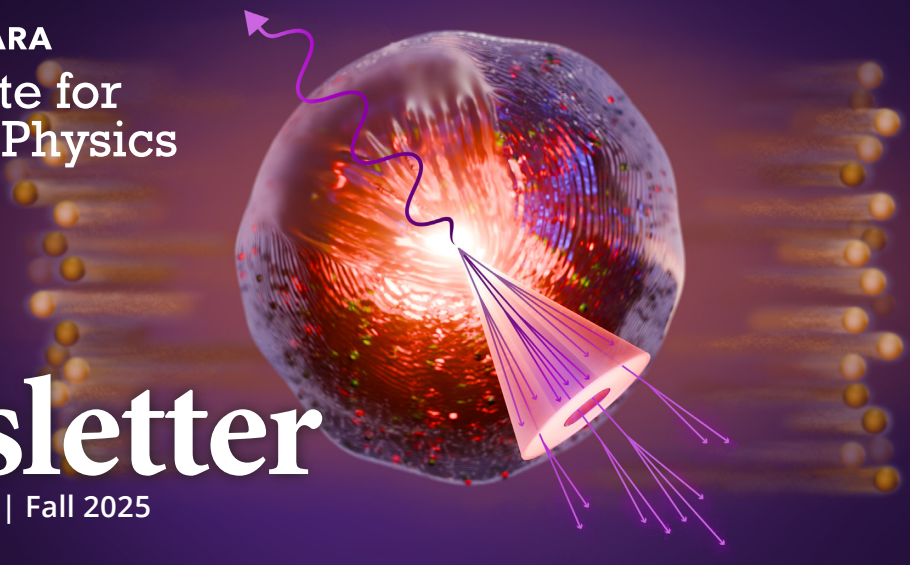
UC **SANTA BARBARA**

Kavli Institute for Theoretical Physics



Newsletter

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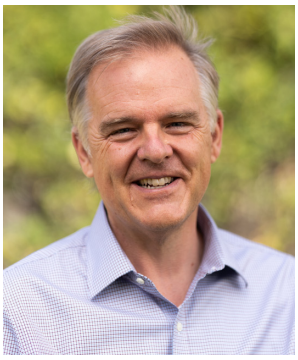


Lars Bildsten

The banner image represents the outcomes from high energy interactions of nuclei. KITP Postdoc Bruno Scheihing-Hitschfeld recently received an outstanding dissertation award from the American Physical Society for his work in this area. You will find the full story on page 7. This acknowledgement of his excellence is a reminder of how these early-career scientists continue to move the frontier of science forward.

I would like to thank all of you who so generously contributed to the Mitchel Postdoctoral Scholars Career Development Fund. This $2M endowment will provide resources for the research expenses of KITP Postdocs, enabling both their research and our ability to recruit them. Right now, we are reading the files of over 700 postdoc applicants, hoping to attract 4-6 new scientists to join us in fall 2026!

In fall 2025, six KITP Postdocs advanced to new positions in industry and academia. Utkarsh Agrawal started his own company, DigitalFence. Fridtjof Brauns left to become a Junior Group Leader at the Max Planck Institute for Physics of Complex Systems in Dresden, and Alex Homrich is now a Burke Fellow at Caltech. Ali Lavasani took a science position at Quantinuum, while Chris Ni is now a Quantitative Researcher at Citadel Securities and Logan Prust is a Flatiron Research Fellow at the Center for Computational Astrophysics in Manhattan. Newly arrived postdocs in fall 2025 span most of physics. In high energy, we have Samuel Leutheusser from the Institute for Advanced Study, while in astrophysics we have Samuel Boos from U. Alabama, Ka Wai Ho from UW-Madison and Linhao Ma from Princeton. We also have two biophysicists: Yanin Guerra from the Dresden University of Technology and Henrik Weyer from Ludwig Maximilian University-Munich.

Our new project, KITP House, continues to progress! Aimed at enhancing collaborative science by providing housing for our postdoctoral scholars, graduate fellows and long-term sabbatical visitors, this facility will complete the needed physical infrastructure to ensure KITP's lasting value to all of physics. Since our last Newsletter, we have submitted our project to the California Coastal Commission and proceeded with the design efforts, reaching a 50% construction document set in late November 2025. We aim to initiate construction in late winter 2026 and open in summer 2028.

