Inside
Neutrinos: Ghostly Particles with Exciting Implications
Mapping the Infant Universe: Revelations from the Cosmic Microwave Background
The Compass Project
Alumni News and More!
Cover:
The Daya Bay Neutrino Experiment, a joint venture between China and USA, is a neutrino-oscillation experiment designed to measure the mixing angle $\theta_{13}$ using anti-neutrinos produced by the reactors of the Daya Bay Nuclear Power Plant and the Ling Ao Nuclear Power Plant in mainland China. Photo documentation of construction. Photographer: Roy Kaltschmidt
4
Neutrinos: Ghostly Particles with Exciting Implications
BERKELEY’S INFLUENTIAL CONTRIBUTIONS TO NEUTRINO SCIENCE ARE ADVANCING THE FRONTIERS OF PARTICLE PHYSICS AND COSMOLOGY.
Experimental physicists Gabriel Orebi Gann, Yury Kolomensky, and Kam-Biu Luk devise cutting-edge experiments to wrest secrets from the elusive neutrino.

10
Mapping the Infant Universe: Revelations from the Cosmic Microwave Background
BERKELEY ASTROPHYSICISTS ARE AT THE VERY CENTER OF COSMOLOGICAL DISCOVERY
Physics professors Adrian Lee, William Holzapfel, Uros Seljak, and Martin White use satellite data, telescope observations, and theoretical calculations to trace the origins of the universe.

16
The Compass Project
BERKELEY STUDENTS WORK TOGETHER TO FOSTER COMMUNITY AND SERVE EACH OTHER’S EDUCATIONAL NEEDS
Physics graduate students Jesse Livezey and Hilary Jack describe Compass, the award-winning mentoring and academic support program that was born in Berkeley’s Department of Physics, designed by students for students.

DEPARTMENTS
2 LETTER FROM THE CHAIR
18 DEPARTMENT NEWS
28 IN MEMORY
31 PHYSICS IN THE MEDIA
35 UNDERGRADUATE AFFAIRS
37 GRADUATE AFFAIRS
42 ALUMNI AFFAIRS
Dear Alumni and Friends,

Greetings from Berkeley!

My first few months as Chair have been a whirlwind, but I am thrilled to have taken on the leadership of this great department. Our former Chair, Frances Hellman, left things in incredibly good shape. She was a remarkable steward of the department for six years, a few of which were financially very challenging, and I am incredibly grateful for her accomplishments. It is my honor to continue many of her efforts in making this department one of the best places for students to pursue a physics education and for faculty to pursue research.

Donald A. Glaser Lab

Physics kicked off the fall semester with the dedication and celebration of the Donald A. Glaser Advanced Lab, formerly known as the Physics 111 Lab. It was exciting to watch the remodeling of the lab and upgrading of the experimental equipment over the summer and to have the revitalized lab ready for the students by fall semester.

As many of you know from firsthand experience, the Donald A. Glaser Advanced Lab is home to the two-semester experimental course required for all undergraduate majors. It is the notoriously challenging capstone course of our undergraduate major and completing it successfully is an enormous achievement. This dedication will ensure that Don Glaser, whom we sadly lost this past year (see p. 28), remains an inspiration to our students and faculty for many years to come.

New Campbell Hall

New Campbell Hall construction is proceeding ahead of schedule, and with continued good luck we will move into the building in fall 2014. New Campbell sits next to Le Conte Hall, on the site of the original (and seismically-poor) Campbell Hall. The new building will house all of our colleagues in the Astronomy Department, and there are offices and shared space for many of our Astrophysics faculty as well as a bridge connecting to the 3rd floor of Old LeConte. We look forward to many fantastic opportunities for collaboration among the entire Astrophysics/Astronomy community here at Berkeley.

New Campbell Hall also includes basement lab space for the NIST-funded Center for Integrated Precision and Quantum Measurements. This will be our lowest noise, highest quality lab space in Physics, and will provide opportunities for new research directions and ever more precise measurements. Many of us experimentalists have enjoyed touring the basement. New Campbell will also be home to the new and exciting Kavli NanoSciences Institute (learn more on pg. 22).

You can watch Campbell Hall being constructed at this website: http://berkeley.edu/webcams.

Promoting Diversity

Addressing issues of student diversity and women in physics is a long-term issue for this department (and the field in general), and so I am very proud of the fact that in January we are hosting the APS Conference for Undergraduate Women in Physics (CUWiP ’14), organized by Assistant Professor Gabriel Orebi Gann. CUWiP is a 3-day regional conference designed to provide undergraduate women with information about graduate school and career opportunities in the physical sciences in the context of a professional conference. Students will have an opportunity to present their research in talks and posters, as well as tour Lawrence Livermore National Laboratory. We are looking forward to a huge turnout for this event.

Similarly, we are increasingly looking at ways for the department to address issues of retaining our students in this admittedly rigorous major. This coming spring, Physics will be joining a handful of other departments on campus in implementing Berkeley Connect, a new mentoring program at Cal. Berkeley Connect offers undergraduate students a chance to connect with their peers, graduate students, professors, and alums based on a
shared love of (in our case) physics. This program pairs a small undergraduate group with a graduate student mentor in a semester-long program that includes advising, small-group discussions, special events, and excursions. The goal of the program is to foster closer ties among our undergrad students through small group interactions, ties that will help support them throughout their undergraduate careers here at Berkeley. We are eager to see how this program plays out in Physics.

Career Development
Our students are enterprising. This past year, a group of our graduate students formed the Career Development Initiative for the Physical Sciences (CDIPS). This student-led organization aims to expose graduate and postgraduate students to careers outside academia, and to strengthen ties between academic science and industry.

CDIPS is running an incredibly successful speaker series that hosts Berkeley PhD alums in successful non-academic or non-traditional careers to inform PhD students about the wide variety of careers available in the physical sciences. I encourage any of our alums who might be interested in sharing their career experiences to be in touch with us.

More Improvements
Looking to the future, I anticipate embarking on a campaign to improve the physical environment for our undergraduate students. You probably remember the “Reading Room” in New Le Conte, just down the hall from the Donald A. Glaser Advanced Lab. It has been the hub of undergraduate life in the department, and it has not changed for decades.

If you stop by the Reading Room on any afternoon you will find dozens of students working together on their homework, discussing the latest physics results, or just enjoying the company of friends. You will also find them clustered around the few electrical outlets on the walls of the room to power their laptops, and sweating profusely since aging ventilation makes this the hottest room in the department. Most of the offices for the advisors and student groups that help support our undergraduate community are scattered throughout the different buildings in the physics complex.

I am just starting to build a vision of how to improve this environment. I would like to remodel the Reading Room and modernize its infrastructure, making this a comfortable and inviting place for students to work and socialize. I’d also like to see the offices for student groups and undergraduate advisors located nearby, making a visible home for our undergraduate majors in the department. Your feedback and ideas are welcome.

Public Events
Just a reminder that Berkeley Physics hosts a number of public events throughout the year, and you are welcome and encouraged to attend. Looking forward to the Spring semester, you are invited to attend the Regents’ Lecture by Nobel Laureate and Cal alumnus John Mather on February 24. Just a few weeks later, we will host Jim Gates for the Oppenheimer Lecture on March 17, as well as throw open the doors for the ever-popular Cal Day on April 12. Please join us if you can!

And now, I invite you to learn more in the following pages about the exciting research and activities going on in Berkeley Physics. I’m sure you will be as proud of the work being done here as I am. Here’s looking forward to another incredible year!

– Steve Boggs
NEUTRINOS:
Ghostly Particles with Exciting Implications

BERKELEY'S INFLUENTIAL CONTRIBUTIONS TO NEUTRINO SCIENCE ARE ADVANCING THE FRONTIERS OF PARTICLE PHYSICS AND COSMOLOGY.

A SNO+ collaborator hand cleans the acrylic vessel that will house the experiment's liquid scintillator target. Also visible are many of the photomultiplier tubes that surround the vessel.
Since the 1930s, when they were first described by Wolfgang Pauli and christened by Enrico Fermi, neutrinos have garnered quite a reputation. They’ve gone from being considered massless and relatively inconsequential to being recognized as keepers of some of nature’s most closely held secrets. Today, scientists all over the world are devising experiments to bring those secrets to light.

Neutrino science has the potential to explain the dominance of matter over antimatter in the universe, shed light on the mechanisms by which subatomic particles attain mass, help solve the puzzle of dark matter, improve understanding of processes taking place in stars and supernovae, open a window onto the first few seconds after the Big Bang, and bring us closer to a Grand Unified Theory that would unite all four subatomic forces.
Neutrinos were created by the quadrillions during the Big \text{Bang}, and they’re still being produced in the fusion reactions of \text{stars}, in supernova explosions, in nuclear reactors and particle \text{accelerators}, and by bombardment of Earth’s atmosphere by cosmic \text{rays}. They have no electric charge, so they aren’t affected by electromagnetic \text{forces}. Neither are they influenced by the strong \text{force} that binds protons and neutrons together in the nuclei of \text{atoms}. Neutrinos far outnumber all the \text{atoms} in the \text{universe}, yet they interact with \text{matter} \text{particles} so weakly that trillions upon trillions pass through Earth unimpeded every second. It takes extraordinary efforts to observe them at all.

Much of what we know about \text{neutrinos} has been learned in only the past couple of decades. The Berkeley Department of \text{Physics} has played a major role in that emergent knowledge, and the department’s contributions to \text{neutrino} detection \text{experiments} continue to grow.

**Flavors and Mixing Angles**

\text{Neutrinos} come in three ‘flavors’: electron, muon, and tau, each with its corresponding \text{antineutrino}. According to the \text{Standard Model} of particle physics, \text{neutrinos} have zero \text{mass}. But recent experiments have proven that they transform from one flavor to another as they fly through space – a feat that can be accomplished only by \text{particles} with nonzero \text{mass}. Although \text{neutrino} \text{masses} have not yet been measured, they are known to be unimaginably small, at most on the order of one millionth of the \text{mass} of the \text{electron}. The simple fact that they aren’t zero is enough to mandate a revision of the \text{Standard Model} of particle physics.

Every \text{neutrino} of a given \text{flavor} is actually a mixture of states of specific \text{mass}. A useful analogy is to think of this mixture of mass states as a quantum mechanical ‘musical chord’ made up of three pure tones. Each \text{tone}, or mass state, is present in a particular amount, and the relative amounts differ for each \text{neutrino} \text{flavor}. The \text{tone} \text{mix} of a \text{neutrino} – the relative percentage of each mass state it contains – is represented by a \text{trigonometric} value called a mixing angle.

As a \text{neutrino} travels through space and time, the \text{quantum} waves associated with its three \text{mass} states travel slightly differently. These differences cause the \text{tone} \text{mix} of the \text{neutrino} to change, creating oscillations that are observed as the transformation of a \text{neutrino} from one \text{flavor} to another.

Now, and in the recent past, faculty from the Berkeley Department of \text{Physics} are involved in groundbreaking advances in \text{neutrino} \text{science}. They include the late \text{Stuart Freedman, Kam-Biu Luk, Gabriel Orebi Gann}, and \text{Yury Kolomensky}.

**Stuart Freedman and KamLAND**

\text{Berkeley’s} entry into \text{neutrino} science was in large part spearheaded by the late Stuart Freedman, a world-renowned nuclear \text{physicist} and member of the Berkeley \text{physics} faculty from 1991 to 2012. Freedman was a leader of the KamLAND experiment, an international collaboration that made definitive measurements of one of the three \text{neutrino} mixing angles, \text{theta} one-two (\(\theta_{12}\)), and provided conclusive \text{proof} of the \text{phenomenon} of \text{neutrino} oscillations.

KamLAND’s results also showed that \(\theta_{13}\) is much larger than many \text{theorists} had postulated. Other experiments discovered that a second mixing angle, \text{theta} one-three (\(\theta_{13}\)), is also larger than expected. These findings raised the possibility that \text{neutrinos} could reveal the mechanism behind the matter-antimatter \text{asymmetry} in the \text{universe}. And the next step in that line of inquiry required measuring the third \text{neutrino} mixing angle, \text{theta} one-three (\(\theta_{13}\)).

**Daya Bay with Kam-Biu Luk**

Enter another \text{Berkeley} pioneer in \text{neutrino} science, physics \text{professor Kam-Biu Luk}, who plays a starring role in efforts to measure \(\theta_{13}\). The leading \(\theta_{13}\) experiment in the world is his brain child. It detects anti-\text{neutrinos} streaming from \text{nuclear power} \text{plants} located at Daya Bay in southern \text{China}. Luk serves as co-spokesperson for the Daya Bay collaboration, heads US participation, and has been a central figure in its conception, design, construction, and operation.

The Daya Bay collaboration includes scientists from China, Hong Kong, the Czech Republic, Russia, Taiwan, and the US. Luk, along with \text{graduate students} and postdocs from his research group, helped design, build, and commission the Daya Bay detectors. They supplied all of the \text{photomultiplier} tubes – the \text{devices} that record \text{photons} as they emerge from the \text{liquid} \text{scintillator} – and designed and built the \text{mounting} \text{assembly}. “Another of our tasks is to study the \text{attenuation} \text{length} of the \text{scintillator},” Luk adds. “This is important, because if the \text{scintillator} is changing with \text{time}, the performance of the \text{experiment} will be affected, and we need to understand that well.” In addition, they are actively involved in ongoing \text{calibration}, data \text{collection}, and data \text{analysis}.

The first real measurements of a non-zero \(\theta_{13}\), released by the Daya Bay collaboration in March of last year, were hailed as one of the AAAS Top Ten \text{Scientific} \text{Breakthroughs} of 2012. The results were surprising enough to be reported even before the experiment was fully \text{underway}, after only six of the \text{experiment’s} eight detectors had been installed. The surprise: \(\theta_{13}\) is much larger than expected.

“We had extraordinary success in detecting the number of \text{electron} anti-\text{neutrinos} that disappear as they travel from the reactors to the detectors two kilometers away,” Luk said in a \text{press release}. “What we didn’t expect was the sizable disappearance, equal to about six percent. The number of disappeared antineutrinos was used to determine the value of \(\theta_{13}\).”

Besides the three mixing angles, there is another \text{neutrino} \text{parameter} called the CP (charge parity) violation \text{phase}. CP violation is an \text{asymmetry} that could have evolved during the first seconds after the Big Bang. A non-zero value for \(\theta_{13}\) has important bearing on \text{investigations} of CP violation. “If this \text{phase} is not zero,” Luk explains, “then the oscillation of the \text{neutrino} will be different from the oscillation of the antineutrino, a kind of \text{neutrino} CP \text{violation} that some \text{theorists} speculate might help us understand why the \text{universe} is now dominated by \text{matter}.”

“That’s one reason our results are so exciting,” Luk continues. “Theta one-three holds the key to future experiments for studying CP \text{violation} in \text{neutrino} oscillation.”

Late this summer, the Daya Bay collaboration reported the most precise \text{measurement} of \(\theta_{13}\) yet. As precision continues to improve, the potential of discovering CP violation in the \text{neutrino} sector is enhanced.

