Kavli Institute for Theoretical Physics
UC Santa Barbara

Newsletter

Winter 2015

Lars Bildsten, KITP Director.

2014 was quite the year for KITP. We ran programs across all of theoretical physics for nearly a thousand international physicists, received international recognition of our researchers' (both permanent faculty and postdocs) science impact, and delivered an expanded outreach program ably led by Deputy Director Greg Huber. Our scientific programs bring together physics leaders for extended periods of intense interaction, driving new collaborations and, sometimes, founding new fields of research. This is our hallmark, and I constantly thank the able KITP staff who make it all happen seamlessly for our visitors.

One of my major goals is to further enhance the scientific experience of our visitors by housing them in one comfortable location, designed with our unique clientele in mind: physicists who just need to keep interacting! This Residence project was started in Winter 2012 with the support of KITP Director David Gross and the UC Santa Barbara administration. On July 4, 2012, only three days after becoming Director, I met with Charlie Munger to discuss the project. That initial interaction led to a wonderful collaboration that is active even now while under construction. Charlie cares deeply about the success of our project and its enhancing influence on our mission. I can't imagine a better partner to work with. Thank you, Charlie!

An integral part of KITP's research is carried out by young scientists (we call them associate specialists or postdocs) who have just finished their PhD and come to the KITP to dive deep into their research. They come here to avail themselves of the broad range of physics we offer, and we encourage and support them to cross the traditional boundaries.

This year, three of our former postdocs, Sean Hartnoll (now faculty at Stanford University), Shinsei Ryu (now faculty at University of Illinois), and Tadashi Takayanagi (now faculty at Kyoto University), were among the recipients of the 2015 New Horizons Prize awarded by the Breakthrough Prize Foundation. All three received the award for work begun at the KITP. This work created a new field, which connects the physics of black holes to the behavior of ordinary condensed matter systems. Hartnoll showed that the properties of an exotic state known as a quantum critical point could be related to those of a black hole. Ryu and Takayanagi discovered holographic entanglement entropy, which relates the quantum entanglement of matter to properties of the black hole horizon, and which may be a key to the origin of spacetime. This continues a long KITP tradition of interdisciplinary work in high energy physics and condensed matter physics.

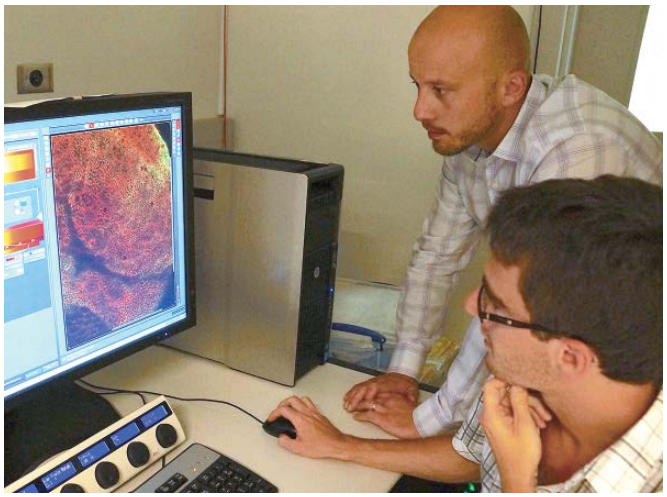
I encourage all of you to engage with the KITP, either by attending our Public Lectures, joining the Friends of the KITP, or making an impactful philanthropic gift. Our needs remain substantial, as evidenced by the overwhelming desire of physicists from around the world to visit and participate in our programs, as well as the young postdocs who choose to kick-start their professional career with us here at the Institute.

– Lars Bildsten, KITP Director

The Dynamics of Morphogenesis

New approaches to quantifying how animals acquire shape and form

It's a summer course like no other at UC Santa Barbara or anywhere else. Spread between the lecture halls of the campus' Kavli Institute for Theoretical Physics (KITP) and labs in the California NanoSystems Institute (CNSI), the Santa Barbara Advanced School



GEORGE FOULSHAM

Nicolas Loyer, a French Ph.D. student (seated), and Leica technical representative, Olivier Brun, look at an image of a fruit fly wing disc.

of Quantitative Biology was abuzz with activity in 2013. Here, participants from around the world — graduate students, postdoctoral fellows and even science faculty members — rub shoulders with leading experts in the field and shed new light on the dynamics of morphogenesis. Morphogenesis is the process that converts the genetic blueprint of a multicellular organism into complex physical structure.

