around Galactic Analogs (SAGA) Survey, which collected spectroscopic data from 378 satellite galaxies identified across 101 Milky Way-mass systems, finding a strong correlation between the mass and abundance of the most massive satellites.

3. A Catalog of Pulsar X-Ray Filaments

__Dinsmore & Romani__, Astrophysical Journal, 2024

Presents a systematic catalog of X-ray filaments associated with pulsars and their observed properties, providing a foundation for understanding particle acceleration and energy transport around pulsars.

4. Variable X-Ray Reverberation in the Rapidly Accreting Active Galactic Nucleus Ark 564: The Response of the Soft Excess to the Changing Geometry of the Inner Accretion Flow

***Yu, Wilkins, Allen**, Astrophysical Journal, 2025*

Presents X-ray spectroscopic and timing analyses of the rapidly accreting active galactic nucleus (AGN) Ark 564, offering new insights into the structure of its accretion disk and the origin of the soft X-ray excess in AGN.

5. Instrument Signature Removal and Calibration Products for the Rubin Legacy Survey of Space and Time

***Plazas Malagón** et al. (incl. **Broughton, Rykoff, Ferte**), Journal of Astronomical Telescopes, Instruments, and Systems, 2025*

Presents the design, implementation, and validation of the Instrument Signature Removal and Calibration Product Pipelines for the Vera C. Rubin Observatory's LSST, detailing how these processes remove detector and electronic artifacts to produce calibrated, science-ready images essential for achieving LSST's transformative astrophysical goals.

6. How Do Uncertainties in Galaxy Formation Physics Impact Field-level Galaxy Bias?

***Shiferaw**, Kokron, **Wechsler**, Astrophysical Journal, 2025*

Investigates how uncertainties in galaxy formation models affect the relationship between the spatial distribution of galaxies and dark matter for quenched, star-forming, and stellar-mass–selected populations.

7. Light Dark Matter Constraints From SuperCDMS HVeV Detectors Operated Underground With an Anticoincidence Event Selection

*SuperCDMS Collaboration (analysis led by **Aralis**; incl. **Anczarski, Brink, Cameron, Kurinsky, MacFarlane, Partridge, Ryan, Simchony, Yu**), Physical Review D, 2025*

Presents new constraints on the interaction strength between dark matter and electrons, based on the first underground data-taking campaign using multiple SuperCDMS HVeV detectors operating together in the same housing.

8. Lens Modeling of STRIDES Strongly Lensed Quasars Using Neural Posterior Estimation

***Erickson**, Wagner-Carena, **Marshall**, Millon, Birrer, **Roodman**, The Astronomical Journal, 2025*

Applies machine-learning techniques to model gravitationally lensed quasars in the STRIDES survey, enabling fast and accurate inference of lens properties and uncertainties and improving the efficiency and scalability of strong-lens modeling.

9. The Simons Observatory: Science Goals and Forecasts for the Enhanced Large Aperture Telescope

*Abitbol, Abril-Cabezas, Adachi, et al. (incl. **Ahmed, Clark, Henderson, Irwin, Maniyar, Pinsonneault-Marotte, Qu, Satterthwaite, Schaan, Sierra**, Young, **Yu**), Journal of Cosmology and Astroparticle Physics, 2025*

Presents updated scientific goals for a wide-field millimeter-wave survey from the Simons Observatory, enabled by major upgrades to its 6-meter Large Aperture Telescope expected to be completed by 2028.

10. Cosmic Recombination in the Presence of Primordial Magnetic Fields

*Jedamzik, **Abel**, & Ali-Haimoud, Journal of Cosmology and Astroparticle Physics, 2025*

Explores how primordial magnetic fields in the early Universe could affect cosmic recombination and shows how these effects may leave detectable signatures in today's cosmological observations of the CMB.

11. Ultrahigh-Energy Cosmic Rays

*Globus & **Blandford**, Annual Review of Astronomy and Astrophysics, 2025*

Synthesizes observations, theory, and simulations to highlight open questions about ultrahigh-energy cosmic rays, including their origins, acceleration mechanisms, and propagation, as well as future directions in the field.

KIPAC Senior Scientist and SuperCDMS group lead Richard Partridge working on a SuperCDMS detector tower prior to its installation into the SuperCDMS experiment in the underground cleanroom at SNOLAB in Canada. (Credit: Kelly Stifter)

12. Bulk Motions in the Black Hole Jet Sheath as a Candidate for the Comptonizing Corona

***Sridhar**, Ripperda, Sironi et al., Astrophysical Journal, 2025*

Uses detailed magnetohydrodynamics simulations near a black hole to show that jet sheath — the layer around the black hole's jet — can behave like the hot "corona" thought to be responsible for producing high-energy X-rays.

“KIPAC + FRIENDS” COMMUNITY DAY

Top: KIPAC professor Dan Akerib (far right) explains the inner workings of a cloud chamber as it detects random particles. (Credit: SaMFontejon/ Fontejon Photography, Inc.)

Bottom: A young attendee proudly showcases his “Junior Scientist” certificate with his mom. (Credit: SaMFontejon/Fontejon Photography, Inc.)

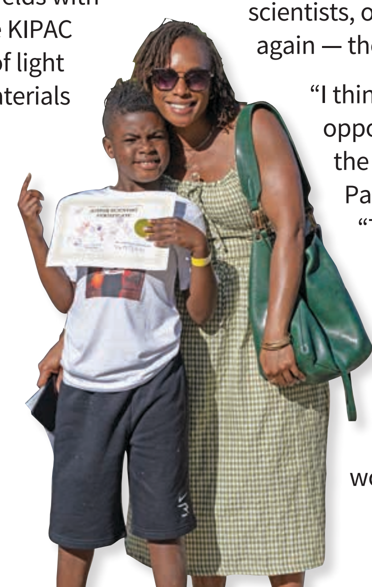
If there’s one thing KIPAC members love in addition to advancing our knowledge of astrophysics, it’s sharing the latest discoveries and inspiring the next generation to explore with us. During our latest Community Day in April 2025, almost 7,000 people of all ages took us up on the offer.

To make the day even more fun (and interdisciplinary), KIPAC invited nine Stanford academic and student groups representing the STEM spectrum, along with external partners like NASA, the SETI Institute, and Lick Observatory, to join forces in the Stanford Science and Engineering Quad to present an afternoon of science activities, learning, and mini lectures suitable for all ages.