Even though \text{exact} \text{mass} \text{values} for the three \text{neutrino} \text{mass} states have not yet been measured, \text{researchers} have inferred possible \text{relationships} among them in a scheme known as the \text{neutrino} mass \text{hierarchy}. Two of the \text{mass} \text{states} are known to be similar in value, while the third could be either much heavier or much lighter than the
other two. The large value for $\theta_{13}$ measured at Daya Bay opens up additional experimental approaches that can further clarify the neutrino mass hierarchy and place tighter constraints on the mass values.

Daya Bay uses eight massive detectors in three separate underground sites called the Near Halls and the Far Hall. The numbers of electron antineutrinos detected in the Near Halls are compared with the number reaching detectors in the Far Hall. The number of electron neutrinos that appear to vanish—those that transform into muon or tau flavors—gives a direct value for $\theta_{13}$. Installation of all eight detectors was completed in the summer of 2012, and data collection has continued nonstop since October 2012.

This summer, by studying the oscillation pattern as a function of the antineutrino energy, the collaboration reported the first measurement of the neutrino oscillation wavelength corresponding to the mixing angle $\theta_{13}$. The data offer more insight into the mechanism by which neutrinos transform. “The measured wavelength yielded an effective mass splitting which is consistent with the one determined by other experiments observing muon neutrino disappearance,” Luk reports. “This finding supports the three-flavor neutrino oscillation framework. In addition, when these effective mass splittings are measured precisely, they will help in resolving the mass hierarchy.”

The Daya Bay experiment is set to run for two more years. “By the end of 2015,” Luk reports, “we will have such a large data sample that it should provide the most precise measurement of this parameter achievable for the next couple of decades.”

**Majorana Particles and Double Beta Decay**

Other experiments have been designed to ascertain whether or not neutrinos are Majorana particles—particles that act as their own antiparticles. A ‘yes’ answer to that question would definitely stretch the bounds of the Standard Model.

Neutrinos have the potential to be their own antiparticles because they have no electric charge; antiparticles are most often defined as having the opposite electrical charge from their ordinary matter sibling. If neutrinos are Majorana, they could be a source of transitions among particles and antiparticles that are preferential to matter over antimatter. And that could explain why we live in a matter-dominated universe.

Learning whether neutrinos are Majorana is a primary aim of two Berkeley physicists who, like Luk, are deeply immersed in neutrino research: assistant professor Gabriel Orebi Gann and professor Yury Kolomensky.

Orebi Gann is the Analysis Coordinator for the SNO+ collaboration, a follow-on to the Sudbury Neutrino Observatory (SNO) experiment in Ontario, Canada. SNO is the experiment that provided the first definitive proof that neutrinos change flavors.

Kolomensky is US Spokesperson for CUORE, the Cryogenic Underground Observatory for Rare Events. CUORE is currently under construction at Gran Sasso in Italy and is scheduled to begin operating late next year.

Both SNO+ and CUORE are attempting to detect a radioac-
tive decay process known as neutrinoless double beta decay. This process is extremely rare, if it occurs at all. It has never been convincingly observed, and extraordinarily sensitive experimental techniques are required to detect it. Successful detection would confirm that neutrinos, unlike all other known constituents of matter, are indeed their own antiparticles.

In certain forms of beta decay, a neutron in the nucleus of an atom changes into a proton, emitting an electron and an electron-flavored antineutrino in the process. In double beta decay, which occurs preferentially in a few isotopes, two neutrons are transformed, and two electrons and two antineutrinos are emitted.

“Neutrinoless double beta decay relies on neutrinos being Majorana,” Orebi Gann explains. “If they are, there is the possibility that the two antineutrinos released in double beta decay can annihilate, because one can interact with the other as a particle would react with its antiparticle. In that case, we get only the two electrons, and no neutrinos.”

**SNO+ with Gabriel Orebi Gann**

Orebi Gann joined the Berkeley faculty at the beginning of 2012, after participating in both the SNO and SNO+ experiments as a postdoc at the University of Pennsylvania. Her PhD thesis at Oxford was the basis of the most precise measurement of solar neutrinos with SNO.

SNO+ is housed in the same underground detector used for SNO, but it’s a different experiment. SNO used a heavy water target to detect neutrinos produced in the sun. SNO+ will use a liquid scintillator target to detect the energies of electrons emitted by double beta decay in specially selected radioactive isotopes.

“The SNO+ scintillator is an organic liquid that produces about 50 times more light when a charged particle passes through it, compared with SNO’s heavy water target,” Orebi Gann explains. “We use the light to measure the energy of the event, so using liquid scintillator means we can observe lower energies with better resolution.”

“If the neutrinos produced in double beta decay annihilate inside the atomic nucleus,” she adds, “they are no longer products of the reaction, thus the electrons have to carry all the energy of the decay.” That means the energy spectrum of electrons emitted from a neutrinoless double beta decay reaction will show a specific energy peak that differs from other beta decay processes. The difference is slight; also, similar energies can come from background radiation, electronic noise, and other sources that make the signal difficult to detect.

There are about 35 isotopes that naturally undergo double beta decay and could potentially undergo the neutrinoless version. SNO+ will be able to search for this reaction in a variety of isotopes, one at a time. A single isotope can be dissolved in the liquid scintillator, tested, then removed and replaced with another isotope.

“If we see something,” Orebi Gann notes, “we can test our own result with a different isotope.” Observing the signs of neutrinoless double beta decay in several isotopes would provide very strong evidence that neutrinos are Majorana particles.

Also, by comparing the half-life of neutrinoless double beta decay in different isotopes, SNO+ collaborators will be able to place tighter constraints on the actual mass of the Majorana neutrino.

Analysis of data from SNO+ will be accomplished by comparing it to a very detailed computer simulation now being designed.
narrow energy range with very high precision,” says Kolomensky. “If this experiment sees signs of neutrinoless double beta decay, we will be very sure that’s the process we are observing. We don’t have to analyze for backgrounds in a broad window as liquid detector experiments do.”

CUORE’s precision comes with an important limitation—it must be purpose-built for use with a single isotope. In this case, the isotope is Tellurium-130, formed into crystals of tellurium oxide (TeO2).

In place of the liquid scintillator and photomultiplier tubes used in the Daya Bay and SNO+ experiments, CUORE uses bolometer technology. Bolometers are devices that convert energy into a change in temperature. CUORE’s TeO2 crystals themselves are bolometers: they’re both the source and the detector for the radioactive decay the experiment is searching for. When a Te atom undergoes double beta decay, it produces a tiny energy release in the crystal that raises its temperature. Each crystal is connected to a very sensitive thermometer that registers these temperature fluctuations.

“This approach is very similar to the bolometer technology astrophysicists use to measure the cosmic microwave background,” Kolomensky explains. “The concept is fairly simple. If the heat capacity of the target is very small, then very small energy changes within the target become relatively large temperature increases. If we know the heat capacity of the target, we can use the temperature variations to infer the total energy of an event. CUORE will be able to measure temperature increases on the order of 100 microKelvin.”

The sensors that provide readouts of temperature fluctuations in CUORE’s bolometers are neutron transmutation doped germanium thermistors (NTDs). They are made using a semiconductor fabrication technique pioneered at Lawrence Berkeley National Laboratory (LBNL). The technique involves irradiating germanium (Ge) atoms, causing some of them to absorb extra neutrons and then decay into gallium (Ga) or arsenic (As) atoms.

For CUORE’s NTDs, the neutron transmutation process is used to dope Ge with Ga and As in such a way that “the electrical resistance of the material becomes a very steep function of temperature,” Kolomensky says. “The material becomes a very sensitive temperature sensor.”

Members of Kolomensky’s research group, which includes personnel at LBNL and on campus, are participating in the construction of the 1200 NTDs needed for CUORE. After the Ge is irradiated at the Massachusetts Institute of Technology, an engineer at LBNL cuts the material into pieces and deposits gold as electrodes. “My research group on campus tests them and measures their characteristics in preparation for delivery to Gran Sasso, where we mount them on the detectors,” Kolomensky notes. The Berkeley group is also responsible for wiring the detector.

“All assembly is done underground in very carefully designed clean rooms,” Kolomensky adds. “Inside the clean rooms we use glove boxes with a nitrogen atmosphere, to prevent exposure to radon in the air. Gran Sasso has a fairly high level of radon because the mountain is granite with uranium veins.”

All neutrino experiments are sited underground, to shield them from cosmic rays. Liquid detectors like Daya Bay and SNO+ are further shielded by their sheer volume. CUORE, on the other hand, must be shrouded in several tons of lead. But not just any lead. The lead used in the experiment must be free of radioactivity.

“Ettore Fiorini, the intellectual leader of this experiment, procured several tons of ancient lead for us to use in CUORE,” Kolomensky reports. “It was retrieved from the bottom of the Mediterranean, from the wreck of a Roman galleon. So it has sat at the bottom of the sea for about 2000 years, protected from radioactivity-causing cosmic rays.”

The entire CUORE assembly, including its lead shielding, is housed in a specially built cryostat that cools everything to 10 milliKelvin. This low temperature reduces the heat capacity of the TeO2 crystals, which in turn increases detector sensitivity. “One of my graduate students claims that CUORE, when it begins operating, will be the coldest cubic meter in the known universe,” Kolomensky says.

Several of CUORE’s 19 towers have been assembled and wired, and the entire detector should be complete and ready for operation by the end of 2014.

**New Physics**

In 2004, the American Physical Society published The Neutrino Matrix, a study of neutrino physics that spells out the directions of research most likely to reveal the neutrino’s secrets. One of the study’s lead authors was Berkeley’s Stuart Freedman. The experiments at Daya Bay, SNO+, and CUORE are following along the lines of inquiry Freedman helped develop.

Daya Bay will continue taking data until the end of 2015. SNO+ and CUORE both begin operation next year. These endeavors, in combination with other neutrino experiments around the world, are sure to reveal new secrets of the ‘ghost particle’. Is physics beyond the Standard Model just around the corner? Stay tuned.
Mapping the Infant Universe
Revelations from the Cosmic Microwave Background

Berkeley astrophysicists are at the very center of cosmological discovery.
Over the past 20 years, observations of the cosmic microwave background (CMB) have revealed that this remnant ‘afterglow’ of radiation, emitted about 380,000 years after the Big Bang, carries abundant detail about the cosmos. To date, studies of CMB radiation indicate that the universe has a flat geometry and have produced evidence that strongly supports cosmic inflation – the theory that the universe went through a very rapid, exponential expansion in the instant after the Big Bang.

Measurements of the CMB enable cosmologists to assess the amount of dark matter and dark energy in the universe, to detect dust-shrouded galaxies that might otherwise go unseen, and to measure the total mass of the neutrino. CMB observations could also make it possible to peer farther back in time, into the roiling, densely energized instant of inflation itself, to explore energies that could never be achieved in earthbound particle accelerators.

CMB radiation was emitted at that moment in the history of the universe when very hot, dense, fluid-like plasma had cooled enough for atoms to form. During the plasma phase, photons were trapped, scattering off free electrons so frequently they could travel only very short distances between encounters. Collapsing, overdense regions coupled to radiation, which resists collapse, creating acoustic oscillations in the plasma in much the same way sound waves create compressions and rarefactions in air.

Once the plasma cooled and atoms began to form, the acoustic oscillations ceased. Photons, no longer trapped, streamed outward as the universe continued to expand. CMB radiation is composed of these photons, which carry an image of the variations, or anisotropies, present at the ‘surface of last scattering’ – those final moments of the ionized plasma. The denser, hotter regions of the CMB represent cosmic ‘seeds’ which, through gravitational attraction, eventually grew into the stars, galaxies, and galaxy clusters of today’s universe.

“The existence of the CMB is one of the pillars of the Big Bang model,” says Berkeley theoretical astrophysicist Martin White. “And it’s become the bedrock of cosmological research. Every calculation you think of starting, every experiment you think of doing, begins with these facts we know from the CMB – the numbers, the model, the initial conditions, even the way we phrase a problem.”

CMB Research at Berkeley

UC Berkeley’s Department of Physics is one of the places where CMB exploration first began. For more than 20 years, experiments based here have made critical contributions to the field, starting with pioneering efforts from experimentalists Paul Richards and George Smoot.

Berkeley astrophysicist and emeritus professor Paul Richards formed the very first CMB research group at Berkeley. Renowned as one of the world’s most important contributors to CMB detection methodology, he pioneered the development of bolometer technologies. Bolometers are detectors specialized for sensing extremely small deviations in energy. He and his research team have invented, fabricated, and implemented several generations of cryogenically cooled, composite bolometers that have proven extraordinarily successful in making sensitive, high-resolution measurements of CMB radiation.

Cosmologist George Smoot shared the 2006 Nobel Prize for his part in producing the first ‘baby picture’ of the universe – a map of temperature anisotropies in the CMB released in 1992. The instrument Smoot and his colleagues developed for the COBE (Cosmic Background Explorer) project, called the differential microwave radiometer, compared temperature differences across relatively large swaths of the sky.

Today, several Berkeley faculty members are involved in CMB research. Theorist Martin White is a member of the Planck satellite collaboration. Two experimentalists, Adrian Lee and William Holzapfel, lead ground-based telescope observations of the CMB. Uroš Seljak, Director of Berkeley’s Center for Cosmological Physics, is involved with CMB theory research.

(oopposite) One of the “plug plates” used for the BOSS experiment. Each plate is an aluminum disk with holes drilled to match the precise position of a previously imaged target and placed at the telescope’s focal plane. Optical fibers are plugged into the holes every day by hand, to guide the light from each target to a spectrograph.
Planck Satellite

COBE’s ‘baby picture’ prompted an avalanche of new research, and has since been superseded by more detailed results from a number of experiments. This past March, the most detailed temperature map of CMB radiation yet produced was unveiled by scientists working with the European Space Agency’s Planck satellite, using the type of bolometer technology pioneered at Berkeley. “It’s designed to be the definitive word on CMB temperature anisotropies,” notes White, who has been a member of the Planck team since the project’s inception.

CMB data collected by the Planck satellite increases evidential support for the theory of cosmic inflation and lengthens the estimated age of the universe by 80 to 100 million years. It indicates that the universe contains a bit more matter than previously thought, and that its rate of expansion is slower than estimates from other astronomical observations. Planck’s temperature map shows larger and more numerous anisotropies in the northern hemisphere of the sky compared with the southern hemisphere, along with an unexplained cool spot – findings that run counter to prevailing assumptions that the universe is largely uniform across the sky.

“One of the amazing things about the Planck data is what it tells us about the period of exponentially rapid expansion of the universe that laid down all the seeds of structure that we see today – the epoch of inflation,” White says.

The theory of cosmic inflation, initially posited by Alan Guth in 1980, became a very active topic of theoretical speculation in the early 2000s. “That’s when we began looking back at assumptions made in the early papers on inflation, to see if different assumptions would be compatible with the observations,” White explains. “But Planck has now ruled out most of those new ideas. The only models left are in some sense very simple. That’s hard to understand, because we try to fit theories of inflation into other theories about the early universe, such as string theory and high energy particle physics. Those models tend to be very complicated, yet none of that complication leaks into inflationary theory.”

Planck data also hint at a relationship between energies of the early universe and the energies of the Higgs boson, which was recently detected at CERN’s Large Hadron Collider. “There’s a theory of inflation in which the energy field that drove the expansion is the same as the Higgs field that gives mass to present-day particles,” he explains. “The only difference is the way in which the Higgs field interacts with gravity in today’s universe versus the early universe. That changes.” He calls the idea “radical, but exciting.”