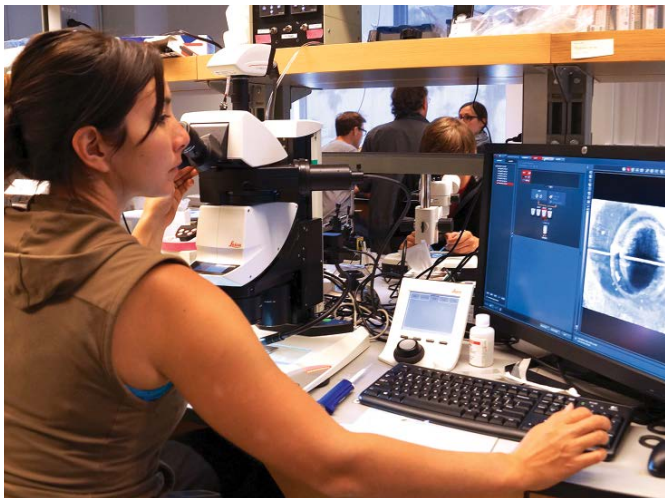
"This program is really unique in that it's incredibly interdisciplinary," said Michelle Dickinson, a senior lecturer (assistant professor) at the University of Auckland and a student in the course. "It's physics combined with biology, and technically I'm an engineer so it combines engineering, too. It's a great place to meet world leaders and experts, and live and eat and breathe the science that we're trying to solve."

The course, "New Approaches to Morphogenesis: Live Imaging and Quantitative Modeling," presented by KITP and CNSI, brings together close to 100 international scientists from various fields to collaborate on the problem of animal development. "Quantitative biology is really a major construction project in science and so is a very natural focus for an interdisciplinary school," said Boris Shraiman, Susan F. Gurley Professor of Theoretical Physics and Biology, permanent member of KITP and a founding co-director of the course. "Our special take on quantitative biology is to bring theoretical modeling together with experiments and integrate it and make it part and parcel of the biological method."

Years in the making, the course is designed to advance late Scottish biologist and mathematician D'Arcy Thompson's agenda of quantitative description outlined in his 1917 book, "On Growth and Form." But almost a century later, these scientists are using the full power of modern imaging and molecular genetics, which makes the field ready for rapid progress. "We designed it in such a way that these experiments would be open-ended," noted Shraiman. "We hope new collaborations will form and the work started here will continue."

On the technical level, the course introduces several model organisms, including fruit flies, roundworms and sea squirts, and provides instruction on live imaging, micro-manipulation and genetic and chemical perturbations as quantitative tools to study developmental dynamics.

"We were able to draw on the research strength of our faculty colleagues on campus, several of whom —Denise Montell and Bill Smith from the Department of Molecular, Cellular and Developmental Biology and mechanical engineering professor Otger Càmpas — are engaged in running experimental projects," said Shraiman.



GEORGE FOULSHAM

Michelle Dickinson, a senior lecturer at the University of Auckland, works on C. elegans' early embryonic development.

The morphogenesis course also got outside help from such experts as Thomas Lecuit, a group leader at the Developmental Biology Institute of Marseilles. In his UCSB project, students built a single-plane illumination microscope (SPIM) and then used it for imaging rapid developmental processes taking place in fruit flies and sea squirts.

Another project, led by Thomas Gregor, an assistant professor of physics at Princeton University, examined with near molecular precision the spatiotemporal dynamics of gene expression in the fly embryo. Other projects focused on spatial arrangement and rearrangement of cells in developing tissues and on temporal fluctuations and oscillations that control cell differentiation and tissue patterning.

"What's clear is they've got the right people, people with expertise from all over," said Seth Donoughe, a Harvard graduate student who worked on the SPIM project. "My fellow students have tons of experience, lots of expertise in different areas. In terms of getting exposure to scientific stuff that people are doing and thinking, it couldn't be better."