KITP has been the long-term intellectual home of many remarkable scientists. Bill Paxton was one very close to me who passed away this summer. A collaborator and friend, Bill made a profound contribution to stellar astrophysics by creating the open-source tool Modules for Experiments in Stellar Astrophysics (MESA). MESA is now constantly used by more than 1,000 astrophysicists around the world. On November 21, 2025, we brought together family, friends and the scientific community to celebrate Bill's accomplishments in the symposium: "Celebration of Bill Paxton: Software for the Stars." See the story on page 3.

When our colleague Joe Polchinski passed in 2018, his spouse Dorothy Chun and I spent time together looking over his accumulated works in his office. I had never seen such a well-organized set of handwritten scientific notes. Dorothy generously agreed to donate these papers to the UCSB Archive, where they were cataloged and scanned over the last six years. This project is now complete, and on page 4, you can read more about that endeavor. Joe had many talents, including being an intense bike rider. He would lead a ride from the front of Kohn Hall to the top of San Marcos pass quite often. This route became famous as "Joe's Ride," and we now have a topographic map mounted in the entry stair at Kohn Hall that shows the route. Please check it out next time you visit!

We very often speak to how interactions amongst KITP visitors lead to new scientific directions. On page 5, we have the story of a different outcome; the creation of a new textbook, *Physics Bootcamp: Mathematical Methods for First-Year Physics and Engineering* by James Dent and Joel Walker. Their article describes how their time at KITP led to the collaboration and the successful finish of this work that will enhance scientific education for generations. Of course, none of these interactions happen without the work of KITP's amazing staff. On page 6, Demi Cain tells the story of Bibiana Rojas; Bibi to all of us! Bibi is the first person most of our visitors meet when they arrive in Kohn Hall. Return visitors are always eager to update her on all they've done since their last visit.

We continue to hear affirmation that KITP's mission of bringing together scientists for prolonged periods of open dialog and collaboration has tremendous value. Thanks to all of you for both participating in, and supporting, all we do here at KITP!

- Lars Bildsten, KITP Director

The Contagious Brilliance of Bill Paxton

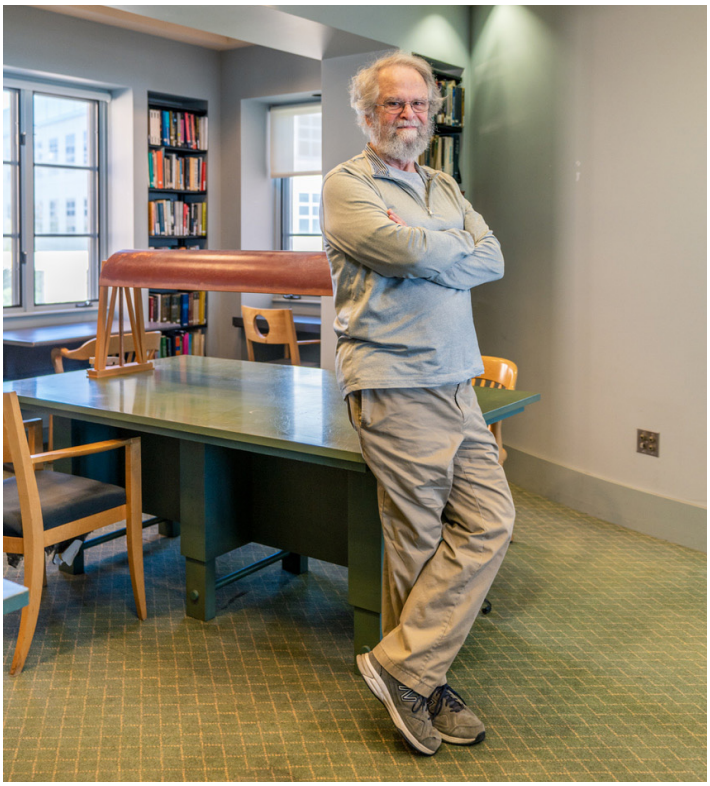


PHOTO CREDIT: MATT PERKO

Bill Paxton at KITP

Bill Paxton ingrained himself into astrophysics, and into the astrophysics community, in an indelible manner. His curiosity and passion have left an enduring imprint on the field. Over 520 students have been trained at MESA summer schools, and the MESA instrument papers have accumulated more than 14,000 citations.

"There are things that are impossible to quantify, though," said Meridith Joyce, an assistant professor at University of Wyoming. Like the professional collaborations he forged and the lasting friendships he fostered.

Friday November 21, 2025 was a day to celebrate Bill, who passed away in July. The afternoon witnessed moments of thunderous laughter and teary emotional breakdowns.

"Long before Bill was a rockstar in the firmament of theoretical physics, he was a pioneer in developing all the things [in computing] that we use and take for granted today," said his colleague and longtime friend Jim Mitchell. From his involvement in the Mother of All Demos, to the invention of PostScript and the development of the PDF, Bill revolutionized the field of computing.