The Planck satellite was launched in 2009, and data collection was completed this summer. Analysis continues, and further results will be released over the next couple of years.

Small-Scale CMB Measurements

With Planck, large-scale structures in the CMB emission have been measured to such a high precision that deeper observations would not improve our understanding of cosmology. However, experiments that focus on smaller regions of the sky can achieve higher precision and detect smaller-scale structure unseen by Planck. This is the approach both Adrian Lee and William Holzapfel have taken in their CMB research.

Lee and Paul Richards have been collaborating on CMB experiments since 1994. Their first project together, a balloon-borne CMB experiment called MAXIMA, evolved into a succession of experiments that probed the CMB in increasing detail. In 2004, when Richards retired, Lee took leadership of the research group. Currently, Lee is Principle Investigator for POLARBEAR, an experiment designed to measure the polarization of CMB light, installed on the Huan Tran Telescope in Chile.

Holzapfel had already been working in CMB science when he joined the Berkeley faculty in 1998 and took leadership of ACBAR, a ground-based experiment mounted on the Viper telescope at the South Pole. He too has led a succession of CMB experiments, many of them in collaboration with Lee’s group. Holzapfel leads the group at Berkeley working on the South Pole Telescope (SPT), a 10m telescope that is the largest ever deployed at the South Pole.

CMB signals are faint and easily obscured by other radiation sources. Collecting temperature data is challenging enough – the temperature of the CMB is only 2.7 degrees above absolute zero, requiring that detectors be shielded from all sources of heat contamination.

These days, Lee and Holzapfel are looking for even fainter signals coming from the polarization of the CMB. Along with Richards, they’ve made critical contributions to an evolution in
bolometer technology that has progressively enhanced the volume and precision of data that can be collected from CMB radiation. Their ideas continue to be applied in the design of CMB experiments all over the world.

**Improved Bolometer Designs**

“Because we keep looking for smaller and smaller signals,” Lee points out, “it’s been essential to build better and better detector systems.” During his postdoc years, Lee’s prior experience with dark matter studies led him to become the first scientist to suggest using superconducting transition-edge sensors (TES) as thermometers in the bolometers used to detect CMB photons.

As a bolometer absorbs photons, its temperature fluctuates. The TES detects these tiny fluctuations by measuring changes in the amount of power needed to maintain the superconductor at its transition temperature. “Paul Richards and I wrote the first paper on that,” Lee recalls, “and now most CMB experiments use the technique.”

Over the years, Lee, Holzapfel, and Richards have incorporated photolithography and other miniaturization techniques into their bolometer designs. Today, the bolometers they produce operate at the physical limits of sensitivity, but they’re overcoming that limitation by combining the bolometers into large arrays. Both the POLARBEAR and South Pole Telescopes already use arrays of more than 1,000 bolometers, and there are plans to go even larger.

Lee and Holzapfel are further enhancing the precision and speed of CMB measurements by increasing the number of functions each bolometer can perform. They’re working on a new design, called a multichroic bolometer, which expands sensitivity from one frequency to three. “A single multichroic bolometer will detect six parameters,” Holzapfel says, “two polarizations in each of three frequency bands.”

Multichroic bolometers detect multiple frequencies coming from the CMB. This photograph shows a dual-frequency-band pixel from a multichroic bolometer. The pixel uses a “sinuous” antenna. Arrays of more than a thousand of these pixels are being built for use in POLARBEAR and SPT. Constructed at the Berkeley Marvell Nanofabrication Lab, each pixel measures two linear polarizations in two frequency bands simultaneously. The antenna is 1mm in diameter.

---

**BEYOND INFANCY: BOSS AND MS-DESI**

Is the cosmological constant really a constant? That’s one of the big questions that interests theoretical cosmologist Uroš Seljak, Director of the Berkeley Center for Cosmological Physics (BCCP), along with many of his colleagues.

The original discovery that the expansion of the universe is accelerating, perhaps due to the mysterious force of dark energy, came from observations of distant supernovae – research for which Berkeley astrophysicist Saul Perlmutter was awarded the 2011 Nobel Prize. “We think this acceleration can be well explained by something like the cosmological constant,” Seljak says. “We are trying to take measurements that can distinguish whether it’s really constant or not. Measuring baryon acoustic emissions in galaxy surveys is a very good example of how to do that. We’re trying to patch together how the universe is evolving in time.”

**BOSS**

Seljak, along with fellow theorist Martin White, has been involved with the Planck satellite collaboration and with a component of the Sloan Digital Sky Survey called the Baryon Oscillation Spectroscopic Survey (BOSS). BOSS shares some science goals with CMB experiments, including the aim of mapping the progression of structure formation in the universe over time. BOSS was the first attempt to use baryon oscillation – a representation of the clumping of matter in the universe – as a precision tool to measure dark energy. It’s also the first survey to use light from bright quasars to map intergalactic hydrogen.

“The idea behind BOSS was to map the acoustic oscillations created during inflation as they appear 10 billion years or so after the Big Bang,” White explains. “By comparing that picture to the CMB, we can look at inflation from 400,000 years after the Big Bang all the way out to 10 billion years. Those observations enable us to trace the expansion history of the universe over that entire period, measure the amount of dark matter in the universe, and begin to get at how much dark energy there is and how rapidly it’s evolving – if it’s evolving at all.”

**DESI**

Seljak and White are participating in a new collaboration, now in the planning stages, called DESI – Dark Energy Spectroscopic Instrument. The project is a scale-up of BOSS that aims to create the largest-ever 3D map of the universe and study dark energy with unprecedented precision.

“It would map millions and millions of galaxies,” Seljak says, “allowing us to measure dark energy to high precision – and would yield other important scientific results as well, including determining neutrino mass and the number of neutrino families.”

In 2012, UC Berkeley received, through the BCCP, a $2.1 million grant from the Gordon and Betty Moore Foundation to fund development of the revolutionary technologies now being designed for the project. In January of this year, the Department of Energy chose Lawrence Berkeley National Laboratory to manage instrument design and fabrication.
CMB Polarization

CMB radiation carries fluctuations in polarization as well as temperature. Now that temperature anisotropies have been well characterized, many experiments, including POLARBEAR and SPT, are focusing on CMB polarization. “The patterns of polarization in the CMB have many things to tell us about cosmology and fundamental physics, especially high-energy particle physics,” Lee says. “The most exciting thing we could learn is the physics of inflation.”

The polarization pattern of the CMB has two components, called E-modes and B-modes. Both are much more challenging to detect than the temperature anisotropies of the CMB.

E-mode polarization patterns originated from the same physics that created temperature anisotropies in the CMB. Measuring them, Lee explains, “will help us understand how and when the first stars and galaxies formed.”

B-mode polarization patterns are more subtle and more difficult to measure. Most B-modes – called ‘gravitational B-modes’ – were produced by the distortion of E-mode polarized light as it encountered the gravitational pull of galaxies on its journey through space and time.

But a second type of B-mode – called ‘inflationary B-modes’ – is more subtle yet, even more difficult to detect, and even more tantalizing to researchers. Inflationary B-modes arose from gravity waves produced during the inflationary epoch, as first proposed by Seljak in 1997. Successfully measuring inflationary B-modes, Lee says, “will not only prove that inflation occurred, but also teach us about the universe when it was very hot and at very high energy density. At that time, particle interactions were occurring at energies 12 orders of magnitude higher than the Large Hadron Collider at CERN.” Inflationary B-modes could reveal physics far beyond what can be studied in particle accelerators built on Earth.

POLARBEAR

POLARBEAR and SPT have similar science goals, including detecting inflationary B-mode polarization, placing limits on the sum of the three neutrino masses, and exploring differences in the behavior of dark energy in the early universe versus present time.

POLARBEAR saw first light in January 2012. “After more than a year of observations, we now have the lowest-noise map of CMB in the world,” Lee reports. At present, the project team is focusing on gravitational B-modes in the polarized CMB. “Hopefully we’ll be able to report we’re seeing that signal by the end of this year,” he says.

Polar Bear will go through a series of upgrades in the next few years. “An array of more than 1,200 bolometers has been installed on the current phase,” Lee adds. “POLARBEAR II, with 8,000 bolometers, will come online in a couple of years. And in 2016, we move to what’s called the Simons Array – three telescopes with a total of 23,000 bolometers. So, in about three years we’ll be taking data a factor of 30 faster than we are now.”

South Pole Telescope and SPTpol

The SPT, initially deployed in 2008, was primarily designed to conduct a search of distant clusters of galaxies as a way of studying dark energy. In addition, SPT has studied gravitational lensing in the CMB. “As the CMB travels through the universe,” Holzapfel explains, “it gets distorted by gravity from intervening structures. The distortion creates a statistical signal that allows us to make high-fidelity maps of all the projected mass the CMB has traveled through.”

“Those measurements are already being used,” he adds. “We’ve published results showing constraints on cosmological parameters and confirmation of the existence of dark energy without any appeal to supernova or other data, just the CMB itself.”

In 2012 SPT was fitted with a new polarization-sensitive receiver and rechristened SPTpol. “We’ve already published preliminary constraints on neutrino mass using data from the first receiver” Holzapfel notes. “By adding polarization data from SPTpol we should be able to reach limits on neutrino mass that are better than terrestrial lab experiments.”

This July, the SPTpol team reported the first detection of gravitational B-mode polarization of the CMB. According to the team’s press announcement, “The signals detected by SPTpol are due to gravitational lensing, and a sufficiently sensitive measurement of these signals will help us learn about neutrinos through their impact on the growth of structure in the universe. Successfully detecting this tiny B-mode signal also represents a major milestone along the way to using the CMB to learn about the earliest moments of the universe with inflationary B-modes.”
When multichroic bolometers are ready for implementation, they’ll be used to upgrade SPTpol, giving it an even larger number of detectors. “It will increase our mapping speed on the sky by an order of magnitude,” Holzapfel says.

In the long term, Lee and Holzapfel report that plans are in the works for a space mission dedicated to CMB polarization science. Called Light Bird, the project is currently in the study phase, and plans call for using multichroic bolometer arrays developed and fabricated at Berkeley.

**Back to the Future**

- Mapping dark matter
- Detecting signals from gravity waves created during cosmic inflation
- Measuring neutrino mass
- Mapping the progression of structure formation in the universe from the beginning of time until now
- Learning whether dark energy has changed since the beginning of time, or is indeed a cosmological constant

These are some of the primary aims of cosmological research today. Achieving them requires looking back into the very beginnings of the universe. Many gifted scientists are focusing their energy and creativity on these questions, using a variety of experimental and theoretical approaches. Findings are coming in. The trickle is growing into a stream.

**BERKELEY CENTER FOR COSMOLOGICAL PHYSICS**

Berkeley astrophysicist George Smoot contributed a large portion of his 2006 Nobel Prize winnings to establish the Berkeley Center for Cosmological Physics (BCCP). The center’s activities include a highly successful postdoctoral program designed to attract outstanding young scientists, and a visiting researcher program that invites prestigious cosmologists from other institutions for extended stays. “We recently received a major donation from the Heising-Simons Foundation that will enable us to expand these programs,” says BCCP Director Uroš Seljak.

“An interesting idea Saul Perlmutter has proposed,” Seljak adds, “is to bring Berkeley faculty from other fields to come and exchange ideas with BCCP members. Maybe somebody in literature wants to write a book about cosmology, or a philosopher wants to spend time talking to cosmologists.” This program will begin once New Campbell Hall is complete and the BCCP has more space available for visitors.

Perlmutter is also spearheading plans for a new computational initiative within the BCCP. The aim is to find new approaches to the analysis of so-called ‘big data’ – the ever-growing volume of data created by precision experiments. “In all fields, including our field, there has been a lot of trial and error approach,” Seljak says. “We want to look at what has been tried and what has failed, in order to develop mechanisms that prevent us from making too many errors. This concept would apply on a broad scale, not just cosmology.”
I

If you walk by the UC Berkeley Department of Physics in August, you might see clusters of excited students dropping Slinkies from balconies or experimenting with a gloppy cornstarch and water suspension playfully known as oobleck. These are scenes from the Berkeley Compass Project: incoming physical science undergraduates using Slinkies to explore the concepts of tension, force, and gravity; or concocting their own experiments with oobleck to investigate the properties of non-Newtonian fluids.

Experiences like these are part of a two-week Summer Program created by the Compass Project – a group of students who have developed an award-winning suite of courses, lectures, and mentoring partnerships for the benefit of fellow students. The Summer Program, offered to incoming freshmen at no cost, offers the chance to explore a physical phenomenon through authentic scientific investigation. So, even before undergraduate coursework begins, freshmen are doing real science. They’re also developing community. Students often form friendships during the Compass Summer Program that last throughout their tenure at Berkeley and beyond.

Compass Wins Awards
The Compass Project was established in 2007 by a group of graduate students who recognized the need for community-building and education-enhancing activities that would welcome incoming undergraduates, help them get established in the scientific community at Cal, and offer them academic and intellectual support.

The Compass Project’s success at implementing research-based educational methods earned it the American Physical Society’s 2012 Award for Improving Undergraduate Physics Education. And Compass programs are being emulated by other universities. Compass members gave an invited colloquium at Colorado University in 2012 and Arizona State in 2013, and consulted for a new Compass-like program at Florida International University that piloted in 2012. Compass members also helped develop a National Science Foundation grant to emulate Compass at University of Maryland.

Compass has Many Facets
In addition to the two-week Summer Program every August, Compass offers a number of programs for undergraduates.

Science Modeling and Measurement
This two-semester course helps freshmen hone their scientific skills in preparation for becoming involved in formal research. Rather than relying on lectures, Compass teaching methods emphasize group work, self-discovery, and collaboration.

Frontiers of Physics
This upper division course offers an overview of active research areas in the physical sciences. Its round-table discussion format allows students to discuss a range of topics with graduate students and research faculty from the Departments of Physics and Astronomy. The course encourages undergraduates to become involved in research, which can help them reach informed decisions about graduate school and the general trajectory of their careers.
Transitioning to Berkeley Physical Sciences

Students who transfer from other institutions often face a unique set of obstacles. The Compass Project’s Transfer Course is designed to give junior transfer students a chance to develop relationships in their cohort while augmenting their technical knowledge and study skills.

Compass Mentoring Program

In the Mentoring Program, graduate students form long-lasting relationships with undergraduates who seek personalized, consistent feedback for navigating academia. Mentors and mentees meet one-on-one at frequent intervals and join others in the program in attending professional development workshops on helpful topics such as goal-setting and dealing with stress.

The Compass Project is currently consulting for Berkeley Connect in Physics—a new campus-wide mentoring program that shares many goals with Compass. The aim is to create an environment in which students can identify as scientists who have an active part in the scientific community at UC Berkeley.

Compass Lecture Series

A lecture series targeted specifically at undergraduates consists of five research talks each semester, given by physical science faculty or PhD candidates nearing graduation.

Compass Builds Community

In a large research university like Berkeley, it’s easy for undergraduates to feel disconnected from professors and graduate students—the very community of scientists they’re being trained to join. Students have a lot to say about how the Compass community influences their lives in science.