– Julie Cohen, UCSB Public Affairs & Communication

Funding Boosts Quantum Materials Theory Research

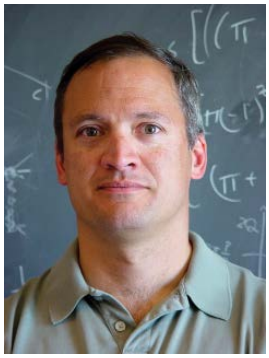
KITP to receive $1.5 million over five years to support Moore postdoctoral scholars

At a time when many scientific organizations are challenged by shrinking budgets, the new Emergent Phenomena in Quantum Systems (EPiQS) initiative will help scientists understand quantum materials in new ways and pave the way for potentially world-changing technological applications.

EPiQS, a program of the Gordon and Betty Moore Foundation, has recently awarded $1.5 million over five years to Kavli Institute for Theoretical Physics (KITP) to establish the Moore Postdoctoral Theory Scholars Program. These scholars will have appointments of up to three years at KITP.

"The award will enable us to competitively attract the best scholars in the field who find the prospect of being named a Moore Postdoctoral Fellow — especially here at the Kavli Institute for Theoretical Physics, which is already one of the preeminent institutions for theoretical physics in the world — to be doubly appealing," said principle investigator (PI) Leon Balents, a permanent member of the KITP and a professor in UCSB's Department of Physics. Matthew Fisher and Cenke Xu, professor and associate professor of physics, are co-PIs.

In the field of condensed matter physics, quantum materials present largely uncharted ground for study and immense opportunity for discovery. Quantum materials are substances that become endowed with unusual properties — such as superconductivity, forms of magnetism and other electronic qualities — as a result of the quantum physics of their electrons. These phenomena often elude prediction, even when the properties of the individual particles that constitute these materials are well understood.



Leon Balents, Permanent Member.

Now, with advances in theory, nanotechnology and quantum control of matter, fresh opportunities have surfaced for examining emergent properties of quantum materials. "We're very excited by the prospect of working with the Moore Foundation to advance the study of quantum phenomena and materials," said Balents. "Receiving this award cements our position as one of the leading institutions in the theory of quantum matter."

– Julie Cohen, UCSB Public Affairs & Communication

Professor Polchinski Wins 2014 Physics Frontiers Prize

Theoretical physicist Joseph Polchinski is recognized for work that has advanced the understanding of string theory

UC Santa Barbara physics professor and permanent member of the university's Kavli Institute for Theoretical Physics (KITP) Joseph Polchinski is one of several laureates for the Milner Foundation's 2014 Physics Frontiers Prize. According to the orga¬nization, this prize recognizes "transformative achievements in the field of fundamental physics and aim(s) to provide recipients with more freedom and opportunity to pursue future accomplishments." This is Polchinski's second win in two years.

"It's an honor and a surprise to receive this for a second time, especially because the selectors are some of the leading physicists in the world," said Polchinski. "This award certainly would not have happened without the stimulating environment at UCSB and the Kavli Institute for Theoretical Physics. I'd like to acknowledge all my colleagues, but especially my collaborator Don Marolf, who has helped generate some recent excitement."

Polchinski was nominated for his contributions to quantum field theory and string theory. His discovery of D-branes — a type of membrane in string theory — has led to advances in the understanding of string theory and quantum gravity.

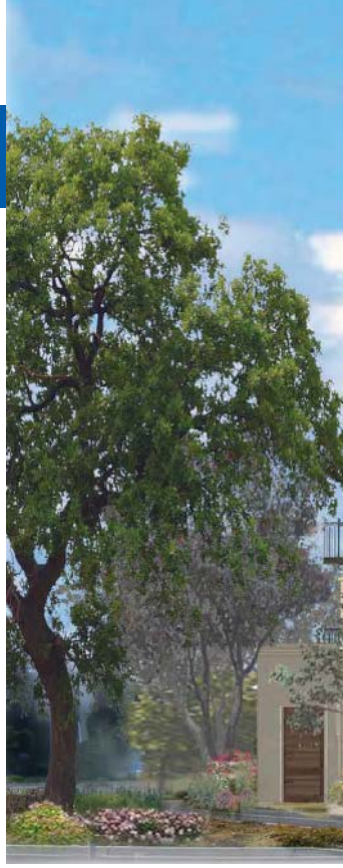
Receipt of the Physics Frontiers prize put Polchinski and fellow winners — Michael B. Green of the University of Cambridge and John H. Schwarz of the California Institute of Technology; and Andrew Strominger and Cumrun Vafa of Harvard University — in the running for the $3 million 2014 Fundamental Physics Prize. Polchinski was also a 2013 Physics Frontiers Prize winner; however the top prize, the 2013 Fundamental Physics Prize, went to Princeton University professor Alexander Polyakov. The selection committee for the 2014 Physics Frontiers Prize, which includes Polyakov and other Physics Frontiers Prize laureates, renominated Polchinski for the award.

