Kavli Institute for Theoretical Physics
UC Santa Barbara

Newsletter

Winter 2016

TONY MASTRES

www.kitp.ucsb.edu

Lars Bildsten, KITP Director.

Yes, that steel you see above is at the Residence! Construction continues apace, and you can actively monitor our progress at http://www.kitp.ucsb.edu/kitp-residence.We have had a few delicate operations; read the article on page 8 to learn about one of them. We remain on pace to open for business in January 2017 and expect to have a large celebration to thank Charlie Munger for his wonderful contribution.

I want to thank all of you who contributed to KITP in 2015, more than 200 individuals! Contributions supported our Family Fund, the Career Development of our postdoctoral fellows, permanent members' research, graduate fellows, our endowment, and Friends of KITP activities. The article on page 4, written by KITP's Program Manager Maggie Sherriffs, describes the impact of the Family Fund on our visitors' ability to attend for long periods, and the articles in here about our postdocs and graduate fellows make clear their impact!

Our annual appeal caused us to tally some yearly statistics about KITP. In addition to the 300 scientific papers published in 2015, we learned that it took over 4,500 pieces of chalk and 5,500 espresso shots to achieve that science! Our KITP Online website that captures all of our talks remains a huge resource for the international community, with over 15,000 talks available. Just last year, our website was visited over 100 million times, with over 2 million downloads of those talks.

Science at KITP proceeds and our postdoctoral fellows and graduate fellows continue to shine in their research efforts. KITP has expanded our Graduate Fellows Program to international institutions, which is detailed on page 7. Description of ground-breaking postdoctoral work in both astrophysics and biology are described in this newsletter. I was particularly pleased to be personally involved in the work with Matteo Cantiello and Jim Fuller. A number of us also ran a summer school highlighting the use of the open-source code Modules for Experiments in Stellar Astrophysics (MESA) developed by KITP's Senior Fellow in Computational Astrophysics, Bill Paxton.

The growth of our efforts in quantitative biology at KITP has been greatly enhanced by the work of Professor Boris Shraiman over the last decade. Most recently, this led to a program on Olfaction that was a wonderful education for me in the intricacies of this sense. Combined with our upcoming program on Hearing, we've now nearly covered all the senses. The work of Idse Heemskerk and Sebastian Streichan on compressing bio-imaging data is described on page 6.

Please enjoy these articles. Private Foundations continue to support our efforts, with the recent renewal of Shraiman's grant to KITP from the Gordon and Betty Moore Foundation to support quantitative biology and the renewal of a $2,500,000 five-year grant from the Simons Foundation that supports our distinguished long-term participants at KITP.

We continue our minor renovations and tidying up in Kohn Hall. This year saw the installation of a new wireless system that allows our visitors to Skype from most anywhere in and around the building, and we are updating some rather dated furniture! I am very happy to report that we have finally found a place for bikes to be stored other than Kohn Hall. In the adjacent Lot 10, this space provides security and coverage, and will be more in demand when the Residence opens.

2016 will be a busy year for KITP. In addition to finishing the building, we will be applying for the renewal of our major grant from the National Science Foundation. Wish us luck!

– Lars Bildsten, KITP Director

A Cutting-Edge Research Tool

Summer school teaches astrophysicists how to use an open source computational code

More than three dozen astrophysicists from across the United States and around the world gathered at UC Santa Barbara for MESA Summer School hosted by KITP. MESA, or Modules for Experiments in Stellar Astrophysics, is a software instrument for performing simulations of how stars change over time.

"MESA is the tool for anybody in science who is studying stars," said KITP Director Lars Bildsten. "For more than half a century, we've understood at a reasonably detailed level how stars work. But it's a complicated problem that involves bringing together many different pieces of microphysics, and the computational tools necessary to do that generally have not been open source. We've made the MESA code open source from its inception 10 years ago."

SONIA FERNANDEZ

Craig Wheeler of the University of Texas, Austin, talks about massive stellar explosions.

Note the key phrase "open source," which means that anyone can download the program and use it. However, as Bill Paxton, a senior fellow in computational astrophysics at KITP and MESA's primary developer, said: "Learning to play MESA is like learning to play the piano. You're going to have to end up putting in lots and lots of hours to really get good at it."