And yet, after all this, he embarked on an entire second career to no less success. Bill's was a mind that wouldn't be left idle. "I just remembered him one time saying, 'Well you know, I think I've decided to learn physics. So, I'm reading a Physics 1 textbook,'" recalled close friend and colleague Ann Robinson.

Well, Bill was never one to dabble, so he soon found himself in class. Tony Piro, at Carnegie Observatories, recalled walking into an upper-division class in the spring of 1999. "Among all the students was a somewhat older man wearing metal-rimmed glasses and a distinguished beard."

Bill bucked the stereotype of retirees who audit university classes. His long, handwritten problem sets were among the most meticulous of anyone in the class. Tony and Bill continued up the physics course ladder together. And when Tony returned to UCSB to pursue his Ph.D. with Professor Lars Bildsten—a KITP permanent member at the time—"lo and behold, Bill was back for graduate school as well!"

Bill's "superb retirement project," as Jim Mitchell described MESA, became the foundation of modern computational stellar astrophysics. And the enterprise has created a community of friends and collaborators around the world.

Many of Bill's relationships were stories narrated in email, from first introductions years ago to many final farewells during the day's events. "We started with an email, and over the ensuing decades we exchanged approximately 20,000," remarked MESA co-developer Frank Timmes (Arizona State University).

On January 8, 2005, Frank received an innocuous message that changed the course of his life:

"Hello, my name is Bill Paxton. May I please use the tools posted on your website?"

Three things immediately stood out to Frank: The message was extraordinarily polite. It also actually asked to use his code. "Nobody asks," Frank said. "They just take it and go." And it had a KITP web address. So, he thought, "Okay, Lars has a new grad student."

"About three emails later…I'm going, 'This is no grad student, is this," Frank recalled. Even in 2005, it didn't take too long to figure out who Bill Paxton was. "I remember thinking to myself, 'Wow, we got a ringer on the line here.'"

Many who knew Bill would also relate with the introduction provided by co-developer Rich Townsend of University of Wisconsin-Madison: "I'm going to talk about how Bill completely derailed my career."

Bill enticed people with intriguing questions that then grew to become challenging projects. But by the time you realized what had happened, you were too invested to leave. "When you start working with [him], it's like you jumped on a rollercoaster," Rich said. "Wherever you [were] going, you are not going there anymore. You are going somewhere else, and you are going somewhere else fast."

While new riders on the Bill-ercoaster may not have known where they were headed, they certainly weren't going alone. Bill would see them through the track's twists and turns—many put there by Bill himself—not so much as a pilot but as a guide.

CREDIT: FRANK TIMMES

The first MESA Summer School, August 2012

Bill pushed people to do things they didn't believe they were capable of; things they may not have had the courage to attempt on their own. "He expected so much more of all of us… than we expected of ourselves," Rich said. Time and again he demonstrated that a cantankerous streak was no barrier to mentorship and generosity. And that patience and hustle were complements, not opposites.

"Bill didn't really go easy on people," said co-developer Jared Goldberg, currently at the Flatiron Institute. But rather than seeking to cut ideas down, his relentless skepticism served to build people up. As Bill once told Jared, "I'm not asking you because I think you're dumb. I'm asking you because I think you're smart, and I want you to explain this to me so that I can understand it."

That said, Bill would absolutely rewrite your code from the ground up rather than try to debug it. Gia DePalma singled out four traits to describe her grandfather: generous, passionate, stubborn, and brilliant. You'd be hard-pressed to find any more fitting.