Bringing science within reach of everyone

KIPAC volunteers shared their enthusiasm for all aspects of the Universe, from our own solar system to the farthest reaches of the cosmos. Attendees cooked comets, classified galaxies, and pictured cosmic magnetic fields with down-to-earth iron filings, while KIPAC Friends demonstrated aspects of light and optics, nanotechnology, materials science, and much more.

The real stars of the day were the kids. Excited, enthusiastic children took part in a variety of hands-on activities, such as making their own pulsars, having hair-raising adventures with a van de Graaff generator, and attending mini lectures on a number of different astrophysical topics. S’mores, with marshmallows toasted using focused solar radiation, provided a quick jolt of sugar. Completion stamps from 15 booths on an activity tracker earned young attendees a certificate, with about 500 kids joining the ranks of Junior Scientists.



Attendees could also give their feet a break while still learning some science by checking out one of the mini lectures — a series of short talks covering areas of KIPAC research in astrophysics, such as dark matter and cosmic structures, as well as other STEM disciplines with applications to space exploration, including the search for extraterrestrial intelligence and stretchable devices.

Sharing knowledge, sharing excitement, sharing joy

Putting on an event of this magnitude is no easy task. What prompts busy scientists to spend hours explaining science to fascinated youngsters?

Even with such a varied group of young scientists, one answer came up again and again — the desire to share.

“I think [Community Day] is a great opportunity to put people in touch with the science,” says KIPAC member and Panofsky Fellow Chelsea Bartram. “The turnout for KIPAC Community Day was very impressive.”

Bartram’s booth showcased a tunable crystal radio that could capture a local Punjabi radio station. The radio is analogous to a detector that Bartram is working on called the Dark Matter

Radio — it "listens" for axions, some of the lightest theorized dark matter particles. "The accessibility of an old-fashioned radio allowed for better understanding," Bartram explains. "It's especially great to see the awe on kids' faces when they first hear a radio signal come in."

"We are so proud of the work we do at KIPAC, and we're inspired by the incredible work of our colleagues across the Stanford campus community," said KIPAC Director Risa Wechsler. "It's been fantastic to have so many of our friends join to make Community Day bigger and better this year."

From top to bottom: KIPAC graduate student Anthony Flores (PhD '25) gives a mini lecture on observing galaxy clusters in X-rays. (Credit: SaMFontejon/Fontejon Photography, Inc.)

Young learners being hands-on at the "Batteries and Sensors" booth led by the Electrical Engineering group, trying to make fruit and vegetable batteries. (Credit: SaM Fontejon/Fontejon Photography, Inc)

The Community Day organizing committee. From left to right: Linda Xu (postdoctoral fellow), Tonya Peshel (post-baccalaureate fellow), Phil Mansfield (research scientist), León Garcia (undergraduate student), Maya Beleznay (graduate student), and Xinnan Du (outreach & engagement manager). (Credit: Sanya Gupta)

Ethan Scott (middle), Stanford undergraduate and member of the Stanford Undergraduate Physics Society, leads the polarization activity. (Credit: León Garcia)

Partnership with the East Side Union High School District

In December 2024, KIPAC received Stanford's Office for Community Engagement Impact Fund to partner with the East Side Union High School District (ESUHSD), which serves nearly 25,000 under-resourced students across 19 schools. Aligned with one of our long-term engagement goals, this one-year seed grant supported a wide range of STEM learning and career exploration opportunities for ESUHSD students through firsthand experiences.

Since January 2025, we have provided four field trips to Stanford, serving approximately 180 students from eight ESUHSD school sites. These field trips include multiple hands-on STEM demonstrations, career panels, lunch conversations with Stanford students and scientists, and a campus tour. In addition, KIPAC has participated in two district-level STEM and career events that drew over 3,000 students and their families seeking information about colleges, academic programs, and opportunities beyond high school. We also sent scientists into classrooms for guest lectures, co-hosted Noches Astronómicas – a STEM family-engagement event – at one ESUHSD site, and will bring ESUHSD students and their families from East San Jose to the Noches Astronómicas event at Stanford. More than 70 volunteers from both KIPAC and other Stanford units and student groups have contributed to this collaborative effort.

Program evaluation shows that students rated their field trip experiences extremely highly, with more than half giving a 10 out of 10. The vast majority (80%) described Stanford scientists and students as caring, open-minded, and knowledgeable. We also observed a significant increase in students' interest in pursuing STEM careers after the engagement, accompanied by more positive attitudes toward Stanford, with the impact best illustrated by students' reflections: "It seems more possible to get accepted into Stanford," and "Stanford offers so many options and opportunities to grow."

NEW POSTDOCTORAL

Shreya Anand (LSST Catalyst Fellow)

My research focuses on the discovery and characterization of transients – objects that change in brightness over time – in the optical and infrared (IR) bands. Specifically, I study broadlined Ic supernovae (SNe Ic-BL), which result from the collapse of massive stars and exhibit high velocities of ejecta that are stripped of both H and He due to strong stellar winds of their progenitors or through binary interactions. Due to their black hole central engines, SNe Ic-BL are among the few proposed astrophysical sites of heavy-element (r-process) nucleosynthesis in the Universe. Using optical/IR photometry and spectroscopy, I search for signatures of r-process production in their ejecta to better understand how heavy elements are created and distributed throughout the Universe. I am also interested in using IR spectroscopy to distinguish between single-star and binary evolution pathways for the progenitors of these SNe.

I also work on wide-field searches for optical/IR counterparts to multi-messenger sources, including neutron star mergers and gamma-ray bursts, with the Zwicky Transient Facility at Palomar, and the Vera C. Rubin Observatory. Up to 3% of Rubin's time is allocated for Target-of-Opportunity (ToO) science, including searches for optical counterparts of transient sources. I am the liaison between the Rubin Observatory and LIGO-Virgo-KAGRA (LVK) collaboration for the current Rubin ToO advisory board, and was closely involved in the first-ever follow-up campaign of a binary black hole merger with Rubin during its Science Validation period. We are currently commissioning the Rubin ToO system and preparing for a joint observational campaign with the LVK gravitational wave observatories during its fifth observing run.

Dylan Jow (Kavli Fellow)

As a theorist with observational interests, I seek to develop new observables that can be used to make robust inferences about the physics of the universe. My work spans topics from the plasma physics of the interstellar gas to the astrophysics of the ultra-long wavelength gravitational wave background emitted by super massive black holes. My research focuses primarily on radio astronomy, and, in particular, pulsar and fast radio burst (FRB) astronomy.