Hence, MESA Summer School, where for the past four years undergraduate and graduate students, postdocs, professors and even avid amateurs have spent five days immersed in learning the nuts and bolts of using the program as well as how to tweak it to address their own research questions.

MESA began as a hobby for Paxton, who retired at a young age from Adobe Systems, where he worked on the development of PostScript and portable document format (PDF). He met Bildsten while auditing classes at UCSB and when Paxton exhausted the physics and math classes available, Bildsten suggested he conduct research. And the idea for MESA was born. It has evolved over the years, becoming more and more complex. This summer school intensive is one of the best ways for users to become proficient.

The specific topics covered at the summer school vary from year to year, depending on the lecturers. The 2015 lineup included Josiah Schwab, a graduate student at UC Berkeley who has been a MESA teaching assistant or lecturer for three summers. He opened the session with a technical introduction to MESA. "I really focused on how MESA works under the hood and how to change the program in order to study a particular problem," Schwab said. "The fun thing about these gatherings is getting a feel for the myriad ways people use MESA."

Astrophysicists employ MESA to understand how stars oscillate and to study stars and binaries, two stars orbiting each other. "MESA can now simulate both stars simultaneously," Bildsten explained, "even when one is dumping matter onto the other — a mass transfer. With MESA, you can actually simulate one losing mass and the other gaining mass."

Some scientists use the program to model extrasolar planets — planets that orbit a star other than the sun — and others to explore supernovae, which are massive dying stars more than 10 times the mass of the sun. MESA can calculate the full range of fusion reactions that take place in supernovae.

"This year in particular there were a lot of improvements to how MESA evolves binaries," said Monique Windju, a teaching assistant from UC Santa Cruz who made her second appearance at the summer school.

KITP astronomer Iair Arcavi (center) and a fellow MESA Summer School participant confer.

"I wanted to learn more about these new tools and get ideas about what I can do with my research topic. I also wanted to participate in astrophysics community development. Astrophysics globally is a very small community, so I'll be seeing these people in the future without a doubt."

Community building is key to MESA's success, according to Frank Timmes, a professor in the School of Earth and Space Exploration at Arizona State University. He has been involved in MESA development for more than a decade.

"We definitely try to build a sense of community both at the summer school and online," Timmes said. "The MESA Summer School is a seed for future collaboration. The participants become seeds at other places across the country and around the world for spreading the good news about this unique computational tool that is changing the way astrophysicists work."

– Julie Cohen, UCSB Public Affairs & Communication

The Nose Knows

Collaboration among international scientists is helping to resolve questions about the sense of smell

Froot Loops mascot Toucan Sam knew what he was talking about when he exhorted cereal lovers to "Follow your nose! It always knows!" But what Sam may not have realized is that all those circles, colored according to the fruit they were meant to represent, tasted exactly the same.

MATT PERKO

KITP Deputy Director Greg Huber, neuroscientist Anne-Marie Oswald and biologist Venkatesh Murthy.

Associations between visual and olfactory sensations corresponding to fruits of different colors confound the perception of taste, which is closely tied to the sense of smell. "You think each color tastes different, but the flavor is identical," said Anne-Marie Oswald, an assistant professor in the Department of Neuroscience at the University of Pittsburgh. "It's the visual perception of the different colors that makes you think they should taste different."

Oswald was one of four coordinators of "Deconstructing the Sense of Smell," an eight-week program at KITP. An international team of experimental and theoretical neuroscientists from a variety of disciplines came together to discuss the chemical, molecular, cellular, circuit and systems mechanisms that underlie neural and behavioral responses to odors.

Smell has been the most difficult of the senses to describe in scientific terms because the olfactory system is highly complex. The system must rapidly detect, identify, categorize and prepare for memory storage myriad odorants that vary in molecular structure and concentration, all while taking other sensory perceptions into consideration.

Despite an extensive body of genetic and perceptual data, scientists face obstacles in quantifying the properties of odorant molecules that lead to the perception of smell. Because subjective language is used to describe smell, researchers are limited in their ability to develop cohesive and comprehensive theories for olfaction.

"Understanding smell is a subset of understanding how the brain perceives the sensory world around us," said Sandeep Robert Datta, an assistant professor in the Department of Neurobiology at Harvard Medical School. "I think one of the challenges is that our ability to generate data far outstrips our ability to understand it. One of the main products of this program has been getting all of us together in a room to think about how we might better understand the data we have."