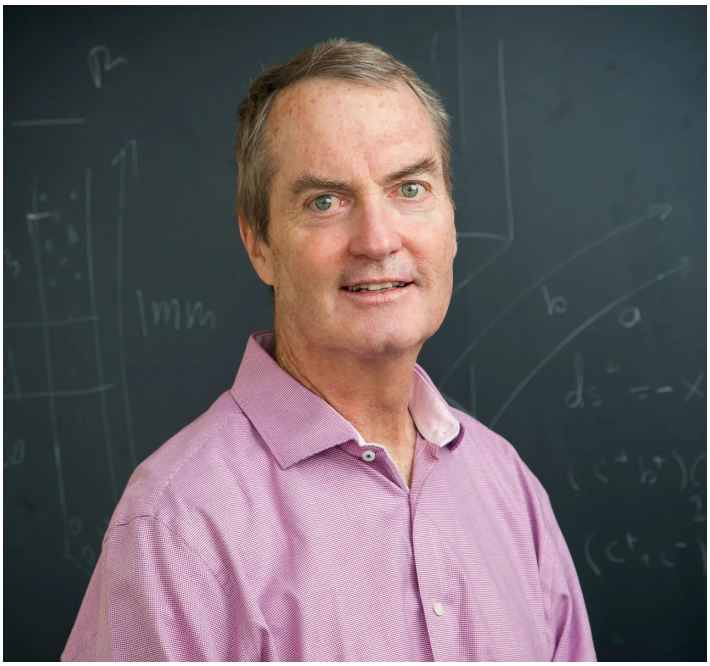
KITP Director Lars Bildsten tried to encapsulate his long, fruitful collaboration with Bill in a few words he saved for after the event. "I worked closely with Bill for over 20 years. He was the deepest scientific collaborator in my life, and I miss him every day," Lars said. "Especially on Saturday mornings, when we would typically engage for a few hours of vigorous scientific debate.

"No one else in my scientific world was as deliberate in thought, purity of calculation and language," Lars continued. "He did not happily tolerate loose language or, worse, loose thinking! This sharpened all of us who had the privilege of working with him."

Bill's zeal, coupled with his brilliance, meant that he simply didn't see the barriers that others tried to point out. It made him an effective mentor, a formidable teammate, and an astounding personality to behold. And it meant that he seemed capable of nearly anything, like a plainclothes wizard. His family, friends, and colleagues likely wouldn't be surprised if Bill becomes bored of his current occupation and, one day, returns unannounced to continue where he left off, with a smile on his face and a twinkle in his eye.

by Harrison Tasoff
Science Writer, UCSB Public Affairs & Communications

The Joseph Polchinski Papers: A Legacy of Theoretical Physics



The UCSB Library recently finalized the processing and digitization of the faculty papers of renowned theoretical physicist and string theorist Joseph Polchinski (1954–2018). The papers offer scholars and enthusiasts unprecedented access to the works of one of the most influential theoretical physicists of the 20th and early 21st centuries. This comprehensive archive encompasses a vast array of materials in over 100 manuscript boxes, including publications, correspondence, and handwritten lecture notes and calculations, chronicling Polchinski's academic journey from his graduate studies to his tenure at UCSB.

Considered one of the most creative physicists of his generation, Polchinski joined UCSB in 1992 as a professor of physics and a permanent member of KITP. His presence at KITP significantly enhanced the institute's reputation, attracting leading physicists worldwide and fostering a vibrant intellectual community. Polchinski's influence extends beyond his research. His two-volume textbook, *String Theory,* published in 1998, remains a foundational resource for students and researchers alike. Throughout his career, he received numerous accolades, including the Dirac Medal in 2008 and the Breakthrough Prize in Fundamental Physics in 2017, recognizing his profound impact on our understanding of the universe.

Polchinski was a giant force in the development of string theory, the ambitious attempt to achieve a "theory of everything," which envisions the fundamental particles of nature as tiny wriggling strings. "Joe's many important contributions to particle theory are characterized by great elegance, clarity, and impact," remarked David Gross, former KITP Director and 2004 Nobel Laureate. "He has had many of the most fruitful ideas about gauge theories, string theories, and the relations between them."

The Joseph Polchinski Papers features a remarkable assortment of documents that provide a unique window into Polchinski's thought process and scholarly evolution. Among the most valuable materials are his original research notebooks, densely filled with equations, diagrams, and annotations that trace the development of his ideas. Drafts of published and unpublished manuscripts reveal the progression of key scientific arguments and collaborations. The archive also includes detailed referee reports, grant applications, teaching materials, and syllabi, offering insight into his roles as educator and mentor.

Notable materials in the collection include extensive correspondences with prominent physicists such as Edward Witten and Leonard Susskind, reflecting the dynamic discourse that shaped modern theoretical physics. These letters often discuss new theories, critique recent papers, and propose bold conjectures, illuminating the collaborative and often speculative nature of cutting-edge science.

The papers provide invaluable insights into the evolution of modern theoretical physics. Researchers can delve into Polchinski's extensive work on string theory, quantum field theory, and the black hole information paradox. Notably, the collection includes materials related to his groundbreaking 1995 paper on D-branes, which revolutionized string theory by introducing new non-perturbative objects that have become central to the field.