Joseph Polchinski, Permanent Member.

"It is wonderful that Joe continues to be recognized for his ongoing fundamental work in theoretical physics," said Lars Bildsten, physics professor and the director of KITP. "His recent work with UCSB colleagues on the nature of black holes generated so much excitement that we needed to organize a two-week KITP program just to bring together all the world's experts to debate their hypothesis!"

– Sonia Fernandez, UCSB Public Affairs & Communication

INVESTING *in the* KITP



With $65 million gift, business titan Charlie Munger invests in Residence for KITP Visitors

Charlie Munger was first introduced to physics as a college student in 1941. That particular encounter was rather brief — World War II saw to that — but the hard science made a strong impact.

After his service with the Army, Munger went on to become first a lawyer, then an investor — arguably one of the world's best. Today, as he has since 1978, he helps helm Berkshire-Hathaway with friend and business partner Warren Buffett. And still he credits physics, and its fundamental approach to problem-solving, for some of his success.

"Physics has enormously helped me in life — the logic and power of it," Munger said. "Once you see what a combination of calculus and Newton's laws will do and the things you can work out, you get an awesome appreciation for the power of getting things in science right. It has collateral benefits for people. And I don't think you get a feeling for the power of science — not with the same strength — anywhere else than you do in physics."

Charlie Munger and Lars Bildsten.

He'd put money on it. And he is.

With a gift of $65 million to UC Santa Barbara, Munger is funding a new visitor housing facility for the Kavli Institute for Theoretical Physics (KITP), the world's leading collaborative study hub of its kind. Funded continuously by the National Science Foundation since 1979, the KITP also receives additional operational support from the Burroughs Wellcome Fund, the Kavli Foundation, the Gordon and Betty Moore Foundation, the National Institutes of Health and the Simons Foundation.

Construction of the KITP Residence by The Towbes Group Inc. began in October 2014, and should be complete in two years. Munger's gift to fund the project is the largest single donation to UCSB in its history.

"The Kavli Institute for Theoretical Physics has been hosting thousands of the world's top scientists since 1979. It is being emulated by numerous universities and is the envy of the physics community all over the world," said UC Santa Barbara Chancellor Henry T. Yang. "We are absolutely thrilled and honored that through Charlie's vision, unbelievable generosity, his love of physics, and his unique architectural and engineering genius and passion, we have been gifted such an unimaginable guesthouse for the visitors of KITP to enjoy and to enable them to continue their groundbreaking research at the endless frontier of physics."

Distinguished theoretical astrophysicist Lars Bildsten, director of KITP and the Gluck Professor of Theoretical Physics at UC Santa Barbara, characterized Munger's donation as a game-changer for the institute which is already an international model for facilitating productive and sustained scientific collaboration.

"KITP's mission is to bring together the world's leading scientists to collaborate on the most challenging and exciting questions in theoretical physics and related fields," Bildsten said. "Charlie's commitment to this mission is profound. Our visitors now spend their day in Kohn Hall, the center of interactions, but once the Residence is complete they will continue those interactions into the nights and weekends. I'm confident we will see an increased number of collaborations and scientific progress."

The three-story KITP Residence will provide housing for the visiting scientists — including preeminent physicists from across the globe — who participate in the institute's programs each year. The design was achieved through a yearlong collaboration led by Munger that included Bildsten, KITP Housing Coordinator Monica Curry, Murray Duncan Architects, and the architect of record, pk:architecture. More importantly, with a variety of common areas meant to foster informal and impromptu gatherings, it will enable the continuation of synergistic interactions that are both a hallmark of KITP's programs and a cornerstone of theoretical science.

That latter point was among Munger's motivations for his own big investment at the Kavli Institute in particular.