Olfactory processing is achieved by relatively few layers of neurons, with anatomical structures and physiological mechanisms that appear repeatedly in widely divergent species. Thus, a study of olfaction offers the promise of insight into a successful and perhaps optimal biological algorithm for processing complex information.

Driven by novel techniques, including next-generation sequencing, optogenetics and imaging/recordings in awake and behaving animals, there is explosive growth in experimental data that can newly inform theory. At the same time, a variety of proposed computational and theoretical models also can help to explain the data.

Most natural odors are mixtures of molecules, and there are hundreds of olfactory receptor types. In many animals, the olfactory sense is also used for tracking objects in turbulent environments, an issue that can benefit greatly from physical approaches. For humans, the sense of smell strongly contributes to our quality of life and is particularly vulnerable to aging and many neurodegenerative diseases.

"There is this need to understand how it works in terms of the pure science point of view," said program coordinator, Venkatesh Murthy, a professor of molecular and cellular biology at Harvard University. "But then more practically one might ask whether the sense of smell is related to human disease. There are epidemiological studies that say you are more likely to be depressed if you lose your sense of smell and that loss also may be a biomarker for neurodegenerative diseases."

The chemosensory processes of smell and taste are highly linked. Oswald illustrates this concept in some of her classes. She gives students grape-flavored candy and asks them to taste it while holding their noses. They taste only sweet. When the students let go of their noses, the grape flavor comes alive. "It's like watching light bulbs go off when they realize on a visceral level this physical connection," she said. "Smell has such quick links to our emotional processing."

The goal of "Deconstructing the Sense of Smell" has been to help parse out the biological processes that power the sense of smell. The end result has been new collaborations between theorists and experimentalists and even among those in each group. "Building on the strong tradition of fruitful collaborative interactions among scientists carrying out theoretical, experimental and computational research, we are confident this KITP program will help catalyze rapid progress in this field," said KITP Deputy Director Greg Huber, a participant in the program.

Other coordinators of "Deconstructing the Sense of Smell" were Maxim Bazhenov, an associate professor in the Department of Cell Biology and Neuroscience at UC Riverside, and Alexei Koulakov, a professor at the Cold Spring Harbor Laboratory in New York.

This program was supported by grants from the National Institutes of Health, the Gordon and Betty Moore Foundation and the National Science Foundation.

– Julie Cohen, UCSB Public Affairs & Communication

Importance of the Family Fund to Visiting Scientists

Because it takes extended interactions to substantively explore ideas together and do collaborative work, visits of several weeks to entire academic years are integral to the success of our programs. The Family Fund is a crucial resource for enabling scientists to make these extended visits to the KITP. It is especially crucial for junior faculty, who tend to have young families, and whose participation is especially important to KITP's diversity efforts. These young faculty members bring scientific talent to the institute and also experience a boost in their professional trajectories due to forming new collaborations and having increased visibility.

In calendar year 2015, we awarded $70,000 from the Family Fund to 33 recipient families. The Fund was established when a loyal housing provider to our visitors donated her home to benefit KITP, and it now receives annual contributions from many donors in the Santa Barbara community, especially Deborah and Doug Troxel.

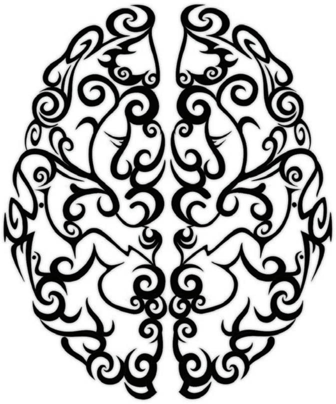
-Maggie Sherriffs, Program Manager

"I would not have been able to participate (and coordinate) the Deconstructing the Sense of Smell program at KITP for a reasonable period without the support from the KITP Family Fund... As a result, the family was very settled and happy, which allowed me, as a coordinator, to immerse myself fully into the KITP program for the entire eight week period. In fact, being an experimental (not theoretical) scientist, I've never been involved before in such an extended program - and I've become a true believer! I would now strongly encourage my colleagues to consider attending these sorts of programs at KITP, and I myself will be glad to come back to KITP. All in all, the Family Fund was crucial for my own attendance, and therefore the Smell 15 program itself, since I was a coordinator."