Pulsars and FRBs produce short, coherent bursts of radio light that can be dispersed and scattered by free electrons along the line of sight. We can use the ways in which these radio bursts are scattered to probe ionized gas in the interstellar and circumgalactic media (the gas within and surrounding galaxies) at tiny scales inaccessible to other probes. FRBs are also expected to be uniquely sensitive to gravitational lensing by objects as small as stars and even planets. By measuring the rate at which FRBs are lensed by these small objects, we can place new constraints on the number of these objects in the universe, including potentially "dark" compact objects that may make up a fraction of the unseen dark matter in the universe. Pulsars, on the other hand, are especially useful because of the predictable periods of their bursts which can be used as precise cosmic clocks to measure ultra-long wavelength gravitational waves (using a method called a pulsar timing array). By measuring and characterizing the ultra-long wavelength gravitational wave background, we can learn about populations of supermassive black holes in the universe and their role in the evolution and formation of structure over cosmic history. I am excited to develop the theoretical frameworks for extracting key information from these sources in novel ways.

FELLOWS

Kate Storey-Fisher (Kavli Fellow)

I research the large-scale structure of the universe. The distribution of galaxies traces the underlying dark matter; it also encodes the universe's expansion history, driven by dark energy. We can make detailed maps of millions of galaxies and compare them to our theoretical models and simulations, allowing us to investigate these dark components of the universe.

I am particularly interested in using quasars for cosmology, which are extremely bright, active supermassive black holes at the centers of galaxies, visible out to large distances.

My work focuses on developing methods to extract the most precise and accurate cosmological information from galaxy surveys. I apply data science techniques to cosmological simulations to push the limits of what we can learn from the galaxy distribution, while maintaining robustness; I am particularly excited about machine-learning emulation and simulation-based inference. I also enjoy working on the data side: I am a member of the Dark Energy Spectroscopic Instrument (DESI) Survey, which is in the process of making the largest and most detailed map of galaxies to date. I have also constructed a catalog of quasars from the public surveys Gaia and WISE, called Quaia which covers the largest volume of any quasar redshift catalog. Our analyses of Quaia have placed some of the strongest constraints on cosmological parameters at the large distances it covers. I look forward to continuing working at the intersection of data and methods for large-scale structure cosmology to explore the questions of how our universe formed and what it's made of.

Weishuang (Linda) Xu (SLAC-KIPAC Fellow)

I am very broadly interested in the discovery and understanding of new particles and fields beyond the Standard Model, especially through astrophysical and cosmological observations. One of my main interests is the particle nature of dark matter — arguably the most concrete example of new particle physics — whose evidence deeply depends on our understanding of stars, gas, and galaxies. I think about which new physics models are compelling, how to make robust predictions, what data and analyses can best test them, and ultimately how to turn a detection into a true discovery.

As an example, minimal electroweak dark matter represents a rare class of models that are both theoretically compelling and experimentally unprobed. Predicting their astrophysical signatures requires careful calculations of particle interactions, and our discovery

potential depends on where we observe and the detailed analysis choices we make. In recent work, my collaborators and I have computed these signatures, obtained state-of-the-art constraints using Fermi-LAT data, and discussed strategies for future observatories like CTA to finally breach the theory benchmark.

Other questions I've been thinking about since joining KIPAC include: How wrong can we be about the local dark matter abundance and velocity, given that no theory or simulation has control at solar-system scales? How should we interpret the preference for "dynamical dark energy" in recent cosmological data, and which classes of new physics can we realistically distinguish? What do CMB anisotropies and primordial element abundances reveal about new relativistic species, especially when many models involve interactions or dynamics?

THE CENTER FOR DECODING THE UNIVERSE:

An Interdisciplinary Approach to Using Big Datasets to Answer Bigger Questions

As surveys map huge swaths of the sky, gathering information for hundreds to thousands to billions of objects, astronomers are facing a "big data" problem: Traditional methods simply can't store, process, and analyze this enormous amount of information. The Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST) alone will produce 20 terabytes of data every night during its 10 years of operation, with all of that data coming directly to the US Data Facility at SLAC National Laboratory under the leadership of KIPAC Senior Member, Adam Bolton.

Other fields are also facing similar challenges with massive, complex datasets. KIPAC scientists are working toward solutions with colleagues across disciplines through the Center for Decoding the Universe at Stanford University. This joint initiative between KIPAC and Stanford Data Science (SDS) is fostering collaboration among astrophysicists, data scientists, computer scientists, engineers, and other experts to better understand the universe through the undiscovered information in vast datasets.

"Our goal is to become a space for cross-disciplinary collaboration and a hub of expertise in the rapidly growing field of data science in astronomy," says Dalya Baron. Both Baron and Ioana "Jo" Ciucă are research scientists hired by KIPAC and SDS to help get the Center off the ground.

The Center will support large-scale projects that apply artificial intelligence (AI), machine learning (ML), and data science solutions to astrophysics problems. Along with nine other KIPAC members, Ciuca contributed to one of the first published Center-sponsored projects: ReplicationBench. Led by Christine Ye, an undergraduate student of mathematics and physics at Stanford, ReplicationBench is an evaluation framework that assesses how well AI agents can replicate entire astrophysics research papers. The team found that AI agents could only replicate about 20 percent of the tasks and struggle with harder tasks. This benchmarking tool will help astrophysicists determine which AI agents could be used as assistants in future research, and provides a valuable tool to test frontier AI models on complex tasks

Another Center-sponsored project, led by Baron and KIPAC postdoctoral fellow Philipp Frank, will allow astrophysicists to learn more about galaxy composition and evolution from complex data, which is made up of images and spectra of varying wavelengths. To do so, the team, including Susan Clark and Risa Wechsler, co-directors of the Center, and Steven Dillmann, a Stanford PhD student, will build a model of galactic emission. Instead of relying on uncertain physical models of emission, the model will use ML to predict galactic emission across the electromagnetic spectrum based on existing observations and knowledge of the instruments that obtained them.

“ML will allow the model to be data-driven and not skewed by limited understanding of physics that drives emission,” Baron says. Stanford Computational Imaging Lab members, including Gordon Wetzstein and Sonia Kim, will help the team combine spectroscopic and imaging data, a challenge that cuts across fields of science and contributes to the advancement of data science more broadly.