"There is no place like KITP anywhere else — and no better programs — so it's a great thing to be able to give them a nice home of their own," Munger said. "Also physicists gain enormously from knowing one another and talking to one another and trusting one another. That's been recognized for a great many decades, but for a long time it just wasn't feasible. Now we can get people together from all over the world and these people can cross-fertilize each other. Physics is getting so hard now, they need all the help they can get. This is a hugely important thing. This isn't a field where we want to be behind."

Carlos Frenk can speak to that.

A rendering of the East entrance to the Kavli Institute for Theoretical Physics (KITP) Visiting Scholar's Residence, a three-story, 75,000-square-foot facility to house the visitors to the KITP. Common space inside and outside will allow for continued scientific interactions for the hundreds of visiting scientists who come to the KITP every year for programs in theoretical physics. Credit: Murray Duncan Architects

Winner of the Gold Medal of the Royal Astronomical Society in 2014, now-renowned cosmologist Frenk spent six months at UCSB in 1983-1984, for a program at what was then known as ITP (it was named for prolific physics benefactor Fred Kavli in 2002). That extended program on the structure of the universe would become, in Frenk's words, a "landmark workshop."

> ***"Physics is vitally important. Everyone knows that."***
>
> **Charlie Munger**
> ***The New York Times* (Oct. 24, 2014)**

"What emerged from that program, to put things in context, was later to be recognized as the standard model of cosmology," said Frenk, director of the Institute for Computational Cosmology at UK-based University of Durham, where he is also the Ogden Professor of Fundamental Physics. "Something of this magnitude happens once in a generation. What did it?"

"Many factors came together, and the subject was ripe for a breakthrough," Frenk continued. "But the nucleus of our group, we were all housed in the same building. That erased any boundaries between work and life, one just merged into the other. One of the key ideas that came out happened by the pool. The freedom of no walls, an informal environment — that's a key part of theoretical science. Sparks fly, electricity is created and that, I think, is vital to the creative process."

Whether those sparks result in a breakthrough as they did for Frenk, or lay the groundwork for future advancements, Munger hopes to foster that creative process for scientists around the world by way of the KITP Residence. It's yet another expression of respect for the discipline he describes as "the most powerful science."

"And, of course, UCSB having risen in my lifetime to the position it now holds in physics is a huge academic achievement. It's hard for me to think of anybody their size that's come up that fast," continued Munger, whose grandson is a UC Santa Barbara alumnus. "This residence is going to be hugely helpful to UCSB. This building will be about as good as it can get and offer as good an experience as a physicist can have — and I don't think you could have a better place on earth to do it."

Munger came to the project, and to KITP, by way of close friend Glen Mitchel, who lives in Santa Barbara. A regular visitor to institute events and public talks, it was Mitchel who first heard about the housing project from Bildsten and shared it with Munger during one of their frequent fishing trips.

"The more Charlie looked into it and saw the importance of KITP and the colloquia they hold, how prestigious it is and the quality of people they attract, he became so enthusiastic he spent hours hand-drafting plans for a residence in accordance with his thoughts," Mitchel said of Munger, one of his best friends of 60 years. "That's how it's progressed. Charlie has been involved all the way along — helping design even the lay out of apartments so they're the most efficient for this use. His ideas have been welcomed and worked into the picture. Of course he's a brilliant guy and he's capable in many areas. He's done a remarkable job here. This building is going to be absolutely fabulous."

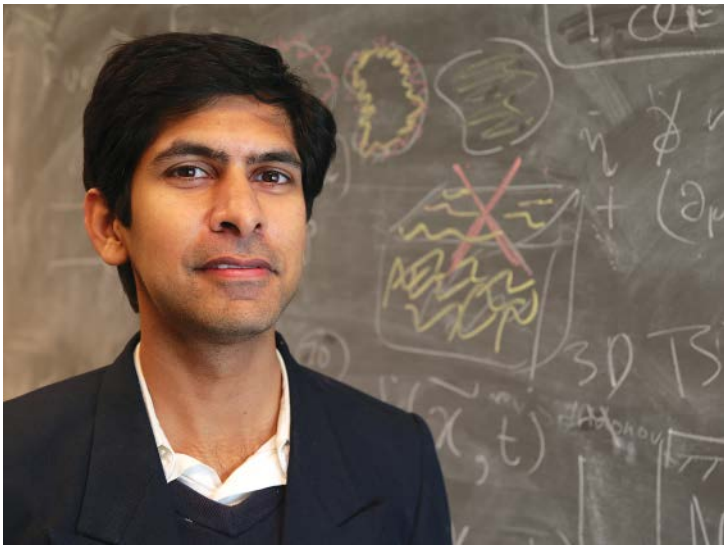
– Shelly Leachman, UCSB Public Affairs & Communication