-Coordinator in the summer 2015 program, "Deconstructing the Sense of Smell"

Ilya Vekhter, Associate Professor of Physics at Louisiana State University, enjoying time with his toddler at a KITP gathering during his four week program visit.

Andriy Nevidomskyy, Assistant Professor of Physics and Astronomy at Rice University, is joined by his family at KITP for a nine week program visit.



KITP keeps it in the family! The program logo (above) was designed by Elena Nikanorova who is married to Alexei Koulakov, one of the Program Coordinators for "Deconstructing the Sense of Smell."

"The Family Fund enabled our family of four to spend seven weeks in Santa Barbara . . . The time we spent in Santa Barbara was enriching and productive for all of us. I started several new collaborations and worked on multiple papers with colleagues. Scientifically, this was an extremely important and productive visit for me, and the long-term nature of the stay was critical to getting the research off the ground. And this was only possible because the Family Fund enabled me to bring my family along . . . We are enormously grateful to the KITP and to the Family Fund for all these opportunities."

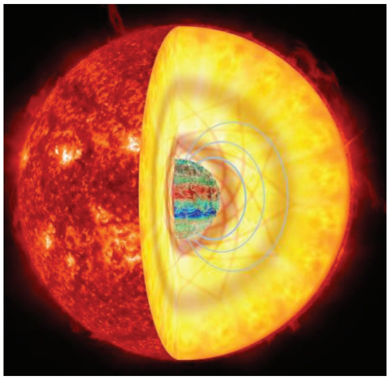
-"Deconstructing the Sense of Smell" program participant

Magnetic Hide and Seek

Researchers develop a new technique to detect magnetic fields inside stars

Magnetic fields have important consequences in all stages of stellar evolution, from a star's formation to its demise. Now, for the first time, astrophysicists are able to determine the presence of strong magnetic fields deep inside pulsating giant stars.

A consortium of international researchers, including several from KITP, used asteroseismology — a discipline similar to seismology — to track waves traveling through stars in order to determine their inner properties. Their findings appeared in the journal Science this Fall.



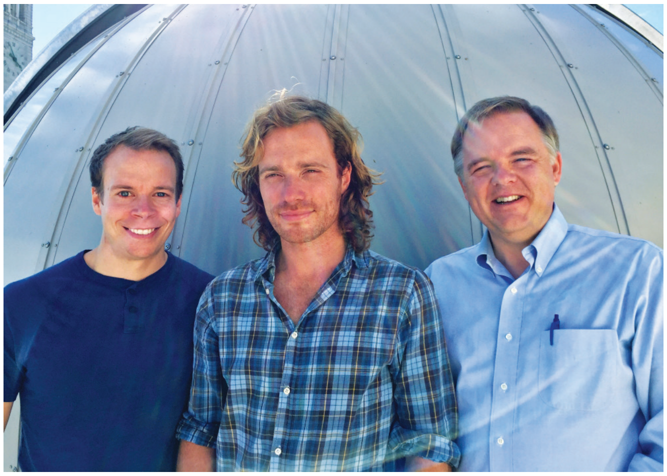
This artist's representation of a red giant star with a strong internal magnetic field shows sound waves propagating in the stellar outer layers, while gravity waves propagate in the inner layers where a magnetic field is present.

CREDIT: RAFAEL A. GARCÍA (SAP CEA), KYLE AUGUSTSON (HAO), JIM FULLER (CALTECH) & GABRIEL PÉREZ (SMM, IAC), PHOTOGRAPH FROM AIA/SDO

"We can now probe regions of the star that were previously hidden," said co-lead author Matteo Cantiello, a specialist in stellar astrophysics at KITP. "The technique is analogous to a medical ultrasound, which uses sound waves to image otherwise invisible parts of the human body."

Cantiello's curiosity and that of his co-authors was sparked when astrophysicist and KITP participant Dennis Stello of the University of Sydney presented puzzling data from the Kepler satellite, a space telescope that measures stellar brightness variations with very high precision. Cantiello, KITP director Lars Bildsten and Jim Fuller, a postdoctoral fellow at the California Institute of Technology, agreed that this was a mystery worth solving. After much debate, many calculations and the additional involvement of Rafael García, a staff scientist at France's Commissariat à l'Énergie Atomique, a solution emerged. The data were explained by the presence of strong magnetic fields in the inner regions of these stars.