Undergraduate Kevin Gutowski says, “Physics can be very difficult, and it’s easy to let the stress get to you. Without such a strong community to keep me inspired, I think my overall experience with physics at Cal would have been much more frustrating.” He adds that Compass programs help freshmen “build a sense of community that creates a safe place to make mistakes and learn from them.” Gutowski is now a member of the Compass design team.

Undergraduate Alexis Williams says, “Compass has made me feel more confident that I can successfully major in geology. I’ve been able to turn to other Compass members for support for academics and personal issues. All along the way, they have shared their love of science with me and made me feel more comfortable discussing scientific discoveries with other physical science majors.”

“I’ve particularly been influenced by my mentor, whom I met during the Summer Program,” Williams adds. “He has been very helpful and encouraging as well as honest.” Williams is now a Compass volunteer.

Compass Benefits Its Leaders

The students who lead the Compass Project give a lot to their fellow students. They also enjoy many benefits, including opportunities to develop mentorship skills and build a professional teaching portfolio by designing an entire curriculum from the ground up.

Joseph Thurakal, a Compass collaborator and physics Graduate Student Instructor, observes, “the Compass classroom creates the type of collaborative, engaged environment I’ve always envisioned creating in my own classroom. It’s inspiring to see that these seemingly lofty teaching goals are actually obtainable.”

Undergraduates who come into Compass as freshmen often go on to assume leadership roles in the organization. This year, planning and logistics for the Summer Program were spearheaded by undergraduates.

Funding for Compass

Since Compass started, the program has grown from 11 freshmen in 2007 to 20 new freshman and 36 transfer students in 2013. Compass struggles to support itself. In 2009, 2011, and 2012, the August Summer Program was reduced to only one week because of financial constraints. In the long term, Compass leaders would like to see the Compass Project become an endowed program, so they can focus more of their time on improving education and building community.

For more information on Compass Project activities, and to find out how you can help support them, visit www.berkeleycompassproject.org.

Compass Project Student Retention Compared to UC Berkeley and the National Average

<table>
<thead>
<tr>
<th></th>
<th>'07-'08 Compass Students Majoring in STEM Field</th>
<th>'07-'08 Compass Students Graduated in STEM Field</th>
<th>'95-'97 Cal Retention in in STEM Field for Minority Students</th>
<th>'95-'97 Cal Retention in in STEM Field for Non-Minority Students</th>
<th>National Retention in STEM Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>'07-'08 Compass Students Majoring in STEM Field</td>
<td>85%</td>
<td>65%</td>
<td>35%</td>
<td>61%</td>
<td>38%</td>
</tr>
<tr>
<td>'07-'08 Compass Students Graduated in STEM Field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>'95-'97 Cal Retention in in STEM Field for Minority Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>'95-'97 Cal Retention in in STEM Field for Non-Minority Students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Retention in STEM Field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Compass Programs have a significant impact on retention rates in science, technology, engineering, and math (STEM) fields. Compared to students at UC Berkeley and nationally, Compass students are much more likely to remain in a STEM major.

Demographics of Compass Students Compared to Demographics of National Physics Bachelor’s Degrees

<table>
<thead>
<tr>
<th></th>
<th>Compass</th>
<th>National</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>45%</td>
<td>21%</td>
</tr>
<tr>
<td>First Generation College</td>
<td>19%</td>
<td>n/a</td>
</tr>
<tr>
<td>Chicano/Latino</td>
<td>26%</td>
<td>n/a</td>
</tr>
<tr>
<td>African American</td>
<td>5%</td>
<td>n/a</td>
</tr>
<tr>
<td>Native American</td>
<td>1%</td>
<td>n/a</td>
</tr>
<tr>
<td>Total Underrepresented Minority Students</td>
<td>32%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Compass serves students from a broad range of racial, ethnic, and socio-economic backgrounds.
Physics professor Robert Birgeneau, while he held the post of UC Chancellor, had many opportunities to work with Hellman while she was Chair. “Our physics department was very good before Frances took on the Chair’s position and it is even better now,” he says. “I was most impressed with how deeply thoughtful and strategic she was. Further, she was always inclusive in her administrative actions, consulting as broadly and as thoroughly as possible. Not only was Frances an outstanding Chair, I suspect that we have not seen the last of her in important administrative positions.”

Birgeneau Awarded 2012 Compton Medal

On June 1, as physicist Robert Birgeneau stepped down from his nine-year stint as UC Berkeley’s Chancellor, he stepped up to new roles and the receipt of new honors. He handed over the Chancellor’s duties to his successor, anthropologist and historian Nicholas Dirks. He’s returning to teaching and research in the Department of Physics. He received the 2012 Karl Taylor Compton Medal for Leadership in Physics from the American Institute of Physics (AIP). And he has taken the reins as leader of the Lincoln Project, a new educational initiative from the American Academy of Arts and Sciences.

“I could not be more pleased once more to be back teaching and doing research full time,” Birgeneau said recently. “I look forward to myriad interactions with my postdocs, students, and colleagues in physics. It will also be sheer pleasure to attend as many as I want of the varied, stimulating talks that are given in the physics department every single week.”

In January, the AIP honored Birgeneau for his “exceptional statesmanship in science” by awarding him the 2012 Compton Medal. Birgeneau was cited “for his leadership in improving the situation for women in science in the United States and around the world, his efforts to enhance diversity in science and for deepening our understanding of magnetism and its interplay with other states of matter.”

The medal, a certificate of recognition, and a $10,000 check were presented to Birgeneau at the American Physical Society’s March 18 meeting in Baltimore, Maryland.

Also in January, the American Academy held a symposium in Birgeneau’s honor. The gathering focused on the benefits of public investment in higher education and included the announcement that Birgeneau will lead the American Academy’s new Lincoln Project for Excellence and Access in Public Higher Education. Its purpose is to advocate for the importance of public colleges and universities, with goals that include assessing the implications of forces that threaten public higher education and developing strategies to preserve the strength and diversity of colleges and universities. Named after President Abraham Lincoln, it commemorates his signing of the 1862 Morrill Act, which laid the groundwork for the nation’s public university system.

“Public disinvestment and escalating costs are increasingly threatening our vaunted system of public higher education,” Birgeneau says. “Without bold steps to stabilize the financial model of our public universities, hundreds of thousands of deserving students will be denied access to a better life and the country’s ability to innovate, create jobs, and support a strong economy will be severely compromised.”

During his tenure as Chancellor, Birgeneau launched initiatives at UC Berkeley that are models for public colleges and universities elsewhere, including a grant-based financial aid plan for middle class families and scholarships and support for undocumented students.

Obama Honors Rosenfeld

At a White House ceremony on February 1, President Barack Obama awarded UC Berkeley emeritus physics professor Arthur Rosenfeld a National Medal of Technology and Innovation for 2011. Rosenfeld received the award for his extraordinary leadership in the development of energy-efficient building technologies and related standards and policies.

“I am proud to honor these inspiring
Economy (ACEEE), and the University of American Council for an Energy Efficiency Energy Commission. He co-founded the Energy and as a member of the California Senior Advisor at the US Department of savings and is viewed by many as “the god- credited with billions of dollars in energy analysis and research, Rosenfeld is often an entrepreneurial environment.”

With a decades-long career in energy analysis and research, Rosenfeld is often credited with billions of dollars in energy savings and is viewed by many as “the godfather of energy efficiency.” He served as a Senior Advisor at the US Department of Energy and as a member of the California Energy Commission. He co-founded the American Council for an Energy Efficiency Economy (ACEEE), and the University of California’s Institute for Energy and the Environment (CIEE). His many honors include the 2006 Enrico Fermi Award “for a lifetime of achievement ranging from pioneering scientific discoveries in experimental nuclear and particle physics to innovations in science, technology, and public policy for energy conservation that continue to benefit humanity.”

The National Medal for Technology and Innovation, first awarded in 1985, is the United States’ highest honor for technological achievement. It recognizes individuals who have made lasting contributions to America’s competitiveness, standard of living, and quality of life through technological innovation, as well as those who have made substantial contributions to strengthening our nation’s technological workforce.

**BrunoFest Celebrates Zumino’s 90th**

BrunoFest – a symposium convened to honor Berkeley emeritus physics professor and world-renowned theoretical physicist **Bruno Zumino** on the occasion of his 90th birthday – brought together some of the world’s most distinguished physicists. Hosted by the Berkeley Center for Theoretical Physics (BCTP), the symposium took place May 2–4, 2013.

Bruno Zumino and Fabiola Gianotti

The weekend included a public lecture from **Fabiola Gianotti**, former spokesperson for the ATLAS experiment at the Large Hadron Collider (LHC) at CERN. Gianotti was runner-up to President Obama for *Time Magazine’s* Person of the Year for 2012, and a sellout crowd came to hear her speak on “The Higgs Boson and Our Life” at International House. She explained the relevance of the 2012 discovery of the Higgs boson and described the unprecedented instruments and challenges involved. Gianotti played a major role in the design and construction of the electromagnetic calorimeter that was central to the ATLAS observations of the Higgs. Her talk can be viewed online at [http://www.youtube.com/watch?v=QJQfmsHSoeY](http://www.youtube.com/watch?v=QJQfmsHSoeY)

BrunoFest speakers also featured Nobel laureate Steven Weinberg and 16 other physicists, including Berkeley alumni **Nima Arkani-Hamed** (PhD ’97) and **John H. Schwarz** (PhD ’66), along with Edward Witten, Savas Dimopoulos, John Ellis, and Luciano Maiani.

Physics professor **Petr Horava**, Director of the BCTP, said, “The easiest part of putting this conference together was gathering these amazing speakers. Everyone wanted to come to honor Bruno because Supersymmetry, his ‘invention’ together with Julius Wess, is the next Holy Grail at the LHC. Not to mention the fact that Bruno is beloved for being a truly kind and wonderful person.”

In addition to Zumino’s groundbreaking work on supersymmetric theory, he is well known for his proof of the CPT theorem, done in collaboration with German physicist Gerhart Luders. Zumino joined the Berkeley faculty in 1982 and has been professor emeritus since 1994.

“For health reasons Bruno was able to attend only part of BrunoFest,” said Maria Hjelm, Director of Development and Communications for the Department of Physics. “He came to his birthday banquet and greeted every single attendee, including physics professor **John David Jackson** and several Berkeley alumni.” Those alumni included Chryssomalal Chryssomalakos (PhD ’94), Oren Cheyette (PhD ’87), David Brahms (PhD ’90), Pei-Ming Ho (PhD ’96), and Ling-Lie Chau (PhD ’88).

**Fellowship and Symposium to Honor Stuart Freedman**

The late nuclear physicist **Stuart J. Freedman** is being remembered with the creation of a new graduate fellowship in his name and a scientific symposium to be held in his honor. Freedman, a nuclear physicist and world-renowned investigator of fundamental physical laws, served on the Berkeley physics faculty from 1991 until his unexpected death in 2012. He had held the Luis W. Alvarez Memorial Chair in Experimental Physics since 1999. A devoted teacher, Freedman supervised 15 graduate students, 40 undergraduate research students, and 18 post-doctoral fellows during his time at Berkeley.

The Stuart J. Freedman Memorial Fellowship Fund in Physics was established last year by Freedman’s wife, Joyce, a longtime UC Berkeley staff member, their son Paul and his wife Emily. The Freedman Fellowship will be used to support graduate students enrolled in physics at UC Berkeley who demonstrate high academic distinc-
Women of the Year Award Goes to SWPS

Berkeley’s Society for Women in the Physical Sciences (SWPS) was one of 16 recipients of the 2013 Women of the Year Awards from California Assembly District 15. The awards recognize individual women and women’s organizations who serve as role models and leaders for women and girls in science, technology, engineering, and math (STEM). Recipients were honored at a June 27 dinner hosted by California Assemblywoman Nancy Skinner and held at the Hilton Garden Inn in Emeryville.

The award announcement reads:

The Society of Women in the Physical Sciences is a volunteer student-run organization at UC Berkeley for women in the physical sciences. For over 20 years, the organization has provided resources, mentorship and leadership development. Each year, SWPS works to strengthen community within UC Berkeley and beyond in order to build the next generation of female scientists.

Outgoing SWPS head coordinator Natania Antler (C) and Kacey Meaker (R), a previous head coordinator, hold the plaque awarded to SWPS by California Assemblywoman Nancy Skinner (L).

“The East Bay is home to many distinguished women who have shattered the glass ceiling in the fields of science, technology, engineering, and math,” Skinner said. “The women and organizations honored are fueling new innovations and technologies that are changing our world for the better. Honoring these role models, we pave the way for many more women and girls to excel and change the faces of STEM.”

Natania Antler, outgoing SWPS coordinator, attended the dinner and accepted the award. “We were honored to accept this award on behalf of all the hard work that SWPS has done over the last 20 odd years,” she said, “and we’re very optimistic about the work that SWPS will continue to do in the future. Next year will prove to be an exciting one for SWPS, with Berkeley hosting the Conference for Undergraduate Women in Physics. As well, we are establishing a SWPS undergraduate organization in close collaboration with Compass, to greatly increase activity in our mentoring program. We are also working to augment our community building, career development, and outreach efforts.”

“I enjoyed listening to heartening stories about the other nominees,” Antler added, “and getting a chance to mingle with those who had come out to support them.”

Keynote speaker at the awards dinner was Carla Peterman, a PhD candidate at UC Berkeley, a Rhodes Scholar, an energy market researcher, and the first African American woman to be appointed to the California Public Utilities Commission.

Berkeley Hosts Conference for UG Women in Physics

UC Berkeley will host the 2014 West Coast Conference for Undergraduate Women in Physics (CUWiP) January 18-19. CUWiP at Berkeley is one of eight conferences to be held at US universities that weekend. Created by the American Physical Society (APS), the conferences aim to help women continue careers in physics following graduation. CUWiP gatherings are open to undergraduate physics majors and have been held annually since 2010.

According to the APS, CUWiP is designed to provide students “with the opportunity to experience a professional conference, information about graduate school and professions in physics, and access to other women in physics of all ages with whom they can share experiences, advice, and ideas.”

The 2014 West Coast conference will feature research talks by UC Berkeley physics faculty, scientists from Lawrence Berkeley National Lab and Lawrence Livermore National Lab, and industry professionals from around the Bay Area. Conference attendees will have the opportunity to tour laboratories on campus and at both national laboratories.

A career fair and panel discussions will introduce attendees to the wide range of opportunities in physics that exist beyond undergraduate work. Students who are involved in original research will be invited to make presentations about their work. Attendees will have the chance to interact with fellow students and engage in discussion with women now working in physics-related careers.

Interested students can find further information and registration details at: http://cuwip.physics.berkeley.edu.
ICOLS 2013 featured a public talk by Nobel laureate Eric Cornell titled “Lazy vs. Sloppy: The Epic Story of Energy, Entropy, Temperature, the Ultimate Fate of the Universe and the Role of Divine Intervention.” Cornell shared the 2001 Nobel Prize with Carl Wieman and Wolfgang Ketterle for their work combining laser cooling and evaporative cooling to synthesize a Bose-Einstein condensate. Cornell is currently a professor in the Department of Physics at University of Colorado and a Fellow at the National Institute of Standards and Technology.