One Kind of Supersymmetry Shown to Emerge Naturally

Tarun Grover outlines how this unique phenomenon occurs in a condensed matter system

UC Santa Barbara physicist Tarun Grover has provided definitive mathematical evidence for supersymmetry in a condensed matter system. Sought after in the realm of subatomic particles by physicists for several decades, supersymmetry describes a unique relationship between particles.

"As yet, no one has found supersymmetry in our universe, including at the Large Hadron Collider (LHC)," said the associate specialist at KITP. He is referring to the underground laboratory in Switzerland where the famous Higgs boson was identified in 2012. "This is a fresh insight as to how supersymmetry arises in nature." The findings of Grover's research, conducted with colleagues Donna Sheng and Ashvin Vishwanath, appeared in the journal Science in April 2014.



SPENCER BRUTTIG

Tarun Grover, Associate Specialist, KITP.

The fundamental constituents of matter — electrons, quarks and their relatives — are fermions. The particles associated with fundamental forces are called bosons. Several decades ago, physicists hypothesized that every type of particle in the Standard Model of particle physics, a theory that captures the dynamics of known subatomic particles, has one or more superpartners — other types of particles that share many of the same properties but differ in a crucial way.

If a particle is a fermion, its superpartner is a boson, and if a particle is a boson, its superpartner is a fermion. This is supersymmetry, a postulated unique theoretical symmetry of space.

While the Standard Model governing the ordinary world is not supersymmetric, it is often theorized that the more "fundamental" theory relevant to very hot systems, such as those probed in high-energy particle accelerators like the LHC (or higher energy ones yet to be built), might exhibit supersymmetry. This has yet to be proved or disproved by accelerator experiments.

However, through their calculations, Grover and his co-authors show that supersymmetry emerges naturally in a topological superconductor. An example is helium-3, a light, nonradioactive isotope of helium with two protons and one neutron (common helium has two neutrons). When helium-3 is cooled to almost absolute zero (0 Kelvin), it becomes a liquid superconductor. As understood only recently, the boundary of its container features fermions.

"The reason these fermions exist is related to time-reversal symmetry, which is unrelated to supersymmetry," said Grover. A video of an object tossed vertically up in the air is a good example of time-reversal symmetry. When the video is played back, it shows the object following the same parabolic trajectory through the air as it did when the video was played normally. "We wanted to see what would happen to these fermions when time-reversal symmetry was broken," Grover explained.

The scientists theorized that the application of a specified amount of magnetic field to the surface of the container would break the time-reversal symmetry. This, in turn, would cause the fermions to disappear due to their interaction with bosons that already exist in the liquid helium-3. Grover and his coauthors found that right at the point when fermions are about to disappear, the fermions and the bosons behave as superpartners of each other, thus providing a condensed matter analog of supersymmetry.

According to physicists, if supersymmetry can be proved in high-energy experiments, it opens the door to answers that physicists have been seeking for years and may pave the way to analyze and even integrate different fundamental physics theories such as quantum field theory, string theory and Einstein's relativity.

"Grover's team shows that supersymmetry may be studied in low-energy experiments," said physics professor Leon Balents, Grover's colleague at KITP. "This would be amazing in its own right and could serve as an inexpensive tabletop model for what to look for at particle accelerators."

"Our paper provides insight into how and in what systems supersymmetry may emerge in a very natural way," Grover said. "Maybe it doesn't exist in our actual universe, but there exist these condensed matter systems, such as topological superconductors, where supersymmetry can exist. This opens the window for experimentalists to go and test supersymmetry and its exciting consequences in real life."

– Julie Cohen, UCSB Public Affairs & Communication

Kavli Institute for Theoretical Physics Bolsters Research Connections

Program draws professors who teach at primarily undergraduate institutions

You could call UC Santa Barbara's Kavli Institute for Theoretical Physics (KITP) a kind of seaside physics resort. For physicists and the like, KITP is a treat for the mind, augmented by the beauty of the campus and near-perfect weather.