The bulk of the collection is made up of Polchinski's personal research binders, which have been individually boxed, and inventoried. Many of the binders correspond to a specific journal article but, due to Polchinski's unique notation style, it can often be difficult to determine which binder corresponds with which article. In order to facilitate the matching of binders and articles, University Archivist Matt Stahl and KITP Director Lars Bildsten decided to scan each binder and make the scans available to the International Physics Community, a process completed by UCSB Library's Digital Library Development Department. Interest in the scans has been high, as physicists from around the world are eager to examine and understand Polchinski's thought process.

"Primary source materials like personal notes or letters between colleagues is what defines a great archive," Stahl said. "Polchinski's binders provide unique insight into the research process of one of the world's leading scholars of string theory."

The availability of his papers at UCSB Library ensures that future generations can continue to learn from and build upon his work. Researchers can access scans of the collection by contacting Special Research Collections.

UCSB Library

Rethinking Math Readiness for First-Year Physics and Engineering

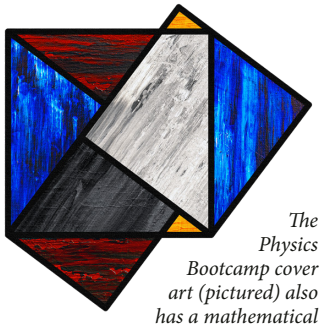
For us, KITP has come to symbolize the cementing of a deep friendship and the inception of a lasting professional partnership. At key moments it has offered a refuge from daily concerns, serving as a catalyst for clear thinking and productive collaboration.

Our first time together at the institute was during the summer of 2016. We had originally met more than a decade earlier, as PhD students at Texas A&M, and had reconnected at the end of 2015 through overlapping research interests and mutual colleagues. James was anticipating a first visit with the KITP Scholars program and Joel had one of three visits remaining. We resolved to coordinate schedules and meet up in Santa Barbara. During these two weeks, we shared an office and pushed forward on an article about coherent neutrino scattering. Beyond that, we visited, bonded, and enjoyed spending this special time together in such a conducive and idyllic setting. When a faculty opening in Physics was announced at Sam Houston State University (SHSU) for the next year, this experience was also a crucial part of James' decision to apply.

James Dent (left) and Joel Walker (right) at KITP in 2016 and in 2022

One of the first things James did after relocating to Texas was to team up on the instruction and continuing development of a new course that Joel had introduced at SHSU a few years prior. This "Physics Bootcamp" was targeted at incoming freshmen and designed to teach the mathematical methods required for first-year physics and engineering, from the perspective favored by physicists. It was motivated by challenges involving recruitment, enrollment, retention, and barriers to student success. For example, few of our students were arriving with the necessary command of calculus, while enrollment in calculus would often be delayed by stacked prerequisites, leaving many students reluctant to invest a year (or more) of effort and expense to explore the physics major. Even those students who had studied calculus often exhibited misalignment between their formal training and the practical computational skills that our courses require, lacking the ability to adapt, extend, or transfer their knowledge to new settings. Conversations with other faculty around the country convinced us that similar challenges were common almost everywhere. We resolved to package our solution for widespread reuse, in the form of a textbook.

A second pivotal visit to KITP occurred during the summer of 2022, after five years as faculty colleagues. Significant effort had been devoted to the creation of draft content for the book, but the project had lost momentum, and it lacked a reliable publishing partner. Our time at the institute proved vital to regaining focus and charting a new path forward, clearing the way for a proposal to Cambridge University Press. After several rounds of review, which included helpful feedback regarding the project's scope and sequencing, a contract was signed in the summer of 2023. Reinvigorated, we returned to work. Two years later, the book is now approaching its final form and is expected to be available for adoption in the fall of 2026.



The Physics Bootcamp cover art (pictured) also has a mathematical meaning, representing a graphical proof of the Pythagorean Theorem. Image courtesy of James Dent and Joel Walker.

The *Physics Bootcamp* textbook is divided into five broadly-defined subject blocks: arithmetic frameworks, algebra and functions, trigonometry and vectors, differential calculus, and integral calculus. Each of these contains eight or nine short, punchy chapters on a narrow range of related topics with enough material to support one or two hour-long university lectures. This modular design makes it easy for instructors to customize their courses by selecting an appropriate window of coverage.

We are incredibly grateful to KITP for the valuable support it has provided to our careers, and for the importance that their leadership has placed on keeping faculty at primarily undergraduate institutions involved in the activities of the broader theoretical physics research community. In particular, we are grateful for the ways in which their actions have contributed to the development of this book. And, we are hopeful that the results will be useful to the education of many future physicists and engineers for years to come.