In addition to Hänsch and Cornell, three other Nobel laureates were invited to give talks, including Serge Haroche and Berkeley alumnus Steven Chu (PhD ’76) and David Wineland (BA ’85). A reception held on the final evening included remarks from Berkeley emeritus physics professors Erwin Hahn, Y. Ron Shen, and Nobel laureate Charles Townes.

Department Chair Frances Hellman hosted a reception for all of the ICOLS speakers prior to the public lecture.

Farewell to Dave Jackson

On January 23, physics department Chair Frances Hellman and Robert Cahn, senior scientist at Lawrence Berkeley National Laboratory, hosted a goodbye and book-signing party for emeritus physics professor John David Jackson. After 45 years on the Berkeley faculty, Jackson was preparing to move to Michigan. While packing up his home, he realized he had many foreign-language editions of his classic textbook, Classical Electrodynamics. Jackson brought the books to the party, and attendees who were able to read from them aloud—in Chinese, Spanish, Swedish, etc.—were given a signed copy.

Students and faculty from campus and Lawrence Berkeley Lab also brought their own well-worn copies for Jackson to sign. They stood in a line that extended out the door of the A. Carl Helmholz Room (375 Le Conte) and on down the hall.

Bob Cahn, Senior Scientist at Lawrence Berkeley National Laboratory (LBNL), is a Berkeley physics alumnus (PhD ’72) and former student of Jackson’s. “For half a century,” Cahn said, “‘Jackson,’ as his text is universally known, has tested the mettle of physics graduate students around the world and made Dave legendary. At Berkeley, ‘Jackson’ meant much more than a textbook. Dave was devoted to the Department of Physics, where he served as Chair, and to the LBNL Physics Division, where he served as Division Director.”

“A particular goal of Dave’s was to increase the number of women in physics,” Cahn continued. “In recognition of his efforts, the women graduate students declared him ‘an honorary woman,’ perhaps the most unusual of the many awards he received, which include membership in the National Academy of Sciences and the Berkeley campus Distinguished Teaching Award. Since 2010, the American Association of Physics Teachers has presented The John David Jackson Award for Excellence in Graduate Physics Education, whose first recipient was emeritus physics professor Eugene Commins.”

Toasts in Jackson’s honor were given by Chancellor Bob Birgeneau, Chair Frances Hellman, and emeritus physics professor Bruno Zumino, among many others.

Murayama Wins Honors

Hitoshi Murayama

Last year, Berkeley physics professor Hitoshi Murayama was recognized by the Cabinet Office of the Japanese government as one of 63 Japanese citizens “who carried out notable activities into the
international community and thereby contributed to spreading the image of Japan to a global audience.”

“I’m greatly honored to be recognized by the Japanese government on my work in physics, its community, and helping its cause,” Murayama said. “I’m committed to building bridges between countries around the world and pushing the physics forward.”

Murayama is shouldering a number of distinguished positions in the international physics community. A member of the Berkeley physics faculty since 1995, he is also Director of the Kavli Institute for the Physics and Mathematics of the Universe, which is part of the Todai Institutes for Advanced Study at the University of Tokyo.

In addition, Murayama recently became Deputy Director of the Linear Collider Collaboration (LCC), which promotes the International Linear Collider (ILC), a next-generation collider project that will be able to follow up on discoveries made at the Large Hadron Collider at CERN.

At a February press conference about the ILC, organizers described it this way: “Truly global from the start. With some 1000 people from around the world working on its design, it can be built in stages – first, at half its design energy, as a so-called Higgs factory for the precision studies of the new particle, second, at its design energy of 500 GeV, and third, at double this energy, which opens further possibilities for as yet undiscovered physics phenomena. Japan is signaling interest to host the ILC.”

Murayama adds, “LCC is led by Director Lyn Evans, the man who built the Large Hadron Collider. He is tremendously capable, but wanted to have somebody next to him who’s familiar with the science of ILC and can communicate its excitement. I was honored that he picked me!”

New Kavli Energy NanoSciences Institute

The Kavli Foundation has endowed a new institute at UC Berkeley and Lawrence Berkeley National Laboratory to explore the basic science of how to capture and channel energy on the molecular or nanoscale, with the potential for discovering new ways of generating energy for human use.

The Kavli Energy NanoSciences Institute (Kavli ENSI), announced on October 3, will be supported by a $20 million endowment, with the Kavli Foundation providing $10 million and UC Berkeley raising equivalent matching funds. The Kavli ENSI will explore fundamental issues in energy science, using cutting-edge tools and techniques developed to study and manipulate nanomaterials — stuff with dimensions a thousand times smaller than the width of a human hair — to understand how solar, heat, and vibrational energy are captured and converted into useful work by plants and animals or novel materials.

Kavli ENSI researchers include Berkeley physics professors Carlos Bustamante and Alex Zettl. Bustamante uses advanced measurement equipment to study the physical properties of molecules in cells. Cells, he says, are seen as “small factories filled with molecular machines that use chemical energy to perform mechanical tasks. These nanodevices have evolved over eons into precise, highly coordinated machines. It is impossible to think about how energy flows at the nanoscopic level without thinking about how nature solved this problem in cells.”

Zettl has built the world’s smallest synthetic motor, consisting of a paddle that drives one perfectly smooth nanotube inside another. He has also built a radio from a nanotube. Zettl is excited to learn about biomolecular motors from Bustamante.

“But we’re not going to take our ideas and just bolt them together,” Zettl says. “We’re going to want to design something elegant that will behave the way we want. I can’t begin to think about this myself, I don’t know enough biology. But Carlos does.”

“The nano world is not just smaller, but fundamentally different,” Zettl adds. “The principles of physics we discovered in the laboratory still apply, but they apply very differently. It is not obvious to one person in one narrow field how to take advantage of this. That’s why the institute is so important. It brings ideas together...now we can work together and take advantage of these new ideas to do new things at this size scale.”

Kavli ENSI has already received matching fund gifts from the Heising-Simons Foundation, establishing a Heising-Simons Energy Nanoscience Fellows program.

Cohen Gives 2013 Oppenheimer Lecture

The 2013 Oppenheimer Lecture was delivered by emeritus physics professor Marvin L. Cohen, who noted that his field, condensed matter physics, is in the “Goldilocks zone”—roughly in the middle of the energies, sizes, and time scales of interest to physicists.

On March 11, the J. Robert Oppenheimer Distinguished Lecture for 2013 was given by Marvin L. Cohen, who has been the organizer of this annual lectureship since its inception in 1998. Physics chair Frances Hellman, in her introduction to Cohen, noted that, “Like Oppenheimer, who is credited with making the tradition of theoretical physics flourish at Berkeley, Marvin has done the same for condensed matter theory, particularly in the area of materials physics.”

Cohen titled his lecture ‘Condensed Matter Physics: The Goldilocks Science’ because, he said, “...the focus in condensed matter physics is on energies, sizes, and time scales that are not extremely big or extremely small, but somewhere we loosely call the ‘middle’, it is an area of science that reminds us of Goldilocks, who said, ‘Ahhh, this porridge is just right.’ It can be argued that because of its Goldilocks nature, condensed matter physics has many links to other branches of physics and more generally other areas of science and engineering.”

He pointed out that condensed matter physics (CMP) “has one foot in theory and one foot in experiment” and has reaped 25 Nobel Prizes.
In his remarks, Cohen gave an overview of the field of CMP, including its accomplishments and contributions as well as the problems and challenges CMP researchers are seeking to solve. He described some of the field’s history, including Alfred Einstein’s work with molecular dimensions and Brownian motion as well as special relativity. He discussed differences between what he termed the Interacting Atoms Model of solids, which focuses on electromagnetic interactions among atoms, and the Elementary Excitation Model, which emphasizes the emergent properties of materials under varying conditions. He summarized results of research on carbon nanotubes, fullerenes, and boron nitride tubes conducted in Berkeley’s Department of Physics and elsewhere. And he described the state of knowledge of the mechanisms behind superconductivity.

At the conclusion of his talk, Cohen returned to his Goldilocks theme. “As a theorist,” he said, “I want to consider a more general solution to all those problems, and all future problems in physics: My suggestion is to ask Goldilocks to convince her girlfriends to consider physics and science in general as a career. We need more diversity in physics, and I wish young girls and young women would take the Goldilocks approach when dreaming about and planning for a career. They may conclude that being a Hollywood star is too hot, being an investment banker is too cold, but being a woman scientist may be just right.”

A webcast of the lecture can be viewed online in the Physics Webcasts Archive on the Department of Physics home page, www.physics.berkeley.edu.

Cohen is University Professor of Physics at Berkeley and Senior Faculty Scientist at Lawrence Berkeley National Laboratory. He has been awarded the National Medal of Science, the APS Oliver E. Buckley Prize for Solid State Physics, the APS Julius Edgar Lilienfeld Prize, the Foresight Institute Richard P. Feynman Prize in Nanotechnology, and the Technology Pioneer Award from the World Economic Forum, along with many other honors.

Berkeley’s Robert J. Oppenheimer Lectureship, awarded annually, celebrates Oppenheimer’s contributions to science by bringing some of the brightest minds in theoretical physics to the Berkeley campus. It was established in 1998 with support from Berkeley alumnus Steve Krieger, Arlene Krieger, the Jane and Robert Wilson Endowment in Physics, and other Friends of Physics.

Since his retirement in 2011, a funding campaign has been underway to honor emeritus physics professor Marvin Cohen by creating the Marvin L. Cohen Condensed Matter Physics Interaction Area. On March 11, 2013, the same evening Cohen presented the 2013 Oppenheimer lecture, it was announced that the campaign’s goal of $300,000 had been reached and that the creation of architectural plans would begin immediately. The interaction area, to be located on the fifth floor of Birge Hall, will help fulfill Cohen’s dream for both condensed matter theorists and experimentalists: to have a place where faculty, postdocs, and grad students can come together to share ideas, collaborate, and further their research.

The dinner, which took place immediately following Cohen’s lecture, was attended by a number of his closest colleagues and friends, all of whom wanted to pay him tribute. Among them were Chancellor Robert Birgeneau and his wife Mary Catherine Birgeneau, as well as physics professors Frances Hellman, Steve Louie, and Alex Zettl.

Several of Cohen’s former students attended, including John Northrup (PhD ’83), a scientist at PARC (a Xerox company), and Jisoon Ihm (PhD ’80), a professor of Physics at Seoul National University in Korea. Ihm represented a group of Korean students and colleagues of Cohen, all of whom gave generously to the funding campaign. Also in attendance were alumnus Steve Krieger (BS ’59, PhD ’63) and Arlene Krieger, who kicked off the Cohen Interaction Area giving campaign a few years ago. Alumni and friends Garrett Gruener (MA ’77), Amy Slater, and Marianne Friedman (ATU ’59) also took part in the festivities. The many toasts given in Marv’s honor struck two common themes—the importance of his physics research and the friendships he has made along the way.

Architectural plans have been created and refined, and further funding is being sought for an expanded interaction area.

Contributed by Maria Hjelm, Director of Development and Communications for the Department of Physics

Peter Jenni Gives 2012 Segrè Lecture

On Nov 5, 2012 Dr. Peter Jenni, CERN Scientist and former spokesperson for the ATLAS experiment at CERN’s Large Hadron Collider (LHC), gave the 2012 Emilio Segrè lecture. The talk was titled “Hunting for the Higgs Boson and More at the LHC.”

Jenni was a leader in the making of ATLAS, one of the two experiments at the LHC that in July 2012 announced the discovery of a new particle consistent with the Higgs boson. Jenni’s involvement with CERN dates back to the 1970s, during his student days, and he became a CERN staff member in 1980. He has been a part of the ATLAS project since its inception, serving as the experiment’s spokesperson from 1995 to 2009. Though he retired this past July, he continues to be involved in the operation and physics of ATLAS as a guest scientist with Albert-Ludwigs-University Freiburg.

In his remarks, Jenni discussed the history of the LHC project, the technical challenges involved in designing and building the largest particle accelerator ever made, and the scientific observations behind the discovery of the Higgs. He described...
how the data are consistent with the Higgs boson predicted by the Standard Model, and pointed out that much more data is needed before a final conclusion is reached.

Jenni also described how scientists working at both the ATLAS and CMS experiments at the LHC are looking for physics beyond the Standard Model. These efforts include searches for supersymmetric particles, which could help solve the mystery of dark matter, as well as the search for the graviton and for evidence of the existence of extra dimensions. He explained that the LHC would be shut down to upgrade it from 8 TeV to its design energy of 14 TeV, with operation to resume late in 2014. Luminosity — the intensity of the particle beams — will gradually be increased from 2014 until about the year 2020.

“We are only at the beginning of the lifetime of the LHC,” he said. “We have exciting discoveries ahead of us. Almost 20 years of working with the Berkeley colleagues and friends in ATLAS was a real pleasure and we are looking forward to a bright future for this enterprise for at least another 15 years.”

A webcast of Jenni’s talk can be viewed online in the Physics Webcasts Archive on the Department of Physics home page, www.physics.berkeley.edu.

The Emilio Segrè lectureship enables the Department of Physics to bring some of the world’s most important and influential experimental physicists to the Berkeley campus. It was established by an endowment from the Raymond and Beverly Sackler Foundation to honor Segrè, who shared with Owen Chamberlain the 1959 Nobel Prize in physics for the discovery of the antiproton.

Berkeley Physics featured in APS Video

The Physics Department at the University of California at Berkeley is full of distinguished professors, exciting research, and scientific breakthroughs. As discoveries in physics propel the world into the future, this department has embraced its students as key collaborators in research and experimentation. The Berkeley Department of Physics is opening doors for aspiring physicists and the great discoveries of tomorrow.

These statements are from the YouTube description of a short video about

the educational opportunities afforded by UC Berkeley’s Department of Physics. Premiered at the March 2013 meeting of the American Physical Society, the video not only puts a human face on the department, but also helps recruit new students. It features lab footage and brief statements from a number of faculty members and students, along with narration by physics professor and former department chair Frances Hellman. Mentoring and peer support offered by the department’s Compass Project are also highlighted.

The video can be viewed online in the Physics Webcasts Archive on the Department of Physics home page, www.physics.berkeley.edu.

New Campbell Hall Construction Update

New Campbell Hall – a replacement building that will house physics and astronomy research – is well on its way to completion. A great deal has been accomplished since May 2012, when the old building was demolished. According to Jim Wert, Project Manager and Site Coordinator, the outside of the building is complete, windows will be installed this winter, and many of the electrical, mechanical, and pumping systems are already in place. The new building is expected to be ready for occupancy by the end of 2014.

“An interesting and unique part of the project,” Wert reports, “is the use of both horizontal and vertical post-tension cables. Usually, only one or the other is used, but this building has both. One wall has more than 3 million pounds of tension. This means a more seismically fit building, as well as less vibration for all the labs.” In addition, the use of fiberglass rebar in about one-third of the laboratory floors will cut down on electromagnetic frequency (EMF) interference that can affect laboratory experiments.

The high-stability low-noise research laboratories located in the basement of the new building have been funded by the National Institute of Science and Technology (NIST). “NIST has been part of the construction process all along,” Wert says, “and they are very pleased. They’ve made three site visits and we’ve also been having monthly phone meetings.”

New Campbell Hall is being constructed in accordance with UC Berkeley’s green building practices and is registered to receive a silver LEED rating from the US Green Building Council.