The puzzling phenomenon was observed in a group of red giants imaged by Kepler. Red giants are stars much older and larger than the sun. Their outer regions are characterized by turbulent motion that excites sound waves, which interact with gravity waves that travel deep into the stellar core. Magnetic fields in the core can hinder the motions produced by the gravity waves.



BILL WOLF

Jim Fuller, Matteo Cantiello and Lars Bildsten

"Imagine the magnetic field as stiff rubber bands embedded in the stellar gas, which affect the propagation of gravity waves," Fuller explained. "If the magnetic field is strong enough, the gravity waves become trapped in the star's core. We call this the magnetic greenhouse effect."

The trapping occurs because the incoming wave is reflected by the magnetic field into waves with a lower degree of symmetry, which are prevented from escaping the core. As a result, stellar surface oscillations have smaller amplitude compared to a similar star without a strong magnetic field.

"We used these observations to put a limit on — or even measure — the internal magnetic fields for these stars," Cantiello said. "We found that red giants can possess internal magnetic fields nearly a million times stronger than a typical refrigerator magnet."

"This is exciting as internal magnetic fields play an important role both for the evolution of stars and for the properties of their remnants," Cantiello added. "For example, some of the most powerful explosions in the universe — long gamma-ray bursts — are associated with the death of some huge stars. These behemoths — 10 or more times more massive than our sun — most likely ended their lives with strong magnetic fields in their cores."

In a subsequent paper in the journal Nature, the same scientists along with additional colleagues, applied this new technique to the very precise data supplied by Kepler. Analyzing the light curves for about 3,000 stars, the team found that the presence or absence of a magnetic field depends on the star's mass.

The researchers saw a very clear dichotomy between stars with masses less than 1.1 times that of the sun and those with masses greater than 1.1. Stars close to the size of the sun did not appear to have magnetic fields in their cores, while the opposite was true of stars in the intermediate category — 1.1 to 2 times the mass of the sun — where upward of 50 to 60 percent had strong internal magnetic fields.

"Because intermediate stars are hotter and more luminous, their core is stirred by convection," Bildsten said. "This magnetic field is created by this 'boiling' pattern sequence and stored inside the star as it evolves to become a red giant. Astrophysicists have suggested this previously but it was very speculative; now it seems clear that this is the case."

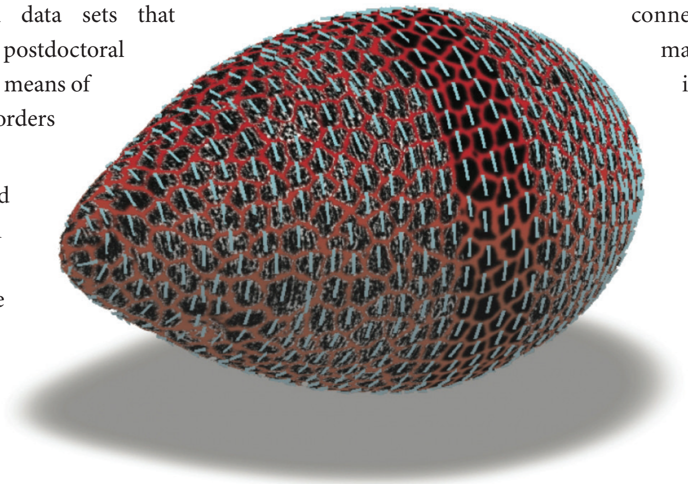
– Julie Cohen, UCSB Public Affairs & Communication

Tissue Cartography

Postdoctoral scholars have developed a way to reduce dynamic bio-image data to 2-D

Today's state-of-the-art optical microscopes produce voluminous three-dimensional data sets that are difficult to analyze. Now, two postdoctoral scholars from KITP have developed a means of reducing data size and processing by orders of magnitude.