James Dent and Joel Walker are faculty colleagues in the Department of Physics and Astronomy at Sam Houston State University in Huntsville, Texas. Dent specializes in the study of dark matter, axions, neutrinos, and primordial black holes. Walker focuses on collider physics, neutrinos, computational algorithms, and software tools. They share a mutual interest in neutrino physics. Dent was recognized as a KITP Scholar in 2016 and 2022. Walker was recognized as a KITP Scholar in 2013 and as a KITP Fellow in 2022. They are co-authors of an upcoming textbook Physics Bootcamp: Mathematical Methods for First-Year Physics and Engineering with Cambridge University Press, which is slated for publication in 2026.

by James Dent and Joel Walker

Fueling Science at KITP, One Cup at a Time

When KITP's visitors arrive at Kohn Hall, before they dig into their science and collaborations, they wonder, "How do I get into the building? Where is my office?" And of course, *"Where is the coffee?"* The remarkable KITP staff member who is tasked with fielding these questions and many more is Bibiana Rojas, known by most as Bibi.

Bibi is KITP's Visitor Services Coordinator, an important role with a variety of responsibilities to enhance the experience for visiting scientists and ensure the day-to-day operations at the institute run smoothly. Bibi does it all; assisting visitors throughout their entire stay, administrative office work, and miscellaneous but essential tasks that she calls "filling in the gaps." Her days are full of questions and requests about anything from financial reimbursements to scheduling maintenance staff. On many occasions when other KITP staff members are approached by visiting scientists and don't know the answer to their questions, the response is often something like "Let's ask Bibi, she would know." Or, when a perplexed physicist is wandering the halls in search of their office, they inevitably end up at Bibi's desk.

KITP's Financial Manager, Amy Burgard, describes Bibi as "a pleasure to work with and an essential member of the KITP team. She handles her role as Visitor Services Coordinator with efficiency and provides our visitors with excellent support. She never hesitates to offer help where needed, often going above and beyond without being asked."

Bibi's admirable work ethic is demonstrated by her long workdays between KITP and her other position at Michaels Arts & Crafts in Goleta. She skillfully balances her time between jobs, raising two children, and maintaining a social life. As a native to Santa Barbara, her family and friends are all local or close enough to see on the weekends, so she takes every opportunity she can to go to Dodgers games, concerts, or travel. When she goes to her favorite local restaurants, it's more than likely everyone working will know her by name—she makes friends nearly anywhere she goes.

Her social, outgoing nature makes Bibi a great fit for her role, as does her ability to address concerns and solve problems directly with grace. Communication with visitors from such diverse backgrounds can be challenging when language barriers and cultural differences exist, "but we make it through," Bibi says. On the other hand, she loves learning about other parts of the world through the scientists she meets and is always curious to hear about their interests or cultures. In most cases, they are out of the routines and environments most familiar to them. Taking the time to get to know KITP's visitors is not only interesting for her, but it also undoubtedly makes visitors more comfortable and feel a greater sense of belonging when they're at the institute.

Flip Tanedo, Associate Professor at UC Riverside, has been coming to KITP nearly every year since 2016. As the holiday cards from Flip that are pinned to the walls of Bibi's office suggest, he knows the KITP staff and Bibi well. He shared that "Bibi is the first person who greets us and she always makes us feel welcome and taken care of. Her warmth and patience make it easy for us to feel at home at KITP." As Flip conveys, Bibi treats people with fairness, kindness, and a playful sense of humor that gets a chuckle out of even the most serious of the institute's scientific visitors.

If it isn't her joyful laugh and friendly demeanor that scientists are drawn to, then it may be the fact that she is the person who keeps coffee and cookies flowing through Kohn Hall by managing an impressive stockpile. Bibi knows more than anyone that "coffee is essential when you're visiting KITP," and half-jokingly reminds people to also drink water sometimes.