Donald A. Glaser Advanced Lab

Friends, colleagues, and family of the late Nobel laureate Donald A. Glaser gathered on Monday, September 16 to christen the newly renovated Physics 111 Lab in his name. Glaser was not only an emeritus professor of physics at Berkeley, but also a professor of molecular and cell biology, and a professor of neuroscience. (See In Memory, p. 28)

UC Berkeley Chancellor Nicholas Dirks officiated at the dedication. “Naming this student laboratory after Don Glaser is fitting for so many reasons,” Dirks said. “Clearly, Don was the ultimate scientist and the ultimate experimentalist.”

“One of my greatest pleasures as a new Chancellor,” he continued, “is learning about the remarkable people who have made this university great. Donald Glaser was one of these people – a man with the kind of mind that could invent the bubble chamber, play concert viola, take part in the invention of cutting-edge medical therapies, and find new insights into the way the human brain works.”

Dirks expressed special thanks to Glaser’s family, many of whom were present, for their generous help in making the renovation possible. Two of the family members who were present at the dedication added
their remarks to the festivities. Glaser’s son, Will Glaser, talked about his father’s love of teaching and his inexhaustible curiosity. Glaser’s granddaughter, Kate Schreiner, who just entered UC Berkeley as an undergraduate, talked about her grandfather’s questions and how every conversation ended with the ultimate question: “What’s next?”

Donors to the Donald A. Glaser Advanced Lab also include Douglas (‘64) and Marion Lee, who established the Chester Archie Lee and Clara Ying Fong Lee Fund were also present at the dedication. The fund was created in honor of Douglas Lee’s parents who, as emigrants from China, owned a grocery store in Oakland’s Chinatown. “They worked tirelessly to send their children to college in the University of California system,” Dirks said. “This endowed fund benefits the Glaser Advanced Lab and will help make this course sustainable over time.” Other donors thanked at the dedication included Stanford Research Systems, Arlene and Douglas Giancoli, Christina Anderson McKinley and Bill and Luisa Hansen.

Maria Hjelm, Director of Communications and Development for the Department of Physics, reported that physics professor John Clarke “gave a lovely toast to Don, the lab, and to the fact that Don’s other great love was music. In his honor, Ethan Filner of the Cypress String Quartet played the prelude and gigue from Bach’s Suite No. 3. It was a fitting tribute.”

**Cal Day 2013**

This year’s Cal Day, UC Berkeley’s annual open house, took place Saturday, April 20. The Department of Physics offered a variety of events, from lectures on cutting-edge physics to guided tours of research labs to demonstrations and lab experiments. Several thousand visitors got to explore the department and experience the fun of being a physicist.

“Hands-On Physics” offered interactive exhibits and demonstrations for all ages and was hosted by physics graduate and undergraduate students in the second-floor labs of LeConte Hall. Professor Bob Jacobsen offered two sessions of the perennially popular “Fun with Physics: Why Should Students Have all the Fun?” complete with jaw-dropping demonstrations.

A guided tour of the Quantum Nanoelectrics Lab taught observers about experiments conducted at temperatures near absolute zero, and tours of the Donald A. Glaser Advanced Lab were held throughout the day. The Dark Matter Search Open Laboratory Tour offered opportunities to learn about weakly interacting massive particles (WIMPS) from graduate physics students.

Visitors were treated to a number of lectures from Berkeley physics professors:

- Adrian Lee talked about “The Microwave Background: a Cosmic Time Machine.”
- Eliot Quataert described how the universe evolved in his talk, “The Modern Origins Story: From the Big Bang to Life on Earth.”

A constant stream of potential physics majors and their parents were invited to meet with Undergraduate Advisor Claudia Trujillo, who answered questions about the physics program, academic requirements and opportunities, and life as an undergraduate. Tables for Physical Science Majors were set up in the Information Marketplace on Sproul Plaza, along with a Society of Physics Students table that featured startling physics demonstrations.

Cal Day 2014 is set for April 12!

**Faculty Awards and Honors**

Robert Birgeneau received the 2012 Karl Taylor Compton Medal for Leadership in Physics. He was also selected to lead American Academy’s New Lincoln Project: Excellence and Access in Public Higher Education.

Raphael Bousso was named a Fellow of the American Physical Society.
Kam-Biu Luk will share the 2014 W.K.H. Panofsky Prize with Yifang Wang of China’s Institute of High Energy Physics “for their leadership of the Daya Bay Reactor Neutrino Experiment, which produced the first definitive measurement of 613 angle of the neutrino mixing matrix.” The 2014 Panofsky Prize is awarded annually by the American Physical Society to recognize outstanding achievements in experimental particle physics.

Joel Moore was named a Simons Investigator for 2013. Support from the Simons Investigators Program enables outstanding scientists to undertake long-term study of fundamental questions. The citation describes him as “one of the leaders in the study of the topological aspects of electronic physics, particularly known for this work with Balents on strong topological insulators and his work with Orenstein and Vanderbilt on magnetoelectric couplings and optical responses induced by geometric and topological terms in various material classes. He has also obtained significant results on nonequilibrium dynamics of interacting quantum systems, significantly elucidating the role of quantum entanglement in these phenomena.”

Hitoshi Murayama was named a Fellow of the American Association for the Advancement of Science (AAAS).

Ramamoorty Ramesh has been awarded the 2014 TMS John Bardeen Award. The award is given by The Minerals, Metals, and Materials Society to recognize “individuals who have made outstanding contributions and is a leader in the field of electronic materials.”

Arthur Rosenfeld was presented with a National Medal of Technology and Innovation at White House ceremony held on December 21, 2012.

Dan Stamper-Kurn was named a Fellow of the American Physical Society (APS).

New Faculty

Oskar Hallatschek

Oskar Hallatschek joined the Berkeley faculty in July of this year as Assistant Professor in the Department of Physics. He holds the Williams H. McAdams Chair on campus, and is also associated with the Physical Biosciences Division at Lawrence Berkeley National Laboratory. He applies methods from statistical physics and soft matter physics to problems in biophysics and evolutionary biology.

Hallatschek studied physics at the University of Heidelberg and ETH Zurich, and obtained his doctoral degree in theoretical biophysics in 2004 from the Freie Universität Berlin. In 2005 he began postdoctoral work on experimental and theoretical evolution at Harvard University, and in 2009 returned to Germany to start an independent research group on Biophysics and Evolutionary Dynamics at the Max-Planck-Institut for Dynamics and Self-Organization in Göttingen.

Hallatschek combines methods from experimental biology and theoretical physics to study evolutionary dynamics in microbial populations. “Much of the biological complexity we see today is the result of chance,” he says, “since biological evolution happens through at least partially random events, such as mutations, birth, and death. Predicting the evolutionary consequences of the vicissitudes of life is at the heart of our theoretical research efforts. We are driven by basic evolutionary puzzles such as ‘How fast is evolution?’ or ‘Under which circumstances is evolution driven by survival of the luckiest rather than the fittest?’”

Finding the answers involves analyzing complex systems that exhibit stochastic, or random, behavior. “These analyses sometimes require inventing novel statistical physics methods,” he adds. “For instance, we recently developed an exact method to predict the accumulation of random mutations in finite populations, which was an open problem for half a century.” To test their theoretical models in the lab, Hallatschek and his colleagues use microbes grown in liquid media, on agar plates, and in micro-fluidic devices. Their research has revealed novel patterns of chance and adaptation that also are found in natural populations of multicellular species.

“Our evolutionary experiments also fuel biophysical research questions,” he adds, “such as ‘What forces can be generated by microbial populations when they grow in confined geometries?’ We want to understand how the organization of microbial colonies relates to the physics of the surrounding matrix, particularly hydrodynamics and viscoelasticity. Ultimately, this interdisciplinary approach might help control the formation and adaptation of biofilms, which are microbial communities involved in numerous infectious diseases and responsible for significant industrial costs.”
Noisy Waves According to Hallatschek, the wave-like spread of discrete entities pervades everyday life. For example, the spread of ions controls the human heartbeat, the spread of pathogens affects the yearly threat of influenza, and the spread of mutations leads to evolutionary progress.

“Despite intensive research in the past, these traveling waves could be analyzed only within deterministic limits or uncontrollable approximations,” Hallatschek explains. “However, through stochastic simulations, many labs have now shown that inevitable number fluctuations have a strong impact on wave dynamics.”

“Simple models of biological evolution are the prime example of this drastic sensitivity to noise, because they are dominated by the few most fit individuals in a population,” he continues, “and these models break down if number fluctuations—a phenomenon also known as genetic drift—are neglected. We recently described an exact theoretical framework to account for number fluctuations in noisy traveling waves and related problems. The framework was subsequently used to predict how fast well-mixed populations adapt in the course of an evolution by the few most fit individuals in a population.”

Amin Jazaeri, New Director of Instructional Support

Dr. Amin Jazaeri joined the Department of Physics in July as the new Director of Instructional Support, succeeding Dr. Tom Colton. Jazaeri comes to the department from George Mason University in Fairfax, VA, where he was an Assistant Professor with the School of Physics, Astronomy and Computational Sciences (SPACS).

In addition to teaching undergraduate and graduate courses at Mason, Jazaeri served as the STEM (Science, Technology, Engineering, and Math) Coordinator, representing SPACS in the Accelerator Program. He was responsible for the retention, recruitment, and advising of students, along with the creation of innovative teaching pedagogy in the classrooms.

Jazaeri’s achievements include the design and implementation of a blended learning environment he calls LOGIC (Lectures Online, Group-work In Class). He has extensive experience teaching online courses. His undergraduate and graduate studies were in physics and electrical engineering, and he earned his PhD in Computational Sciences from George Mason University in 2007.

Benjamin Spike, New Academic Coordinator

In August, the Department of Physics welcomed Benjamin Spike to the post of Academic Coordinator and Lecturer. He received a Bachelor’s degree from the University of Wisconsin-Madison in 2007 and most recently attended the University of Colorado-Boulder, where he received his MSci in Physics in 2010 and will be awarded a PhD this fall.

During his time at CU-Boulder, Spike conducted research on the pedagogical development of physics teaching assistants. He also co-directed programs designed to foster community among graduate students and enhance their ongoing professional development. From 2008 to 2013 he served as Lead Graduate Teacher for the CU-Boulder physics department.

In his new role at Cal, Spike serves as a mentor and consultant for physics Graduate Student Instructors (GSIs). He is working to improve GSI preparation through weekly course meetings and the Physics 375 pedagogy seminar. He also leads efforts to incorporate research-based instructional strategies into the lower division physics course series and supports faculty, GSIs, and staff in using new tools and materials to enhance student learning.

Staff Retirements

Carol Dudley basks in the glow of her retirement celebration.

Carol Dudley, Human Resources and Administrative Manager, retired in January. She had been working in the physics department since 1993. She began her career at Berkeley in the Department of Physics, working here from 1984 to 1990, then moved to the Department of Chemistry for three years before returning to physics. “Carol was an invaluable source of knowledge about the department and campus,” said Frances Hellman, outgoing Department Chair. “She was regularly my go-to person when I needed to brainstorm about a new idea or how to approach some difficult project.”

Tom Colton, Claudia Lopez and Marco Ambrosini enjoy their retirement send-off.

Claudia Lopez, Director and Administrative Manager, retired on July 1. She had been working at the Department of Physics since 2005. She began her career in the Chancellor’s Office, and spent 25 years in the College of Letters and Science prior to coming to physics. “Claudia Lopez understood all the financial complexities of running this large department with its

Staff News

Welcome to Anil More, New Director of Administration

The Department of Physics is pleased to welcome its new Director, Anil More, who took up the post this summer. Anil comes to physics from Lawrence Berkeley National Laboratory (LBNL) where he most recently held the post of Operations Manager for the Office of the Chief Financial Officer. Prior to that, More directed the Administrative Services Department at LBNL.

Physics Chair Steve Boggs commented that, “The physics department will grow even stronger with More’s 30-plus years of diverse operational experience that includes strategic planning, financial and human resource management, and leadership at all levels.” Anil holds an MBA in Finance from Golden Gate University.
many sources and needs for funds,” said outgoing Department Chair Frances Hellman. “She was the person I give all the credit to for getting us through the state and campus financial crisis in the middle of my term as chair of the department.”

Thomas Colton, Lab Instruction Supervisor, retired on July 1. A member of the Department of Physics staff since 2000, he came to physics after ten years in Berkeley’s Integrative Biology Department. Prior to that, he spent eight years at the Department of Physics staff since 2000, he came to physics after ten years in Berkeley’s Integrative Biology Department. Prior to that, he spent eight years at the University of Chicago. “Tom brought a biologist’s eye for patterns and communities to Physics, and made us a better place,” said physics professor Bob Jacobsen. “Tom kept making things happen, even when nobody else was sure they were even possible.”

Marco Ambrosini, Machine Shop and Engineering Tech Supervisor, retired on July 1. Marco, a native of Italy who served two years in the Italian navy, came to the University of California San Francisco. He worked in the Department of Physics from 1985 to 1993, when he moved to the Physiology Department at University of California San Francisco. He returned to Berkeley’s physics department in 1996, where he remained until retirement. Marco’s successor, Warner Carlisle, said of him, “He was well-liked by the faculty and staff because of his personable approach, not to mention the excellent work performed by the Machine Shop.”

In Memory
Donald A. Glaser (1926-2013)

Donald Arthur Glaser, a Nobel-prize winning physicist who reinvented himself as a biotech pioneer and later dove into the field of neurobiology, died in his sleep on the morning of February 28, 2013 at his home in Berkeley. He was 86.

Glaser, a professor emeritus of physics and of molecular and cell biology at the University of California, Berkeley, won the 1960 Nobel Prize in Physics for inventing the bubble chamber, a device to allow scientists to track the paths of electrons, protons and other charged particles after collisions, which led to the discovery of whole families of new particles.

In 1961 he began to explore the new field of molecular biology. As with the bubble chamber, he used his experience designing equipment to improve the experimental process, automating and accelerating essential phases of the work, leading to new discoveries in the field. In 1971 he joined two friends, Ronald E. Cape and Peter Farley, to found the first biotechnology company, Cetus Corp., to exploit these new discoveries for the benefit of medicine and agriculture. The company developed interleukin and interferon as cancer therapies, and was also known for producing a powerful genetic tool, the polymerase chain reaction, to amplify DNA. In 1991, Cetus was sold to Chiron Corp., now part of Novartis.

In the 1980s, Glaser turned his attention to the field of neurobiology and spent a semester at The Roland Institute for Science in Cambridge, Mass., where he began psychophysics experiments in human vision, investigating the way that the brain processes what it sees. Based on these experiments, he developed mathematical models that he simulated on a computer, said neurobiologist Tomaso Poggio, a professor in the McGovern Institute for Brain Research at the Massachusetts Institute of Technology, who first met Glaser as he was changing fields in the 1980s.

“He was a great human being and a close friend who was incredibly kind,” Poggio said. “He was always able to see the world in a different way, and make remarks that were refreshing, original and very often witty.”