Building interdisciplinary connections

In addition to collaborative projects, the Center holds quarterly forums that bring together astrophysicists and data scientists. The inaugural quarterly forum in October 2024 featured presentations about current challenges in astrophysics juxtaposed with talks about complementary methodologies from non-astrophysicists.

At the second quarterly forum in January 2025, three groups of researchers shared their Center projects, which use modeling techniques, multi-modal datasets,

and AI advances to study the universe. These were followed-up with presentations about similar work outside of astrophysics. The inaugural annual conference, which hosted off-campus collaborators as well, was held in June 2025.

“How to optimally use data, especially multitracer data, is a question in a lot of fields,” says Clark, assistant professor of physics at Stanford and senior member of KIPAC. Her group combines different types of data to reconstruct the 3D structure of the interstellar medium, or the matter between the stars. Methodologies her group develops through the Center could be relevant to biomedical researchers that want to combine various kinds of data to reconstruct biological structures in 3D.

A place to share

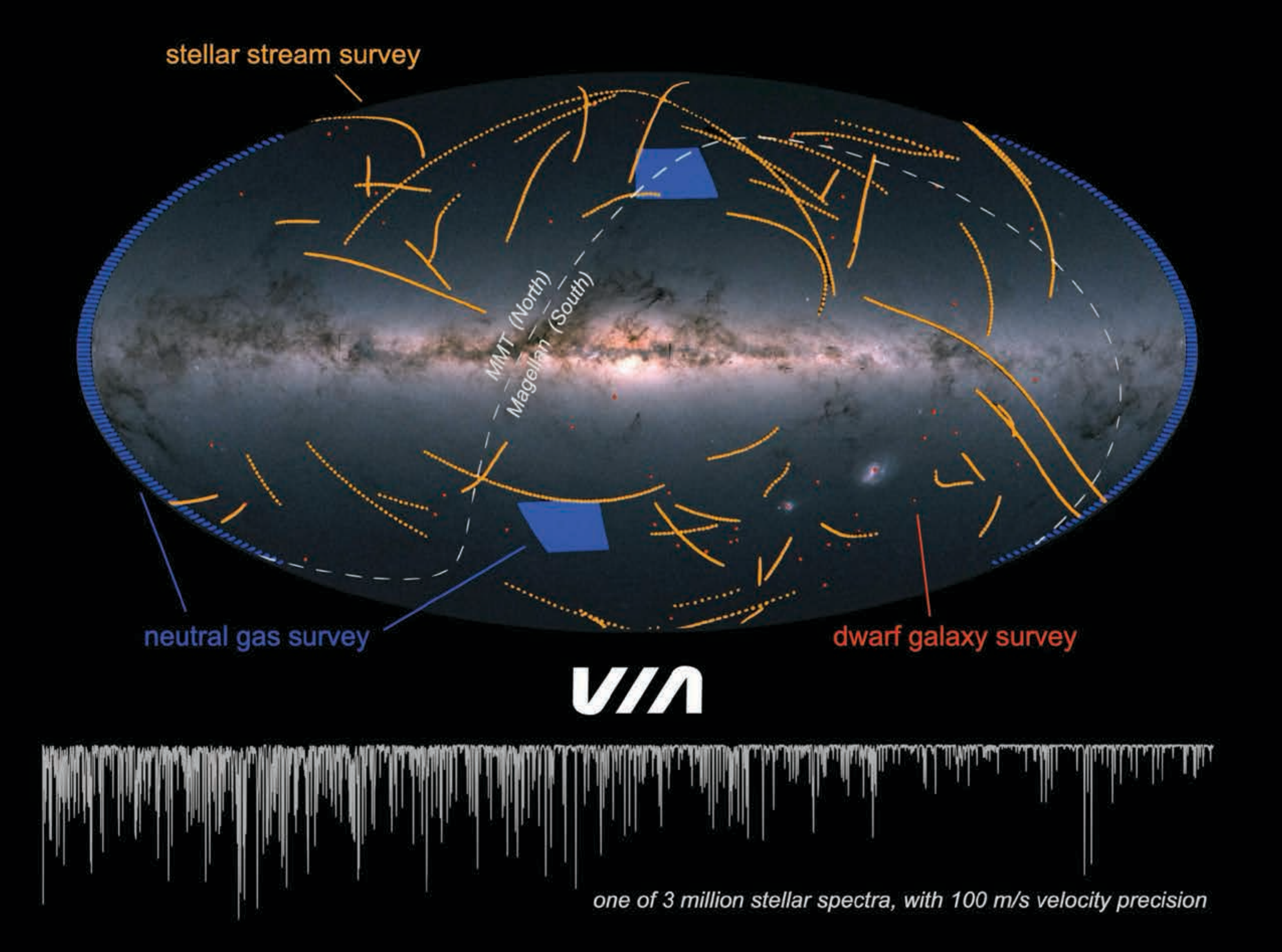
In 2025, the Center opened a physical space in the SDS building where more experienced researchers can mentor earlier career scientists. Sydney Erickson, a Stanford PhD student studying physics, SDS scholar, and KIPAC member, uses ML to model strong gravitational lenses and learn about the expansion of the universe. Attending Center events has inspired her to pursue other data-intensive methods, and she has gained career insight from postdocs in the Center.

“Through talking with them about my science and my career, I’ve learned so much from them,” Erickson says. “I’m working on applying to postdoc positions, and they’ve been giving me good advice on how to prepare.”

Clark hopes the mentorship and interdisciplinary connections fostered by the Center will lead to new findings.

“If we didn’t have the Center, these kinds of collaborations, which are more than the sum of their parts, would never pop up,” Clark says. “I want to discover something fundamentally new that was made possible because we looked at the problem or data in a new way. That’s what makes me excited about collaborating like this.”

Left: At the Center’s first quarterly forum, Susan Clark (left) and Risa Wechsler discussed what they hope to learn about the Milky Way using large datasets and new methodologies. (Image credit: Paul Sakuma) Top: Dalya Baron helped organize the Center’s first-ever annual conference, “Data-Driven Discovery in the Rubin Era,” which facilitated discussions among small and large interdisciplinary groups to explore potential solutions for astronomy’s big data problem. (Image credit: Paul Sakuma) Bottom: The quarterly forum featured a wall where attendees could share how they hope to collaborate with others on astrophysical datasets. KIPAC member Alex Broughton added “Anomaly detection in large datasets” to the mix. (Image credit: Paul Sakuma)



THE VIA PROJECT

Key to a New Grasp of Dark Matter and Galaxy Evolution

In the hope of learning more about the universe at large, KIPAC scientists are setting their sights on the stars in and around our home galaxy.