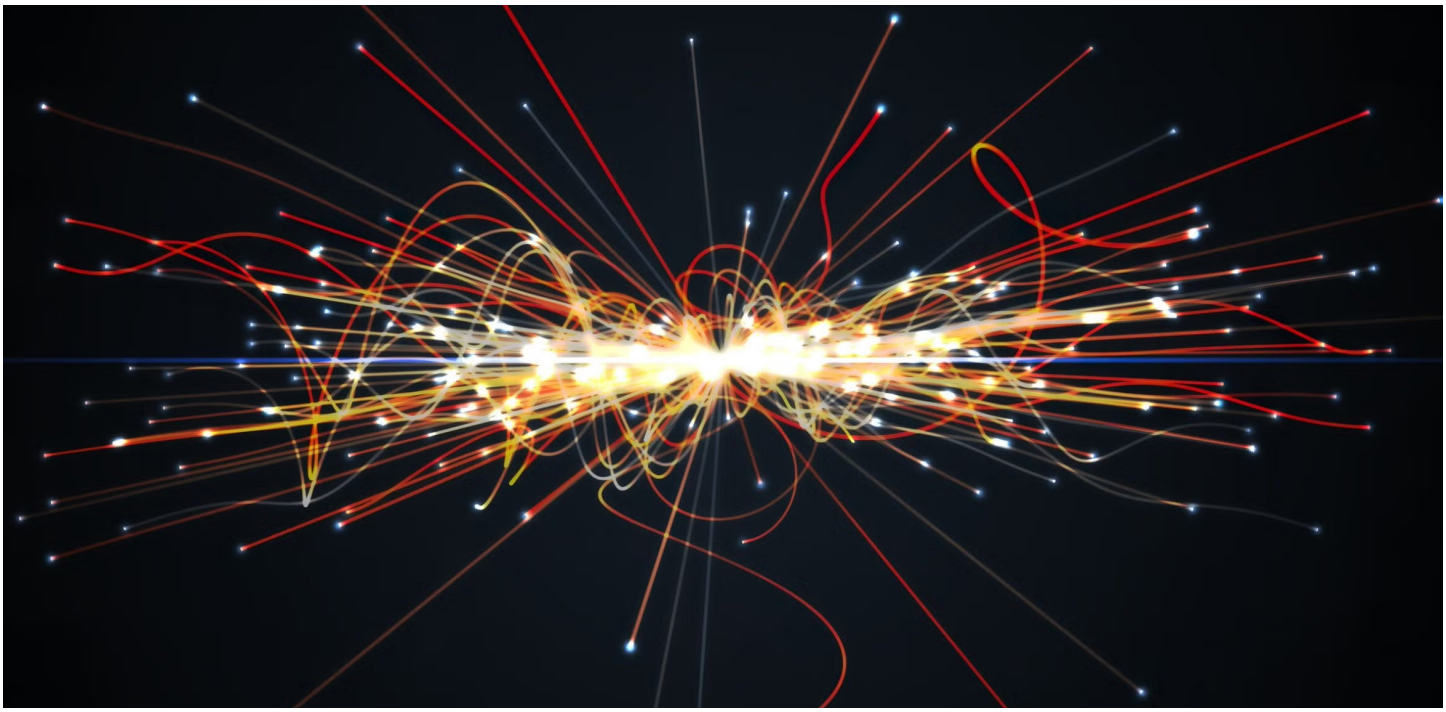
Anyone who has ever visited or worked at KITP also knows about the infamous daily cookie tradition. Bibi is responsible for making sure a platter of cookies and large coffee carafes are set out for visitors by 3:15pm each afternoon. While they can access coffee any time during the day, the addition of a sweet treat brings scientists together to connect with anyone who happens to be in the building. When asked for feedback about their experience, visitors emphasize how many new projects, paper ideas, research directions, and connections have resulted from this informal gathering. It is a simple way the institute enables spontaneous, cross-disciplinary exchanges that often have far-reaching effects on science. Or sometimes it may spark new friendships between scientists who wouldn't have otherwise interacted.

Like many of the comforts and conveniences enjoyed at KITP, staff and visitors of all kinds are grateful to Bibi for the extra fuel, laughter and connection that she provides.

by Demi Cain
KITP Development Coordinator

A Rewarding Dissertation on the Strong Nuclear Force

KITP Postdoc Bruno Scheihing-Hitschfeld is awarded for outstanding dissertation in nuclear physics by the American Physical Society



3D rendered illustration of particle collision

Our account of the strong nuclear force is full of imaginative terms. Six flavors of quarks have color charges of red, green and blue, which dictate how they bind to form particles like protons and neutrons. Gluons mediate these interactions in a system called quantum chromodynamics, though its relation to color is in name only.

KITP Postdoctoral Scholar Bruno Scheihing-Hitschfeld has received the American Physical Society's award for dissertations in nuclear physics for his theoretical work on this fundamental force done for his PhD at MIT. The distinction "recognizes doctoral thesis research of outstanding quality and achievement in nuclear physics."

"I feel like there's this piece of work that I put together over five or so years that the physics community appreciates," said Scheihing-Hitschfeld.

"It's wonderful that Bruno has received this important recognition of his path-breaking work," said Lars Bildsten. "As a KITP Postdoc, he's now actively exploring new scientific directions and taking full advantage of our institute's strength of being the place to forge new collaborations. He's off to an amazing start in just his first year."