Glaser was born in Cleveland, Ohio, on Sept. 21, 1926, the son of Russian immigrant parents William J. Glaser, a business man, and his wife Lena. He received his early education in the public schools of Cleveland Heights, and completed his Bachelor of Science degree in physics and mathematics at the Case Institute of Technology in 1946. During this time he also pursued his lifelong passion for music, playing viola with the Cleveland Philharmonic Orchestra. After serving as a teacher of mathematics at the Institute, he began his graduate studies at the California Institute of Technology in fall 1946. He obtained his PhD in physics and mathematics from Cal Tech in 1950 with a thesis on the momentum spectrum of high energy cosmic ray and mesons at sea level.

“He was always able to see the world in a different way, and make remarks that were refreshing, original and very often witty.”

In 1949, Glaser began teaching in the physics department of the University of Michigan, where he examined various experimental techniques, including diffusion cloud chambers and parallel-plate spark counters, for visualizing elementary particles. He finally hit on the idea of a bubble chamber – “a pressure cooker with windows,” in his words – and built the first one-inch prototype in 1952. The device worked by superheating a liquid – for example, xenon – above its boiling point so that a particle moving through it left a trail of boiling bubbles that could be tracked and photographed.

“The bubble chamber was a major breakthrough and led to the discovery of a zoo of new particles,” said particle physicist Herbert Steiner, UC Berkeley professor emeritus of physics. “It was the dominant particle detector in the 1960s and ’70s, and had an enormous impact on the field of particle physics.”
Among Glaser’s associates in research were J. Brown, H. Bryant, R. Burnstein, J. Cronin, C. Graves, R. Hartung, J. Kadyk, D. Meyer, M. Perl, D. Rahm, B. Roe, L. Roellig, D. Sinclair, G. Trilling, J. van der Velde, J. van Putten and T. Zipf.

Glaser came from an accomplished academic lineage. His advisor, Carl Anderson, was the student of Robert Millikan, both Nobel Laureates from Cal Tech. According to Glaser, his students used to wonder who might continue this distinguished tradition. In 1993, Kary Mullis, one of Glaser’s colleagues at Cetus Corp., received the Nobel Prize in Chemistry for his invention of the polymerase chain reaction (PCR) method. Just two years later in 1995, Martin Perl, another colleague, also received the Nobel Prize in Physics for the discovery of the tau lepton.

Glaser received many honors for his work, including the 1953 Henry Russel Award at the University of Michigan for distinction and promise in teaching and research; the 1958 Charles Vernon Boys Prize of the Physical Society, London, for distinction in experimental physics; the 1959 American Physical Society Prize for his contributions to experimental physics; the honorary degree of Doctor of Science by the Case Institute of Technology, and in 1966 the Caltech Distinguished Alumni Award.

Glaser was also a consultant and adviser to many governmental organizations, industrial boards of directors, non-profit groups, and a member of the editorial boards of several scientific publications. He also was a member of the Life Sciences Division at Lawrence Berkeley National Laboratory.

Glaser is survived by his wife, Lynn Glaser (nee Bercovitz), a musician, painter and Cal alumna; two children, pediatrician Louise Ferris Glaser of Sacramento and high-tech leader William Thompson Glaser of Berkeley, from his first marriage to Ruth Bonnie Thompson; and four granddaughters.

In September 2013, the Donald A. Glaser Advanced Lab, an undergraduate experimental teaching lab in Physics, was dedicated in his memory. A required course for all Physics majors, Physics 111 is a notoriously difficult class, but it is where students experience the basics—the pitfalls and the triumphs—of experimental research which was at the heart of Glaser’s entire career.

“He was a man of wide-ranging interests, very inventive, always thinking outside the box,” his colleague Herbert Steiner said. “I think all his life he had the mind, the curiosity, the freshness of a kid,” Tomaso Poggio said. “He was fun. That is something I will really miss a lot.”

This remembrance is from the Academic Senates’ In Memoriam publication.

Contributors include:
Lynn Glaser, Maria Hjelm, Tomaso Poggio, Bob Sanders, Margaret Thow, George Trilling, and Herbert Steiner

Robert Lin (1942-2012)

Physicist Robert Peichung Lin, a former director of the Space Sciences Laboratory at the University of California, Berkeley, who designed and built dozens of instruments to study solar flares, the magnetic fields on the surface of the moon and Mars and the plasma environment of Earth, died suddenly of a stroke on Saturday, Nov. 17.

Lin, 70, professor emeritus of physics, was working on at least four upcoming satellite and balloon experiments at the time of his death. He passed away at Alta Bates Medical Center in Berkeley.

According to Stuart Bale, UC Berkeley professor of physics and current director of the Space Sciences Laboratory (SSL), Lin essentially invented the field of high energy space physics after he and the late UC Berkeley physicist Kinsey Anderson accidentally discovered that solar flares emit high-velocity charged particles that can be observed from Earth.

“Much of what we know about astrophysical particle acceleration comes from X-ray and gamma-ray measurements that are based on underlying physics discovered by studying solar flares, much of it Bob’s work,” Bale said.

Bale said that it is hard to pigeonhole Lin’s field of study, since he excelled in many. Lin built satellite instruments to detect the energy of electrons and then put these electron reflectometers/magnetometers aboard the NASA missions Mars Global Surveyor in 1997 and Lunar Prospector in 1998.

These instruments enabled scientists to remotely measure the surface magnetic fields and reconstruct the geologic history of Mars and the moon. That technique contributed to the development of a full instrument suite being readied for launch next year aboard NASA’s Mars Atmosphere and Volatile Evolution Mission (MAVEN) mission.

RHESSI Satellite
Lin was the principal investigator for the 11-year-old Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI), which is still using X-ray and gamma-ray detectors to explore the basic physics of particle acceleration and explosive energy release in solar flares.

“Bob Lin’s greatest achievement was RHESSI,” said astrophysicist Brian Dennis of the Solar Physics Laboratory at NASA Goddard Space Flight Center in Maryland. “It most probably would not have happened at all without his energetic support and leadership; it certainly would not have been nearly so successful.”

Lin’s team also built instruments for the Solar TErrestrial RElations Observatory (STEREO) and, most recently, the innovative modular minisatellite called CubeSat for Ions, Neutrals, Electrons, & MAgnets (CINEMA), as well as European spacecraft such as Giotto, a 1986 mission to Halley’s Comet. That experiment led to the first report of a large molecule—a polymer of formaldehyde—on a comet, probably dating back to the origin of the solar system more than 4 billion years ago.

Most recently, he was working with graduate and undergraduate students on two other CubeSats and conducting balloon tests of a new Focusing Optics X-ray Solar Imager (FOXI), which successfully observed the sun for six minutes on Nov. 2 during a flight in the New Mexico desert.

When SSL celebrated its 50th anniversary in 2009, Lin remarked that “It’s fortunate that, once our missions are up there, they work great and last forever,” a point of pride many colleagues largely credit to Lin.

“His late advisor, Kinsey Anderson, described him once as a juggler who could keep many items in the air at one time and who would sometimes just voluntarily add another one,” recalled astrophysicist Hugh S. Hudson of SSL and the University of Glasgow in Scotland. “In all of his fields, he was fully supportive of the students.
and postdocs involved, and all of them will miss his invariably helpful and intelligent inputs keenly now.”

**From China to Berkeley**

Lin was born in Kwangsi, China, on Jan. 24, 1942, but moved with his parents to London at a young age, and thence to Michigan. He obtained his B.S. from Caltech in 1962 and his PhD in physics in 1967 from UC Berkeley. He continued his research at SSL, and in 1980 he was appointed a senior fellow at the laboratory. In 1988 he became an adjunct professor of astronomy at UC Berkeley, and in 1991 he was named a professor of physics. He served as SSL director from 1998 until 2008.

Hudson noted that one of Lin’s balloon experiments in 1984 discovered solar micro-flares, which inaugurated a large literature of research that quickly led to theoretical proposals that solar flares are made up of many micro- and nanoflares that heat up the sun’s atmosphere to several million degrees.

During Lin’s 40-year tenure at SSL, he was a member of the lab teams involved in many satellite missions, including IMP 4, 5 & 6; Explorer 33 & 35; Apollo 15 & 16 Subsatellites; ISEE 1, 2 and 3; Wind; Cluster CODIF and THEMIS.

“He really defined what SSL was,” Bale said. “People around the country called it Bob’s lab.”

Bale also noted that more than 40 years ago, Lin began hosting his research group for lunch on Mondays at a local Chinese restaurant, a tradition that spawned similar Chinese lunch outings at places like the University of Minnesota.

Lin was a member of the National Academy of Sciences, a fellow of the American Academy of Arts and Sciences and the American Geophysical Union, and a recipient of the George Ellery Hale Prize from the Solar Physics Division of the American Astronomical Society. He also received a Docteur Honoris Causa de l’Universite de Toulouse in France.

In 2001, in recognition of his work with young science and engineering students, UC Berkeley’s College of Letters and Science gave Lin its Distinguished Research Mentoring of Undergraduates award.

Lin is survived by his wife, Lily Lin, of Berkeley, and a stepson, Limus Sun, of New York City.

A graduate scholarship in Lin’s honor is being established at SSL. More information is available at the SSL web site, http://ssl.berkeley.edu.

**Wulf Kunkel (1923-2013)**

Wulf B. Kunkel, emeritus professor of physics at the University of California at Berkeley, died in his sleep on September 3, 2013 at his home at the Lake Park Retirement Residence in Oakland. He was 90.

Kunkel was born in Germany on February 6, 1923. He spent his formative years at the Quaker school Eerde in Holland where he fell in love with writing, directing, and acting in plays, to the point that it was difficult for him to decide between theater and another interest, physics. During World War II, he studied physics at the University of Amsterdam.

During that year he also became Professor of Physics at UC Berkeley. From 1971 to 1991 he served as leader of the Fusion Research Program at LBNL. He was a Fellow of the American Physical Society and was a Guggenheim Fellow twice. In 1982 he received the Alexander von Humboldt Award. He became Professor Emeritus in 1991 and continued as a Participating Scientist in LBNL’s Accelerator and Fusion Research Division.

“Wulf specialized in the development of ion beams for plasma heating,” said his colleague, Alan Kaufman. “He regularly taught the undergraduate plasma course, and was an outstanding teacher.”


Kunkel loved Berkeley, but when not in Berkeley, he and his family enjoyed spending time in Sea Ranch and Pt. Reyes. He is survived by his wife Erika, three children, Laurence, Barbara, and Maya, his sister Mia and brother Bill, grandchildren Katia and Timothy Nonet, and son-in-law Michael Nonet. He was preceded in death by his brothers Peter and John.
Physics in the News
Excerpts from news coverage of UC Berkeley physicists

Quantum Measurements Leave Schrödinger’s Cat Alive
From NewScientist, October 3, 2012, by Lisa Grossman

...By making constant but weak measurements of a quantum system, physicists have managed to probe a delicate quantum state without destroying it—the equivalent of taking a peek at Schrödinger’s metaphorical cat without killing it. The result should make it easier to handle systems such as quantum computers that exploit the exotic properties of the quantum world.

Researchers had suggested it should be possible, in principle, to make measurements that are “gentle” enough not to destroy the superposition. The idea was to measure something less direct than whether the bit is a 1 or a 0—the equivalent of looking at Schrödinger’s cat through blurry glasses. This wouldn’t allow you to gain a “strong” piece of information—whether the cat was alive or dead—but you might be able to detect other properties.

Now, R. Vijay of the University of California, Berkeley, and colleagues have managed to create a working equivalent of those blurry glasses. “We only partially open the box,” says Vijay.

Even though the measurement was gentle enough not to destroy the quantum superposition, the measurement did randomly change the oscillation rate. This couldn’t be predicted, but the team was able to make the measurement very quickly, allowing the researchers to inject an equal but opposite change into the system that returned the qubit’s frequency to the value it would have had if it had not been measured at all.

Gordon and Betty Moore Foundation Gives a Big Boost to Big BOSS
From Phys.org December 4, 2012

A $2.1 million grant from the Gordon and Betty Moore Foundation to the University of California at Berkeley, through the Berkeley Center for Cosmological Physics (BCCP), will fund the development of revolutionary technologies for BigBOSS, a project now in the proposal stage designed to study dark energy with unprecedented precision. BigBOSS is based at the U.S. Department of Energy’s Lawrence Berkeley National Laboratory (Berkeley Lab).

“BigBOSS is the next big thing in cosmology,” says Uroš Seljak, Director of the BCCP, who is a professor of physics and astronomy at UC Berkeley and a member of Berkeley Lab’s Physics Division. “It would map millions and millions of galaxies, allowing us to measure dark energy to high precision—and would yield other important scientific results as well, including determining neutrino mass and the number of neutrino families.”

[Editor’s note: In January 2013, BigBOSS was renamed DESI – Dark Energy Spectroscopic Instrument.]

The Farthest Supernova Yet for Measuring Cosmic History
From Astronomy, Jan 10, 2013 by Paul Preuss

...“This is the most distant supernova anyone has ever found for doing dependable cosmology,” said [David] Rubin [of Lawrence Berkeley National Laboratory and the Supernova Cosmology Project (SCP)]. “The most important unanswered question we have about the nature of dark energy is whether it varies over time—whether it affects the expansion of the universe differently in different eras. With SN SCP-0401, we have the first example of a well-measured supernova sufficiently far away to study the expansion history of the universe from almost 10 billion years ago.”

“Imagine you’re channel surfing, and you come across live news coverage of an exploding star—and then you see the date-line that says it’s July 22, 9,947,989,219 BCE,” said Saul Perlmutter of Berkeley Lab’s Physics Division [who is also a professor in UC Berkeley’s Department of Physics]. “By August 9, the supernova is at its brightest and starts to fade, but you get to watch the whole thing—even though before the news could ever reach your TV our solar system had to form, and then our planet, and intelligent life had to evolve on Earth.”

“To be able to directly compare different type Ia supernovae, we have to fit their light curves—the time it takes the supernova to reach maximum brightness and the time it takes that brightness to fall off,” said Rubin. “We also have to be able to compare the brightness of the different colors during this process in order to calibrate the supernova.”

Perlmutter remarks that such calibration “can be a lot like trying to match a particular shade of house paint when you’ve got a thousand color chips to compare, maybe more.” In this case, calibration meant finding exactly the right shade of red.

A Rock is a Clock: Physicist uses Matter to Tell Time
From ScienceNewsline, January 10, 2013, by Robert Sanders

Ever since he was a kid growing up in Germany, Holger Müller has been asking himself a fundamental question: What is time? That question has now led Müller, today an assistant professor of physics at the University of California, Berkeley, to a fundamentally new way of measuring time.

Taking advantage of the fact that, in nature, matter can be both a particle and a wave, he has discovered a way to tell time by counting the oscillations of a matter wave. A matter wave’s frequency is 10 billion times higher than that of visible light. “A rock is a clock, so to speak,” Müller said. In a paper appearing in the Jan. 11 issue of Science, Müller and his UC Berkeley colleagues describe how to tell time using only the matter wave of a cesium atom.
Physicists Seek Cosmic Domain Walls

From Physics World, January 17, 2013, by Edwin Cartlidge

Exotic structures known as cosmic domain walls could be observed from Earth by measuring the subtle effect of their magnetic-like fields as they pass through our galaxy. That is the conclusion of a team of physicists in the US, Canada and Poland that has proposed a new way of probing the nature of the mysterious dark matter and dark energy thought to permeate the universe.