Starting in 2027, the twin spectrographs of the Via Project, located in New Mexico and Chile, will collect the spectra of millions of stars in the furthest reaches of the Milky Way. Via is unique because of its combination of all-sky coverage, the ability to take 600 spectra at once, and very high resolution. KIPAC scientists will spearhead learning more about mysterious dark matter and the formation of our galaxy from Via's measurements. The instrument will also be a key tool to follow up new discoveries from the Rubin Observatory.

Homing in on dark matter

Using the Via survey, KIPAC director Risa Wechsler plans to pursue the nature of dark matter. Despite making up 85 percent of the universe, this invisible substance lurks beyond our detection abilities because it doesn't interact with light or other forms of radiation.

Researchers suspect dark matter is made up of some sort of particle, but different models predict particles with different properties. Wechsler will narrow down these dark matter candidates with Via's unprecedentedly detailed measurements of the motions of stars. She and her team are also working on precise simulations in order to be able to make robust predictions for the connection between dark matter models and Via's observations.

KIPAC scientists will lead the Via Project's stellar stream survey, dwarf galaxy survey, and cold gas survey. Via's twin spectrographs on the Magellan telescope in the southern hemisphere and the MMT in the northern hemisphere will be able to access the entire sky. (Credit: Via)

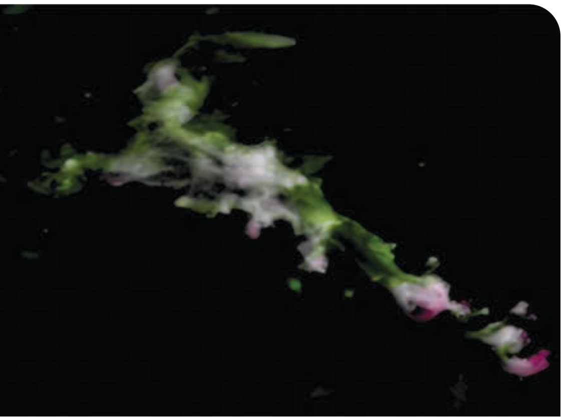
Top: A map of all known stellar streams in the Milky Way, which were discovered by the Gaia telescope. (Credit: Ana Bonaca) Bottom: An example of a cloud of cold gas that Via will observe. The different colors correspond to how fast different parts of the cloud are moving toward Earth. (Credit: Ben Dodge using data from Westmeier 2017)

"Some of the best clues we have to the nature of dark matter are in the outskirts of our own galaxy. Via's high spectral resolution provides a novel window into the 'missing' dark matter substructure of our Galaxy." says Wechsler, KIPAC director. "The existence of these objects is predicted by our current dark matter models, but we have not yet seen them."

She'll start with stellar streams, which are stars that orbit the Milky Way in like a ribbon, pulled off their initial clump by the gravity of our galaxy. Wechsler and her team will figure out how fast the stars in a stream are moving. Then, they'll look for gaps in the spread of star velocities that correspond to where small dark matter clumps may have collided with the stream, punching a hole through it. The number of gaps in the streams will tell them how abundant these small dark matter blobs are.

"The cool thing is that different dark matter models predict different numbers for this abundance," says Christian Aganze, a Stanford Science Fellow working in Wechsler's group. "With Via's sensitivity and precision, we'll definitely be able to rule out some models. It's super exciting to be in a place where you can do this kind of science. I can't wait to have this on sky and take data."

Scientists think dark matter provides a sort of scaffolding for galaxies, determining where matter clumps together and stars form through gravity. Wechsler and her team will also use Via to determine how fast stars are moving inside of satellite galaxies that orbit the Milky Way. The spread of their velocities will allow her to map the dark matter in those galaxies. Because different dark matter models also predict different numbers of these satellite galaxies and differences in how the stars move, the team will be able to further constrain predictions of this enigmatic material's characteristics.



"With the Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST), we expect to detect hundreds of new satellite galaxies and stellar streams," Wechsler says. "Via will enable us to make precise measurements of these new discoveries, to learn about how they are moving and about when the stars formed."

Mapping the fuel for stars

Susan Clark, assistant professor of physics at Stanford and KIPAC senior member, wants to paint a clearer picture of how the Milky Way formed. To do so, she'll transform Via's measurements into a 3D map of the galaxy's cold gas that feeds the formation of stars.

"We have a really wonderful group of people who don't all have the same science goals, so we're thinking creatively about how to approach data to serve multiple exciting realms of science at once," Clark says. "I'm most excited about tracing the gas."

Currently, astronomers only know where this gas is in 2D projected in the sky, not how far away it is. Clark and her team, including Ben Dodge, a PhD student at KIPAC and Stanford University, are working on new methods to chart this gas in 3D.

The gas is mostly hydrogen, but also contains a tiny bit of sodium that absorbs light of a specific frequency. Via will measure the spectra of stars that light this gas from behind, looking for dips in their light that correspond to sodium absorption.

"By looking at which stars are behind the gas and which stars are in front of the gas, we'll start to get a sense of where the gas is," Dodge says. "Scaling that up and making it rigorous with some fancy techniques, we'll then make a whole 3D map."

Once she knows how far away these gas clouds are, Clark will be able to extract their masses, densities, temperatures, and other properties that influence how they've contributed to the Milky Way's evolution.

"These fundamentally new measurements of the distribution and evolution of this gas will help us understand the fueling and basic physics of the Milky Way – very big picture, open questions that we don't have a good handle on," Clark says.