"I absolutely love the place," said Janna Levin, associate professor of physics and astronomy at Barnard College in Manhattan and a KITP Scholar from 2010 to 2012. "I think it's such an inspiring environment. I love the workshops and the open time for spontaneous collaboration, the chance just to talk and think and work out new possibilities."

SPENCER BRUTTIG

KITP Scholar Dimitra Karabali and Nobel Laureate David Gross discuss the finer points of physics.

Celebrating its 35th anniversary, KITP is a pioneering scientific research facility where theorists in physics and allied fields congregate for sustained periods of time to work together intensely on a broad range of questions arising from investigations at the leading edges of science. The breadth of topics ranges from cosmology and biology to string theory, climate science and geophysics, as well as covering such traditional physics fields as condensed matter, particle physics, atomic physics, optics, turbulence and complexity.

The KITP Scholars program was established in 1998 by David Gross during his tenure as KITP director. One of six Nobel laureates at UCSB, Gross is a permanent member at KITP and a professor in the Department of Physics.

"I thought KITP was not taking advantage of its uniqueness or leveraging its possibilities," Gross said. "My idea was to run a program where we could give physics professors with heavy teaching loads the opportunity to get the stimulation they need in order to continue their research careers. The KITP Scholars program has been more successful than I ever imagined."

The program awards funds to cover a total of three visits and up to six weeks of local expenses to be used over a period of up to three years, usually two weeks per year. Approximately eight scholars are chosen each year, with a total of more than 100 awards to date.

One of the unique aspects of the KITP Scholars program is the fact that everyone is equal, whether they come from a graduate-degree-granting university or a primarily undergraduate institution. "Everyone is a visitor and nobody is asked to do anything except to interact and do physics and talk and lecture and learn," Gross said. "It can be the scientific highlight of their year."

"The KITP Scholars program addresses the needs of people in undergraduate institutions," said Dimitra Karabali, professor in the Department of Physics and Astronomy at Lehman College, part of the City University of New York (CUNY). "Being faculty there can be challenging, because compared to major research universities, there is more teaching, more administrative duties and, most importantly, not enough research-active people to talk to."

A KITP Scholar from 2000 to 2002, Karabali is in the middle of a second term (2013-2015). "Every time I visit KITP, it gives me an opportunity to hear new developments in my area, learn new techniques, interact with people and maybe get ideas for future projects," she said.

Cross-pollination is at the heart of the KITP Scholars program. "One good thing about this place is its mixture of people doing different physics, so there is a lot of tolerance for questions," said three-time KITP Scholar Peter Orland, a physics professor in the Department of Natural Sciences at CUNY's Baruch College in Manhattan. "If I have a question or am working on a problem, I can ask people when I'm at KITP and get suggestions for resources that have the information I need. That actually happened on my last visit."

Another early KITP Scholar, Herb Bernstein, a professor of physics at Hampshire College in Amherst, Mass., made such important connections at KITP and valued the experience so highly that he went on to help form a professional organization to promote research in all areas of theoretical and computational physics at primarily undergraduate institutions.

Formalized in 2007, the Anacapa Society provides networking opportunities and disseminates information to create, in effect, a large virtual department of theorists to support their distinctive role at undergraduate institutions. In recent years, the Anacapa Society has solicited applications for the KITP Scholars program, offering a small additional stipend and a dash of prestige to those chosen as the KITP Anacapa Scholar.

"Out of each workshop and each visit, at least one idea came to fruition and became a publication or a research program," said Barnard College's Levin. "There is no question that there were collaborations that began or were solidified at the KITP. It's really in the collaborations that the magic happens."

– Julie Cohen, UCSB Public Affairs & Communication

Twinkle, Twinkle Little Star

KITP hosts physics café to begin an ongoing dialogue between physicists and the public

How I wonder what you are.

From the moment humans first beheld the stars in the night sky, people have sought an answer to that line in the well-known English lullaby.

"Humans have always tried to understand what the lights in the sky are as well as their meaning and function," Matteo Cantiello, an astrophysicist at UC Santa Barbara's Kavli Institute for Theoretical Physics (KITP), told the standing-room-only crowd at SOhO restaurant in Santa Barbara last April.