Taking advantage of the layered structure of many biological specimens, Sebastian Streichan and Idse Heemskerk created the Image Surface Analysis Environment (ImSAnE), a method that constructs an atlas of two-dimensional maps for dynamic tissue surfaces such as the early fruit fly embryo. Their findings appear today in the journal Nature Methods.



This 3-D fruit fly egg chamber is color coded so that locations can be identified when mapped in two dimensions.

By implementing ImSAnE as an open source MATLAB toolbox, the KITP researchers provide a practical, highly accessible tool for data reduction and analysis of layered tissues. MATLAB is a high-level language and interactive environment used by millions of engineers and scientists to explore and visualize ideas and to collaborate across disciplines.

"We can now record the entire development of fruit flies from a couple hundred cells until a maggot hatches and crawls away — at a resolution that is good enough to track individual cells," Streichan said. "Such data allows us to answer basic questions about developmental biology and the role of physics in shaping the developing body," Heemskerk added.

The downside of high-resolution recordings is the resulting very large data set. "A 10-hour recording is easily 2 terabytes (TB), which exceeds the hard drive capacity of most computers and would take 100 hours to transfer with a good Internet connection," said Heemskerk. "That makes it challenging to extract the information we want from the data."

SONIA FERNANDEZ

Sebastian Streichan and Idse Heemskerk

Often in biology, the action is on a curved surface of interest. Although the recording of the cube containing this surface is 2 TB, the surface itself is only a few gigabytes. ImSAnE takes advantage of this by isolating the surface and reducing it to a number of overlapping 2-D images that contain all the same information, much like making maps of Earth, which is why they dubbed their method "tissue cartography". Cartography makes the resulting data not only much smaller but also much easier to interpret.

While ImSAnE's cartographic projections of tissue are very useful, they result in distortion similar to what happens in common Mercator projections of Earth, in which Africa and Greenland appear as the same size. However, ImSAnE automatically corrects for such warping to enable correct measurement of quantities such as cell size.

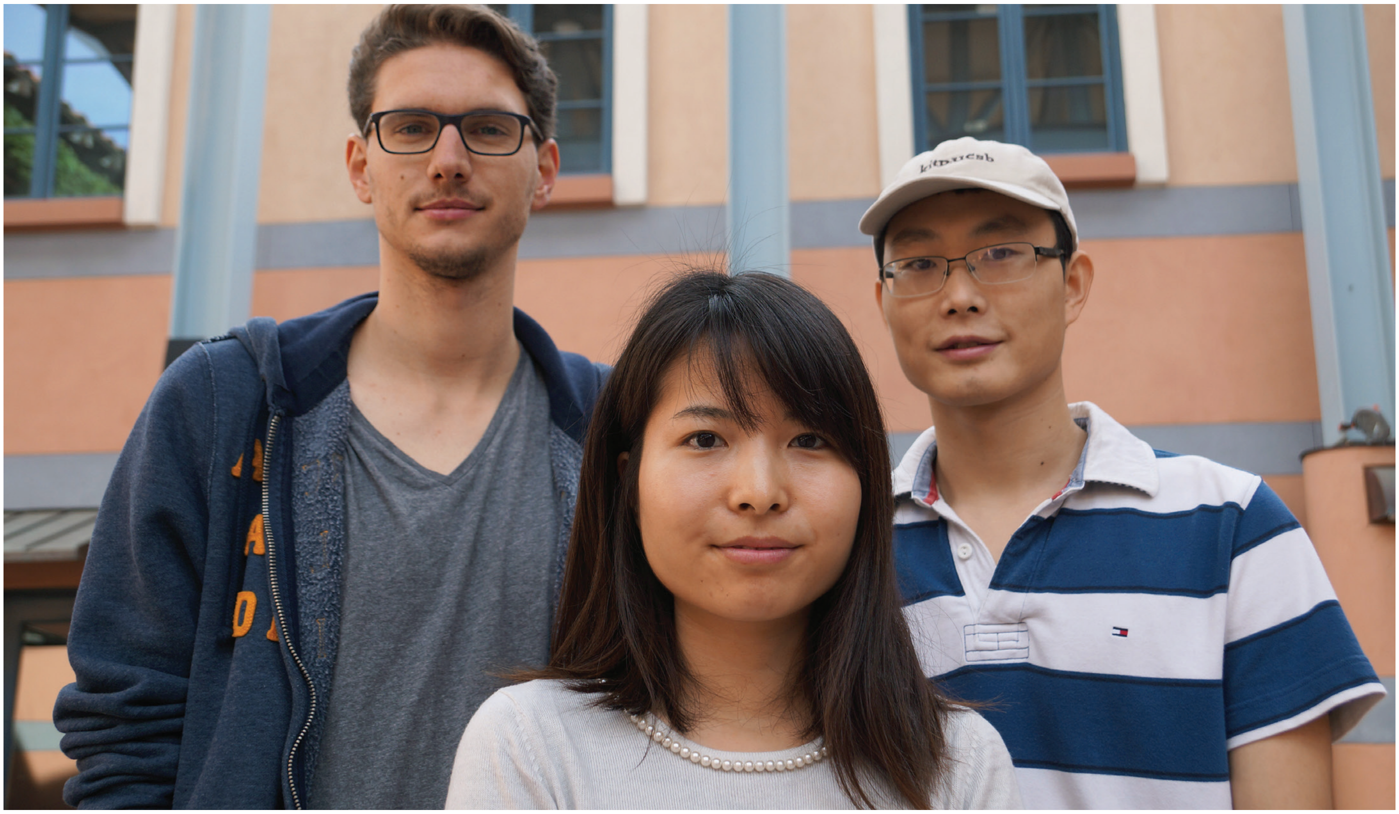
ImSAnE does this in a completely general way, even for surfaces of complicated shape that change in time. To demonstrate the power of their method, Streichan and Heemskerk decided to apply it to a live recording of a zebra fish heart, beating roughly two times per second while undergoing dramatic deformation. "By mapping it to the plane we were able to follow cells in a heartbeat," Streichan said. "So a task that used to be very hard is now becoming relatively simple."