KIPAC Leadership

Director
Risa Wechsler

Managing Director
Josh Shiode

Steering Committee
Daniel Akerib
Steve Allen
Pat Burchat

KIPAC Members 2024-25

Senior Members

Faculty
Tom Abel
Zeesh Ahmed
Daniel Akerib
Steve Allen
Roger Blandford
Pat Burchat
Susan Clark
Josh Frieman
Peter Graham
Todd Hoeksema
Kent Irwin
Chao-Lin Kuo
Brian Lantz
Ben Nachman
Peter Michelson
Vahe Petrosian
Roger Romani
Aaron Roodman
Rafe Schindler
Tom Shutt
Eva Silverstein
Risa Wechsler

Emeritus Faculty
Elliott Bloom
David Burke
Sarah Church
Steve Kahn
David MacFarlane
Bob Wagoner

Scientific Staff
Marcelo Alvarez
Chelsea Bartram
Adam Bolton
Eric Charles
Jim Chiang
Hsiao-Mei (Sherry) Cho
Seth Digel
Shawn Henderson
Tony Johnson
Ralf Kaehler
Kirit Karkare
Noah Kurinsky
Rebecca Leane
Enrique Lopez Rodriguez
Steffen Luitz
Greg Madejski
Adam Mantz
Stuart Marshall
Phil Marshall
Josh Meyers
Maria Elena Monzani
Glenn Morris
Igor Moskalenko
Nicola Omodei
Peter Orel
Richard Partridge
Troy Porter
Andrew Rasmussen
Kevin Reil
Eli Rykoff
Emmanuel Schaan
Josh Shiode
Kelly Stifter
Keith Thompson
Dan Wilkins
W.L. Kimmy Wu

Members

Scientific Staff
Humna Awan
Dalya Baron
Tomasz Biesiadzinski
Ioana Ciucă
Orion Eiger
Agnès Ferté
Noemie Globus
Shea Hess Webber
Bryce Kalmbach
Alexander Koufos
Philip Mansfield
Declan O'Neill
Andrés Alejandro Plazas Malagón
Maria Salatino
Sidney Stevens

Postdocs/Research Associates
Christian Aganze
Shreya Anand
Tyler Anderson
Taylor Aralis
Maris Arthurs
Dominic Beck
Federico Bianchini
Alex Broughton
Iryna Butsky
Tanmoy Chattopadhay
Suchetha Cooray
Sanskriti Das
Niccolo Di Lalla
Alex Droster
Lukas Eisert
Kevin Fanning
Philipp Frank
Shenming Fu
Peter Gaemers
Fei Ge
Sayan Ghosh
Minhee Hyun
Yijung Kang
Aya Keller
Jae Yeon Kim
Shuang Liang
Sushant Mahajan
Abhishek Maniyar
Peter Marinos
Sergio Martin Alvarez
Miltiadis Michailidis
Eli Mizrachi
Eric Moseley
Kate Napier
Tristan Pinsonneault-Marotte
Artem Poliszczuk
Aditi Pradeep
Frank Qu
James Ryan
Chiara Salemi
Carlos Sierra
Maria Simanovskaia
Navin Sridhar
Kate Storey-Fisher
Wren Suess
Mehrnoosh Tahani
Ann Wang
Osmond Wen
Linda Xu
Andrew Yi
Zhefu Yu
Sihan Yuan
Cheng Zhang

Graduate Students
Andrew Ames
Jadyn Anczarski
Tori Ankel
Jay Baptista
Maya Beleznay
Christina Bell
Diogo Braganca
Dylan Britt
Brianna Cantrall
Ruben Coronel
Tara Dacunha
Steven Dillmann
Boyang Ding
Jack Dinsmore
Benjamin Dodge
Taj Dyson
Sydney Erickson
Nicolas Ferree
Anthony Flores
Hope Fu
Geoge Halal
Abby Hartley
Bryen Irving
Kaitlyn Karpovich
Jamar Kittling
Ameya Kunder
Minjie Lei
Zhixuan (Abi) Li
Tom Lui
Hannah Magoon
Viraj Manwadkar
Sidney Mau
Guillem Megias i Homar
Matiwos Mebratu
Yuka Nakato
Marta Nowotka
Abby Pan
Nicholas Rapidis
Maya Redden
Bernardita Ried Guachalla
Sephora Ruppert
Allesandro Russo
Toby Satterthwaite
Lillian Santos-Olmsted
Theo Schutt
Delon Shen
Liam Sherman
Ben Sherwin
Mahlet Shiferaw
Ana Carolina Silva Oliveira
Aviv Simchony
Jyotirmai Singh
Zoë Smith
Pam Stark
Haley Stueber
Andrew Sullivan
Chloe Tayler
Josh Tong
Bahrudin Trbalic
Cady van Assendelft
Sebastian Wagner-Carena
Jenny Wan
Hanyue Wang
Qihua Wang
Yunchong (Richie) Wang
Matthew Withers
Josephine Wong
Barkotel Zemenu
Hazal Zenger
Zhuoqi (Jackie) Zhang

Post-baccalaureate Scholars
Jacob Laurel
Tonya Peshel

Senior Associate Members

Faculty
Bob Byer
Lance Dixon
Alex Friedland
Giorgio Gratta
Michael Peskin
Laura Schaefer
Dustin Schroeder
Lauren Tompkins

Emeritus Faculty
Blas Cabrera
Phil Scherrer

Emeritus Scientific Staff
Rob Cameron
Richard Dubois

Scientific Staff
Joanne Bogart
Sasha Buchman
Paul Brink

NEW STAFF

Marcelo Alvarez

Marcelo Alvarez is a KIPAC scientist working at the intersection of theory, simulation, and data in cosmology. He has contributed to the study of reionization, large-scale structure, and the cosmic microwave background. Marcelo's current research focuses on using AI to accelerate discoveries in fundamental physics with next-generation cosmology surveys. He also helps manage the shared computing resources that support KIPAC science and, since early 2025, has served as a research engineer for Marlowe, a powerful new computing platform to advance research at Stanford.

Josh Shiode

Josh Shiode joined KIPAC as our new Managing Director in March 2025. Josh came most recently from the DOE Office of Science, where he was a Senior Advisor and Chief of Staff, serving under then-Director Asmeret Asefaw Berhe. Josh received a PhD in astrophysics from UC Berkeley in 2013 and subsequently worked in various roles advocating for science and technology policy in Washington, DC, including within the DOE Office of Science National Laboratory complex.