They had gathered for the inaugural Café KITP, a series whose motto is "Eat, THINK, and be merry!" to hear Cantiello's talk on "Music of the Spheres: The Secret Songs of the Stars."

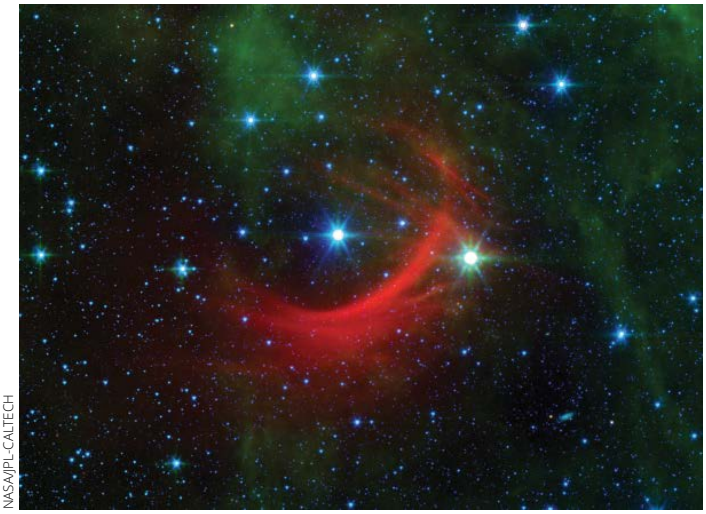
For Cantiello, the stars are singing astonishing songs. The music begins with oscillations that travel many light-years to reach Earth. Precious information about a star's deep core comes from oscillations created when the star is shaken by its own turbulent outer layers. The sound of these oscillations can be brought into the range of human hearing by shifting the pitch several octaves.

Despite their distance, stars have a greater connection to us than we might realize. In fact, as Cantiello noted, the elements of which we are made have also been produced inside a star. "Stars are not only the building blocks of the universe," he said, "but they play a very important role in the chemical evolution of the universe, and they tell us how life as we know it came to be."

Café KITP came to be as a collaboration between the KITP and its journalist-in-residence, Ivan Amato, a science and technology writer, editor and communicator based in Silver Spring, Maryland. In May 2011, Amato began the quasi-monthly DC Science Café at the local restaurant and cultural hub, Busboys and Poets, to experiment with more direct engagement with the public.

"One of the drivers for me is that science is part of culture not apart from it," said Amato. "I think the greatest gift that science has to offer is really the invitation to experience awe as science reveals how nature works."

It is awe-inspiring, indeed, to realize, as Cantiello pointed out, that stars are similar to humans, not only because both contain common elements, but also because both live and breathe and die.



NASA/JPL-CALTECH

A massive, hot supergiant, Kappa Cassiopeiae is surrounded by a streaky red glow of material in its path called bow shocks, often seen in front of the fastest, most massive stars in the galaxy.

He went on to explain that since 2009, NASA's Kepler space observatory has been surveying a portion of our region of the Milky Way galaxy to discover Earth-size planets in or near the habitable zone and determine how many of the billions of stars in our galaxy have such planets. To date, Kepler has discovered more than 3,800 planet candidates and confirmed 961 planets.

"Potentially habitable planets seem common," said Cantiello. "But it's a question of life versus intelligent life." So hundreds of thousands of years after first contemplating the night sky, humans are still wondering about the secrets of the stars.

"KITP has been instrumental in advancing astrophysics as a whole, and in nucleating some of the recent excitement in the area of asteroseismology," said Greg Huber, deputy director of KITP. "What the KITP is really good at is bringing researchers together from around the world and creating for a period the world's greatest academic department in one particular area. And we've done that for the field of astrophysics."

Café KITP takes place every few months. For information about dates and topics, visit the KITP website at www.kitp.ucsb.edu.

– Julie Cohen, UCSB Public Affairs & Communication

Engaging with KITP

There are many ways to contribute to the life of KITP.
We urge you to become involved by:

- Becoming a Friend of KITP
- Attending a public lecture or Café KITP event
- Making a Philanthropic Gift

To do so, call (805) 893-6316
or visit our website at www.kitp.ucsb.edu

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