ImSAnE allows scientists to take better advantage of cutting-edge microscopes. Analyzing certain data now takes a couple of days instead of a couple of months and requires much less computational infrastructure, saving both time and money.

"ImSAnE is an alternative to brute force 3-D data crunching that allows people to quantitatively analyze complex-shaped organs with relative ease," noted Streichan. "The program is especially useful for biologists who otherwise would have to acquire the skillset and hardware to handle large data."

This research was funded by the Gordon and Betty Moore Foundation.

– Julie Cohen, UCSB Public Affairs & Communication



SONIA FERNANDEZ

Thomas Scaffidi, Rina Takashima and Xiao Yin

Going International

KITP Graduate Fellows Program grows to include students from foreign institutions

For many of the graduate students who come to KITP, the experience is a dream come true simply for the science. The nearby ocean and the area's mild weather is an added benefit.

Since 1999, Ph.D. candidates from institutions across the United States have been mixing California sun and science as participants in KITP's Graduate Fellows Program. And this year, for the first time, graduate students from foreign institutions are enjoying the experience as well, thanks to a grant from the Gordon and Betty Moore Foundation.

"Our program visitors are international and now our visiting graduate students are as well," said KITP Director Lars Bildsten. "The Graduate Fellows Program is unique because while the students are far along on their theses, they get huge exposure to the scientific community here, where participants have time to interact in ways they wouldn't be able to if they remained at their home institutions."

Graduate fellows stay for six months and each is assigned a KITP permanent member as a mentor. Bildsten noted that the students are essentially free agents.

"They are treated similarly to postdoctoral scholars in that their research is not directed in any way," he said. "As long as they are interacting and benefiting, we let them do their own thing."

During their tenure at KITP, graduate fellows attend lectures on a variety of topics in physics, some related to their area of study but many outside their field. Not only do they benefit from being in a different environment, they also expand their knowledge of physics.

"I've definitely found that discussions I've had with other students could lead me in new directions," said Rina Takashima, a graduate student from Kyoto University who is writing her thesis on magnetism in condensed matter.

"The program is intended to broaden your horizons," said graduate student Xiao Yin of the University of Colorado at Boulder, whose thesis will examine the intersection of cold atomic and condensed matter physics. "Ph.D. study is very specialized on one point, but the goal of KITP is to open your eyes to see other fields."

The graduate fellows program is the brainchild of Nobel laureate and UCSB physics professor David Gross, a former KITP director and now a permanent member at KITP. More than 16 years ago, he envisioned the program as a mutually beneficial experience for both Ph.D. candidates and KITP.