Concetta Cartaro
Tom Glanzman
Sven Herrmann
Heather Kelly
Sina Koehlenbeck
Homer Neal
Aimee Norton
Blair Ratcliff
Massimiliano Turri
Sierra Villarreal
Junwei Zhao

Associate Members

Staff
Ian Roque

Postdocs
Anirban Das
Davide Racco

Graduate Students
Zach Bogorad
Jason Corbin
Anita Dunsmore
Neel Kundu

Institute Staff

Outreach & Communications Staff
Xinnan Du
Lori White

Administrative Staff
Yasemin Al-Kasimi
Andrea Davies
Xiomara Forbez
Courtney (Desisto) Heath
Maria Herraez
Maridee Huston-Charlton
Sara McCardle-Blunk
Josh Shiode
Martha Siegel
David Stricker
Jeff Wade

2024-25 Fellowships

Postdoctoral Fellows

Hubble Fellows
Iryna Butsky
Sanskriti Das

Stanford Science Fellow
Christian Aganze

Kavli Fellows
Dylan Jow
Jaeyeon Kim
Taweewat Somboonpanyakul

Porat Fellows
Chiara Salemi
Cheng Zheng

KIPAC Fellows
Federico Bianchini
Suchetha Cooray
Philipp Frank
Phil Mansfield
Eric Moseley
Frank Qu
Carlos Sierra
Mehrnoosh Tahani
Zhefu Yu
Sandy (Sihan) Yuan

Graduate Student Fellows

Chabolla Fellows
Brianna Cantrall
Ana Silva Oliveira
Hannah Magoon

Giddings Fellow
Andrew Sullivan

Stanford Graduate Fellows
Maya Beleznay
Ruben Coronel
Minjie Lei
Viraj Manwadkar
Mahlet Shiferaw
Chloe Taylor
Jenny Wan

Stanford Data Science Scholars
Sydney Erickson

NSF Graduate Fellowships
Tori Ankel
Jay Baptista
Ben Dodge
Sid Mau
Viraj Manwadkar
Theo Schutt
Delon Shen
Ben Sherwin
Mahlet Shiferaw
Andrew Sullivan
Jenny Wan

Physics Fellow
Jay Baptista
Andrew Sullivan
Joshua Tong
Lillian Santos-Olmstead

Siemann Fellow
Taj Dyson

HEPCAT Fellows
Zoe Smith

PHD GRADUATES

1

2

3

4

1. SIDNEY MAU worked with Prof. Pat Burchat on using weak gravitational lensing to probe the cosmological content and evolution of the Universe. He developed image simulations to calibrate measurements of galaxy shapes and lensing shear, and studied methods to mitigate the impact of chromatic atmospheric effects on galaxy shape measurements. Sidney is continuing his research and will be active in next-generation weak lensing surveys as a postdoctoral associate at Duke University.

2. GUILLEM MEGIAS I HOMAR worked with Prof. Steven Kahn on developing and commissioning the Active Optics System for the Vera C. Rubin Observatory, ensuring the telescope delivers the image quality required for discovery. He also explored novel methods for detecting ultra-fast transients in Rubin's LSST. Guillem has joined Caltech as a Millikan Fellow, where he will continue advancing the next generation of large telescopes, designing concepts for novel X-ray space telescopes, and pursuing studies of fast astrophysical transients.

3. ANTHONY FLORES worked with Prof. Steven Allen to better understand the thermodynamic and chemical evolution of galaxy clusters. Using X-ray observations of the hot intracluster medium, he analyzed many of the highest redshift galaxy clusters known to determine how various processes (such as AGN feedback) affected their early growth. Anthony will expand the scope of this work with new observations of galaxy clusters at additional wavelengths as a postdoctoral researcher at Rutgers University.

4. DREW AMES worked with Profs. Dan Akerib and Tom Shutt on LUX-ZEPLIN (LZ), an experiment designed to directly detect dark matter. He characterized key sources of instrumental background from low-energy electrons and krypton, as well as explored "doping" the xenon with molecular hydrogen to increase LZ's sensitivity to lower-mass dark matter particles. Drew will be working on liquid argon detector development for gamma-ray astrophysics at Northeastern University.

ALUMNI UPDATES

Frédéric Effenberger received an ISSI Team Grant as a co-lead investigator to better understand the transport of energetic charged particles in space plasmas.

Simon Foreman, a member of the CHIME Collaboration that was awarded First Place for the 2024 Buchalter Cosmology Prize, co-led the award-winning paper.

Saurabh Jha received the 2025 Guggenheim Fellowship, which recognizes trailblazing scientists and artists and provides a stipend toward their ongoing work. He was appointed co-chair of the Nancy Grace Roman Space Telescope Research Oversight and Time Allocation Committee.

Herman Shiu-Hang Lee began a new position as an Associate Professor at Kyoto University, Japan.

Yu Lu was appointed Senior Manager of Data Science at Lam Research Corporation, a supplier of wafer-fabrication equipment and services.

Bruce Macintosh was named a Fellow of the American Astronomical Society in 2025 for leadership in exoplanet imaging, instrumentation, and mentorship.

Warit Mitthumsiri was named a Top 1% Researcher at Mahidol University in Thailand for his exceptional research performance.

Jessica Muir began a new position as Assistant Professor at the University of Cincinnati.

Devon Powell began a new position as a Machine Learning Optimization Engineer at Distributed Spectrum, a company that develops advanced wireless communication technologies.

Giuseppe Puglisi began a new position as an Associate Professor at the University of Catania, Italy.

Miguel Sánchez-Conde was appointed co-head of the Department of Theoretical Physics at the Madrid Autonomous University, Spain.

Marina Shmakova is now a physics instructor at Mission College.

Jack Singal was promoted to full professor at the University of Richmond.

Justin Vandenbroucke was promoted to full professor at the University of Wisconsin. He received an NSF grant to support the construction of ten telescopes in Chile as part of the Cherenkov Telescope Array Observatory, to study the highest energy photons in the Universe.

RETIREMENTS

Rob Cameron

After more than twenty years spent supporting several important missions, KIPAC mainstay Rob Cameron has retired from his position at the SLAC National Accelerator Laboratory (SLAC). Cameron came to SLAC and KIPAC after 11 years at the Harvard-Smithsonian Center for Astrophysics, where he worked with Chandra X-ray Observatory, ending as Flight Director for Chandra during its operations phase.

Cameron brought his mission management skills to SLAC and KIPAC to support the Fermi Gamma-ray Space Telescope (Fermi), then called the Gamma-ray Large Area Space Telescope, as manager of the Instrument Science Operations Center (ISOC) at SLAC for the Large Area Telescope (LAT), Fermi's principal instrument. Cameron worked closely with NASA to integrate the ISOC into Fermi's ground operations system.

During its 17 years of operation, Fermi has mapped the entire gamma-ray sky, all the way from a diffuse background of gamma rays filling the entire Universe to gamma rays generated by lightning strikes here on Earth. Cameron has been ISOC manager for the entire time.