Scheihing-Hitschfeld studies the fundamental particles found in the atomic nucleus, called quarks and gluons, and the strong nuclear force that binds them together. He's interested in how they behave under extreme conditions, like in particle accelerators or within the first millisecond after the Big Bang.

At these energies, protons and neutrons dissociate into a phase of matter called quark-gluon plasma. "In this state, the quarks and gluons are no longer confined inside nuclei, but rather they are released from their nuclear bindings," Scheihing-Hitschfeld explained. They're not exactly free—the strong nuclear force still affects them—but they're better thought of as interacting by themselves as opposed to within the protons and neutrons that they regularly form.

Experimentalists can recreate these conditions by smashing heavy ions, like atoms of gold, at relativistic speeds. The plasma forms and dissipates within ludicrously short timeframes: 10^{-23} seconds, or a few dozen yoctoseconds. "It's essentially the time it takes for light to travel across these atomic nuclei," Scheihing-Hitschfeld said.

Fortunately, this is also just about the amount of time the plasma takes to settle to a fluid state that evolves according to the laws of hydrodynamics, expanding due to its own pressure. The first part of Scheihing-Hitschfeld's dissertation examines how this unfolds.

Scheihing-Hitschfeld developed a new approach to describe this process based on kinetic theory, a well-studied framework often used to model gasses. Kinetic theories characterize the behavior of a fluid in terms of the motions and interactions between its constituent particles. This approximation provides a more familiar place from which to build a description of the plasma. "One of the things we do as theorists is to write equations that approximately describe what is going on, and then we start adding layers and layers of complexity to get a better and better description," he said.

Bruno Scheihing-Hitschfeld

Scheihing-Hitschfeld and his collaborators developed a framework to isolate the particular aspects of the system that govern how it evolves from initial conditions to a hydrodynamic plasma. They demonstrated how, as the unstable plasma transitions to a fluid, the number of variables you have to track in order to describe the system drops. In other words, most of the characteristics of the initial condition are lost once the transition is complete. This formalization provides insight into how the earliest stages of the Big Bang unfolded, insights we can actually test in heavy-ion particle colliders.

The second part of his thesis investigates the behavior of composite particles that form in this plasma to learn more about the inner workings of the strong force.

Quarks come in six varieties, or flavors, of increasing weight: up, down, strange, charm, bottom and top. And each has its own antimatter counterpart. The charm, bottom and top quarks are each heavier than a proton or neutron, which consist of up and down quarks.

Despite the absurd energy density of a quark-gluon plasma, the strong nuclear force can often still bind these quarks together into composite particles. Scheihing-Hitschfeld is interested in quarkonium particles, which are made from one of the three varieties of heavy quarks (charm, bottom and top) bound to its own antimatter counterpart (charm antiquark, bottom antiquark and top antiquark). These pairs are inherently unstable, yet charm and bottom quarkonium particles can exist long enough to have meaningful interactions within the plasma.

As its name suggests, a pure quark-gluon plasma is a sea of dissociated quarks and gluons. But a typical heavy ion collision won't reach a high enough temperature to completely melt the quarkonium particles that may form. How long the quarkonium stays together depends on the energy of the plasma itself.

Scheihing-Hitschfeld and his coauthors formulated a way to calculate how quarkonium melts in the plasma, set in the framework of quantum field theory. The result accounts for the most relevant subtleties and adds some mathematical components that the authors noticed were missing in other descriptions of the system. Their framework provides a starting point for computational calculations to begin.

Now Scheihing-Hitschfeld plans to combine the tools he's developed with the tools he's learned to further explore complex quantum phenomena like quark-gluon plasma. While his own interests lie in understanding the strong force, his research also carries insights for strongly coupled quantum systems in other disciplines, such as condensed matter physics, materials science and quantum computation.

"One of the nice things about theoretical physics is that sometimes the conceptual framework to think about a problem is not specific to that problem," Scheihing-Hitschfeld said. "You can apply it to many other physical scenarios that may actually come from an entirely different setup."

Studying quantum chromodynamics provides a glimpse into some of the most fundamental aspects of our universe, however the field's practical implications are sure to surprise us when they appear. "We never know when discoveries or new pieces of understanding will have unexpected consequences in the long distant future," Scheihing-Hitschfeld said. "People didn't know how impactful the development of electrodynamics would be over a hundred years ago, and now it's all around us: our phones, cars, TVs, even artificial intelligence."

Scheihing-Hitschfeld received the award in October 2025 at the APS Division of Nuclear Physics' fall meeting, where he gave an invited talk on his research.

by Harrison Tasoff
Science Writer, UCSB Public Affairs & Communications

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