"On one hand, this institution — and physics for that matter — needs interaction with young people," Gross said. "On the other hand, students working on their Ph.D. theses are very narrowly focused and coming here not only exposes them to other areas of physics but also shows them firsthand what it's like to be a researcher and how important collaboration really is."

Oxford University student Thomas Scaffidi, who is completing his Ph.D. thesis on symmetry-protected topological phases, embarked on a new collaboration with people he met during his recent tenure as a graduate fellow. "I already had a few projects going on before I arrived," he said. "Coming to KITP enabled me to gather feedback about them and has given me a lot of new ideas to pursue."

– Julie Cohen, UCSB Public Affairs & Communication

Moving the Internet

Residence Project Required a Delicate Operation

Prior to laying the foundation for the Residence, it was realized that a major campus communications duct bank would need to be shifted 22 feet while keeping the internet alive for UCSB! This particular duct bank protects the key fiber optic cables for the CENIC fiber route, a high-speed, high-bandwidth connection running from northern to southern California. Not only is this the main UCSB internet connection, it also connects the UCSB campus with other major research universities.

The conduits are encased in concrete buried five feet underground, so that the start of the process was excavation of more than 100 feet of duct bank, followed by methodical chipping away at the concrete to avoid damaging the conduits or the fiber. The next step was to move the entire group of conduits that contain the active fiber, while crews at other locations would feed the available fiber optic cable slack. All while the internet was live!

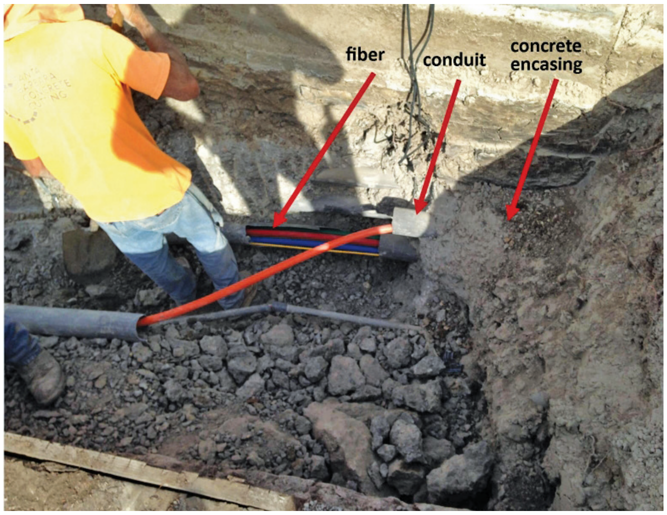
"This had never been attempted here at UCSB; nor, to my knowledge, anywhere else," said Bill Neuner, Engineering Manager & Infrastructure Supervisor for Communications Services-ETS.

At 8:00 am on the morning of November 4, 2014 approximately 20 people representing Tierra Construction, the Towbes Group, UCSB Facilities Management, and ETS Telecommunications huddled around the site to discuss the point-by-point process of moving the structure of conduits. In preparation of the move, Principal Technician Chad Cook from ETS Telecommunications meticulously cut into the conduits exposing the fiber optic cables.

With everyone in place, Bill Neuner gave the countdown to start the move. Using two way radios, the UCSB manhole crews started feeding the fiber towards the site from both sides. Tierra Construction had 10 personnel down in the open pit taking small steps with the conduits/fibers, moving it inches at a time toward El Colegio Road. Forty-five minutes and 22 feet later, the move was completed with no issues or interruption of internet connectivity to the campus.

"This was a very creative effort on the part of the ETS Telecommunication staff and our campus partners that ensured uninterrupted internet connectivity" said Denise Stephens, Interim Chief Information Officer. "Efforts like these are successful when no one notices them. I want to thank Bill Neuner, Chad Cook, John Loman, and the rest of the team for a job very well done." KITP Director Lars Bildsten agreed: "We never imagined that such a large operation could be achieved so seemlessly!"

– Matt Erickson, ETS Communications & Outreach Manager



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, contact Senior Director of Development, Laura Lambert at laura.lambert@ucsb.edu and (805) 450-9591, or visit our website at www.kitp.ucsb.edu

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