In 2016, Cameron gained another operations management role with the Super Cryogenic Dark Matter Search (SuperCDMS) experiment currently being installed two kilometers underground at SNOLAB in Sudbury, Ontario. The experiment uses advanced quantum sensors to "listen" for the collisions of dark matter particles with atoms in silicon and germanium crystals—at temperatures in the millikelvin range.

"During my time in KIPAC, I have been very impressed with the great dedication and excellent work shown in accomplishing various experiments and research programs," he says, "and I have learned tremendously from working with my colleagues."

Following his retirement, Cameron plans to continue his involvement in the Fermi mission and in SuperCDMS.

Sarah Church

KIPAC professor Sarah Church, Professor of Physics Emerita, took on several roles during her 25-year career at Stanford: teacher, researcher, mentor, administrator, rising to the position of Vice Provost of Undergraduate Education (VPUE). But they can all be boiled down to two key priorities: the science and the students.

Church joined the Stanford Physics Department in 1999. She made key contributions to measurements of the Cosmic Microwave Background, including the Planck, SuZIE, QUaD, and QUIET Collaborations. She then became interested in intensity mapping, which maps the locations of the giant clouds of primordial gas that made up the bulk of the early Universe, and initiated a new intensity mapping experiment called COMAP.

Church's time spent teaching undergraduate students was as distinguished as her research career. In 2014, she was named the Pritzker University Fellow in Undergraduate Education in recognition of her extraordinary contributions to undergraduate learning.

She was just getting started. While teaching Mechanics (Physics 41), Church spent time with a core of students who were having trouble in the class. "I had trouble giving them what they needed, and I wondered why my teaching wasn't working."

Church determined that the standard methods of teaching physics didn't teach students how to be physicists. She joined forces with distinguished Stanford physicist Carl Wieman, who is an international expert in science education, and they revamped Physics 41 to create Physics 41e, which focused on practical problem solving skills. "Students loved it. They all passed and they said it was their favorite class." Church considers the experience "one of the most rewarding projects in my educational career."

Church became Vice Provost of Undergraduate Education in 2019 – and shortly afterwards, the pandemic put everything on hold. Church was tasked with leading the effort to adapt Stanford education to pandemic protocols – a challenging effort she took on with incredible energy, putting the needs of the students first. She returned to teaching afterward – and is continuing these efforts in retirement – currently working on a textbook based on her experience helping undergraduates learn.

"I like to help people. I really do."

David MacFarlane

Professor of Particle Physics & Astrophysics Emeritus David MacFarlane came to SLAC shortly after the founding of KIPAC, in 2005. Although he joined KIPAC much later, says MacFarlane, "I've been supporting KIPAC as an idea for a long time." MacFarlane, who retired at the end of 2024, officially joined KIPAC in 2018 as Project Director of the Super-Cryogenic Dark Matter Search (SuperCDMS) at SNOLAB, one of KIPAC's premiere dark matter detection experiments.

A particle physicist by training, MacFarlane started supporting KIPAC as the Associate Lab Director (ALD) of Particle Physics and Astrophysics (now Fundamental Physics) at SLAC, which jointly hosts KIPAC with Stanford University. During his early years as ALD, the particle physics field as a whole realized that it was intertwined with cosmology in a way that "manifested as unknown components of the Universe" such as dark matter. However, he adds, "These components are not reachable at energies we can hit with our instruments."

MacFarlane thus made it a priority to support KIPAC experiments, such as the Fermi Gamma-Ray Space Telescope and dark matter searches. He also recruited outstanding faculty members like Dan Akerib and Tom Shutt (dark matter) and Kent Irwin (quantum sensors). As recently as 2023, MacFarlane led a search for new faculty members specializing in AI, quantum measurement, and accelerators.

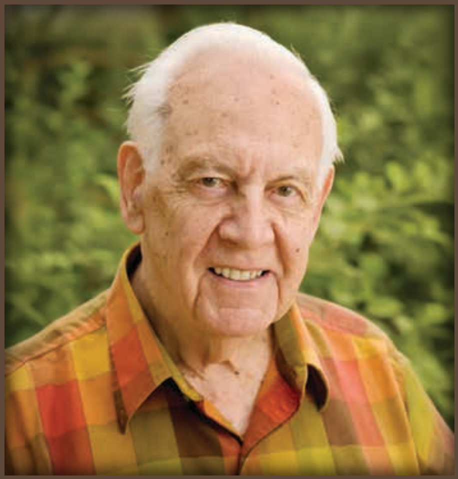
Such a long view has paid off for both MacFarlane and the institute. "I feel some satisfaction that those investments are very much front and center at KIPAC," he says.

Meanwhile, the future beckons. MacFarlane says he'd like to find a role that takes advantage of his people and management skills "and is rewarding, impactful, and new."

In Memoriam of

Peter Sturrock

Peter Sturrock, a leader in plasma and solar physics, passed away on Aug. 12, 2024 at the age of 100. Sturrock retired from Stanford as professor of applied physics before KIPAC started in 2003, but his leadership provided the spark for the institute.



"In some ways, Peter's legacy is KIPAC," says Roger Blandford, founding director and senior member of KIPAC. In 1985, Sturrock helped create the Center for Space Science and Astrophysics at Stanford. "He fostered the growth of plasma physics, space and solar physics, and astrophysics at Stanford. This provided a foundation on which KIPAC could grow."

As a KIPAC member, Sturrock attended tea talks and colloquia. "He was unfailingly supportive and had good perspective," Blandford said. "He was always a bold and fearless thinker. To his credit, I never felt reticent about presenting alternative views and we had several friendly debates."

SLAC NATIONAL ACCELERATOR LABORATORY

KIPAC
KAVLI INSTITUTE FOR PARTICLE ASTROPHYSICS & COSMOLOGY

KIPAC
SLAC National Accelerator Laboratory
2575 Sand Hill Road, M/S 29
Fred Kavli Building, Bldg. 51
Menlo Park, CA 94025-7015

KIPAC
Stanford University
452 Lomita Mall
Physics & Astrophysics Building
Stanford, CA 94305-4085

FOLLOW KIPAC FOR MORE!

Website: kipac.stanford.edu/
Facebook: www.facebook.com/KIPAC/
Instagram: @kipac_stanford
Twitter: @kipac1
YouTube: kipac

Content: Chris Patrick, Raquel Destefano, Lori Ann White, Xinnan Du, Josh Shiode, and Barkotel Fesseha Zemenu | Design: Alexander Atkins Design, Inc.