Most direct searches assume that dark matter consists of some kind of particle, while dark energy is often taken to exist in the form of a “cosmological constant” that is added to the field equation for general relativity. A number of other possibilities have been put forward, however. One is the idea that dark matter and dark energy are instead contained within objects known as “domain walls”.

In the latest work, a collaboration headed by theorist Maxim Pospelov of the University of Victoria in British Columbia and experimentalist Dmitry Budker of the University of California, Berkeley, set out to establish whether or not such walls could be detected using instruments on Earth. The researchers’ idea is to use magnetometers, devices made up of atoms whose spins are initially lined up and can then be rotated by an external magnetic field.

Budker concedes that the idea of domain walls is “a little bit exotic” and outside the mainstream when it comes to searching for dark matter and dark energy. He also acknowledges that the theoretical uncertainties make it hard to know what the chances of detection might be. But he maintains that detection should not be taken as the only measure of success. “It is very important to realize in the search for exotic physics that not seeing something is not a failure,” he says. “If instead you rule out a whole class of possible models then that is a success.”

The Compass Project: Charting a new course in physics education

From Physics Today, January 18, 2013 by Nathaniel Roth, Punit Gandhi, Gloria Lee, Joel Corbo

It’s the middle of August 2011, and a group of incoming students at the University of California, Berkeley, huddle over an audio speaker that is covered in a layer of mysterious, sticky liquid called oobleck. One of the students flips a switch, and suddenly the liquid begins to dance, forming intricate, finger-like extensions that reach up from the speaker’s surface before abruptly collapsing back onto it. The students jump back, surprised by what they see. They haven’t even attended their first lecture, but they are already hard at work studying exotic physical phenomena as part of a week-long program sponsored by the Compass Project.

... In 2006 three Berkeley physics graduate students – Angie Little, Hal Haggard, and Badr Albanna – began a series of conversations. All three were troubled by some of the things they noticed in the physics department, including a significant lack of women and minorities among the students and faculty. ... Many students, it seemed, found their introductory physics courses to be demoralizing experiences that drove them away from physics, and often that effect was stronger for women and other traditionally under-represented students.

...Inspiration struck when Badr and Hal spent several weeks as co-instructors for Berkeley’s Pre-Engineering Program, an intensive program that focuses on preparing incoming engineering students for their introductory calculus, chemistry, and physics courses. The program is academically rigorous, but the part Badr and Hal found most worthy of emulation was its community-building aspect. According to Hal, “This was what we got really excited about. This was something that we really wanted to bring to the physics department.”

Long Predicted Atomic Collapse State Observed in Graphene

From Science Daily, March 7, 2013

The first experimental observation of a quantum mechanical phenomenon that was predicted nearly 70 years ago holds important implications for the future of graphene-based electronic devices. Working with microscopic artificial atomic nuclei fabricated on graphene, a collaboration of researchers led by scientists with the U.S. Department of Energy’s Lawrence Berkeley National Laboratory (Berkeley Lab) and the University of California (UC) Berkeley have imaged the “atomic collapse” states theorized to occur around super-large atomic nuclei.

“Atomic collapse is one of the holy grails of graphene research, as well as a holy grail of atomic and nuclear physics,” says Michael Crommie, a physicist who holds joint appointments with Berkeley Lab’s Materials Sciences Division and UC Berkeley’s Physics Department. “While this work represents a very nice confirmation of basic relativistic quantum mechanics predictions made many decades ago, it is also highly relevant for future nanoscale devices where electrical charge is concentrated into very small areas.”

Women @ Energy: Gabriel Orebi Gann

From Energy.gov, Office of Economic Impact and Diversity, March 12

Gabriel Orebi Gann is an Assistant Professor at U.C. Berkeley, and does research in Particle Physics at Lawrence Berkeley National Laboratory.

How can our country engage more women, girls, and other underrepresented groups in STEM? The most important aspect in my mind is support and mentorship. ...It is also important to recognize that we are not all the same: there are gender differences, just as there are differences between people of the same gender, but these do not affect how good a scientist you can be. ...
change we need to make is in attitude: there is no typical personality type that succeeds as a physicist, if you are motivated and interested in the field then you should pursue that interest. What we need to do is to offer people the support, and the opportunity, to enable them to make their own informed decision. That involves educating people as to what it really means to be a physicist, and the earlier we start that the better. Public lectures, talks in schools, workshops aimed at high-school students – outreach is a critical part of our work, both for education and recruitment.

**Universe as an Infant: Fatter than Expected and Kind of Lumpy**
*From The New York Times, March 21, 2013 by Dennis Overbye*

Astronomers released the latest and most exquisite baby picture yet of the universe on Thursday, one that showed it to be 80 million to 100 million years older and a little fatter than previously thought, with more matter in it and perhaps ever so slightly lopsided. Recorded by the European Space Agency’s Planck satellite, the image is a heat map of the cosmos as it appeared only 370,000 years after the Big Bang, showing space speckled with faint spots from which galaxies would grow over billions of years.

Within the standard cosmological framework, though, the new satellite data underscored the existence of puzzling anomalies that may lead theorists back to the drawing board. “The biggest surprise here is that the universe is expanding more slowly than previous measurements had indicated. …Pressed for a possible explanation for the discrepancy, Martin White, a Planck team member from the University of California, Berkeley, said it represents a mismatch between measurements made of the beginning of time and those made more recently. And that it could mean that dark energy, which is speeding up the expansion of the universe, is more complicated than cosmologists thought.

**Perpetual Motion Test Could Amend Theory of Time**
*From Wired, April 30, 2013 by Natalie Wolchover*

Physicists plan to create a “time crystal”—a theoretical object that moves in a repeating pattern without using energy—inside a device called an ion trap.

... “For a physicist, this is really a crazy concept to think of a ground state which is time-dependent,” said Hartmut Häffner, a quantum physicist at the University of California, Berkeley. “The definition of a ground state is that this is energy-zero. But if the state is time-dependent, that implies that the energy changes or something is changing. Something is moving around.” …

An international team led by Berkeley scientists is preparing an elaborate lab experiment, although it may take “anywhere between three and infinity years” to complete, depending on funding or unforeseen technical difficulties, said Häffner, who is co-principal investigator with Zhang. The hope is that time crystals will push physics beyond the precise but seemingly imperfect laws of quantum mechanics and lead the way to a grander theory.

**Would an antimatter apple fall upward from the earth?**
*From the Los Angeles Times, April 30, by Eryn Brown*

... Theorists think that ordinary matter and antimatter, which annihilate when they come into contact with each other, were generated in equal quantities during the Big Bang. But there must be some differences between the two types of matter, they also think, because otherwise matter and antimatter would have canceled each other out completely and there would be no universe.

**Imaging Breakthrough: See Atomic Bonds Before and After Molecular Reaction**
*From Wired, May 30, 2013, by Nadia Drake*

For the first time, scientists have visually captured a molecule at single-atom resolution in the act of rearranging its bonds. …The team initially set out to precisely assemble nanostructures made from graphene, a single-layer material in which carbon atoms are arranged in repeating, hexagonal patterns. Building the carbon honeycombs required rearranging atoms from a linear chain into the six-sided shapes; the reaction can produce several different molecules. UC Berkeley chemist Felix Fischer and his colleagues wanted to visualize the molecules to make sure they’d done it right.

To document the graphene recipe, Fischer needed a powerful imaging device, and he turned to the atomic force microscope housed in physicist Michael Crommie’s UC Berkeley lab. … With it, the team managed to visualize not only the carbon atoms but the bonds between them, created by shared electrons.
A Black Hole Mystery Wrapped in a Firewall Paradox
from The New York Times, August 13, 2013,
by Dennis Overbye

This time, they say, Einstein might really be wrong. ... A high-octane debate has broken out among the world’s physicists about what would happen if you jumped into a black hole ... Crushed smaller than a dust mote by monstrous gravity, as astronomers and science fiction writers have been telling us for decades? Or flash-fried by a firewall of energy, as an alarming new calculation seems to indicate?

Raphael Bousso, a theorist at the University of California, Berkeley, said, “I’ve never been so surprised. I don’t know what to expect.”

You might wonder who cares, especially if encountering a black hole is not on your calendar. But some of the basic tenets of modern science and of Einstein’s theory are at stake in the “firewall paradox,” as it is known.

...The existence of a firewall would mean that the horizon, which according to general relativity is just empty space, is a special place, pulling the rug out from under Einstein’s principle, his theory of gravity, and modern cosmology, which is based on general relativity. This presented the scientists with what Dr. Bousso calls the “menu from hell.” If the firewall argument was right, one of three ideas that lie at the heart and soul of modern physics, had to be wrong. Either information can be lost after all; Einstein’s principle of equivalence is wrong; or quantum field theory, which describes how elementary particles and forces interact, is wrong and needs fixing. Abandoning any one of these would be revolutionary or appalling or both. ...which of the items on Dr. Bousso’s “menu from hell” might have to go depends on who is speaking.

Science for Future Presidents
Debuts on Japanese Television
Earlier this year, Nippon Hoso Kyokai, the Japanese Broadcasting Corporation, aired “Physics for Future Presidents”, the lecture series created and presented by UC Berkeley emeritus physics professor Richard A. Muller. The series consisted of five broadcasts, overdubbed in Japanese, broadcast in April and May.

Physics in Print
Books and articles authored or edited by UC Berkeley physicists
Optical Magnetometry
Dmitry Budker, UC Berkeley, and Derek F. Jackson Kimball, California State University East Bay, Editors. Cambridge University Press, April 2013. ISBN 9781107010352

Ultracold Bosonic and Fermionic Gases

Berkeley physics professor Dan Stamper-Kurn has co-edited a book that offers an accessible introduction to the many actual and potential applications of ultra-cold atoms for condensed matter science. The book introduces ultracold Bose and Fermi quantum gases at a level appropriate for first-year graduate students and non-specialists, and discusses landmark experiments and their fruitful interplay with basic theoretical ideas.
Society for Physics Students

Berkeley’s Society for Physics Students (SPS), founded and operated by physics students, was established to foster a sense of community in the Departments of Physics and Astronomy. SPS sponsors monthly barbecues, helps out with annual Cal Day activities, manages hands-on activities at the Bay Area Science Festival in ATT Park, organizes tutoring sessions for lower division students, sponsors an annual Undergraduate Student Poster Session, and presents a series of noontime seminars that give students an opportunity to learn about the careers of physics alumni.

**Undergraduate Poster Session**

This year’s Undergraduate Poster Session took place on April 17 in the Carl A Helmholz Room (375 Le Conte). Student researchers and the topics they presented included:

- Loic Anderegg, Francisco Monsalve, Michael Holhensee – *Precision Test of Lorentz Invariance with a High Finesse Optical Cavity* (Professor Holger Müller)
- Maris Asatryan – *Electrostatic Ion Trap for Trapping Radioactive Isotopes & Beta-Neutrino Correlation*
- Maryrose Barrios – *A 2D-MOT as a Source of Cold Rubidium Atoms* (Professor Dan Stamper-Kurn)
- Max Baugh and Kimia Haghighi – *SNO+ Particle Decay Simulation*
- Shawn Tang and Byung Choi – *Search for a 4th Generation Bottom-like Quark at the Large Hadron Collider* (Professor Marjorie Shapiro)
- Thamine Dalichaouch, Shane Cybart, Stephen Wu, and Steven Anton – *Modeling Mutual Inductances in 2D Arrays of SQUIDs* (Professor Robert Dynes)
- Joe DeRose – *On the Negative Correlation between Max Intrinsic Luminosity and Silicon II Ratio of Type Ia Supernovae*
- Alexey Drobitzhov – *Low-Temperature Thermal Conductivity Measurements of Al2O3 Ceramic for Use in Bolometric Particle Detector* (Professor Yury Kolomensky)
- Nitin Kitchley Egbert – *Linear Behavior and Long-Term Constraints with Spring-Coupled Masses in Otherwise Keplerian Orbit* (Professor Edgar Knobloch)
- Kelsey Oliver-Mallory, Maurice Garcia-Scivere, John Kadyk, and Mayra Lopez-Thibodeaux – *Directional Dark Matter Detector: Time Projection Chamber*
- Abhimat Gautam – *Automated Pipeline to Search for Radio Transients in the Kepler Field*
- Joel Grebel and Maria Simanovskai – *Nitrogen Vacancy Centers in Diamond*
- Ayman Kamrudi – *A Geometric Crescent Model for Black Hole Images*
- Tanner Kaptanoglu – *SNO+ Research* (Professor Gabriel Orebi Gann, Post-Doc Freia Descamp)
- Dong Won Kim – *Search for Strong Gravity Signature in Same-Sign Dimuon Final States Using the ATLAS Detector* (Professor Marjorie Shapiro)
- Gloria Lee – *Base Catalyzed Synthesis of Graphene Aerogels* (Professor Alex Zettl, Mentor Anna Goldstein)
- Matt Noakes – *Determination of Flavor Fractions in Conjunction with a Search for a 4th Generation b’Quark*
- Darius Roohani – *The Research and Development of Cherensonkov Light Sources*
- Andrew Vanderburg – *Improving Radial Velocity Precision for Faint Star Extrasolar Planet Surveys*
- William Walker – *Development of Helium3 Sorption Fridge for Millimeter Wave Experiment* (Grad Student Aritoki Suzuki, Professor Adrian Lee)
- Rui Zou – *Investigation of Alkali-Wall Interactions in Antirelaxation-Coated Vapor Cells*

**SPS Noontime Career Seminars**

At each noontime career seminar, undergraduate students are treated to pizza and a presentation about how a physics education can lead to a wide variety of successful careers. Offerings from the fall 2012 semester featured presentations from two Berkeley alumni and a Cornell University alumnus.

- **Marc Petera** (BA ’72) is a partner in the Intellectual Property Group and the Litigation Department at Morrison Foerster LLP. He represents clients involving semiconductor, electronics, and computer-related technologies, such as virtual machine software, semiconductor fabrication equipment, gallium-nitride based laser diodes and LEDs, high-speed processors, optoelectronic transceivers, surgical lasers, and video-on-demand servers.
- **Hal Zarem** (BA ’84) is President and CEO of Seeo, a company that is using technology developed at Lawrence Berkeley National Laboratory and UC Berkeley to create a new class of high-energy rechargeable lithium ion battery. A technology executive with extensive experience at leading semiconductor, optical component, and MEMS companies, Zarem was CEO of Silicon Light Machines when that company developed the OvationONSTM optical sensor, and commercialized Grating Light Valve technology for computer-to-plate printing and direct-write lithography.
- **Will Glaser**, recognized as an innovative leader in Silicon Valley for more than two decades, was named one of the 100 Most Influential People in High Technology by Microtimes. Most recently, he co-founded Pandora Media, the leading provider of online radio. Glaser currently operates a consulting practice specializing in business startups, new product architectures, and high technology turnarounds.

**New Course Aids Physics Transfer Students**

A new course designed to smooth the transition for transfer students entering the physics department is being offered for the first time this fall. The Compass Physics Transfer Course gives incoming transfer students an array of opportunities, including the chance to meet each other early in the semester. “They have only two years to
complete the program,” said Claudia Trujillo, Student Affairs Officer. “Getting to know their peers earlier and knowing what to expect in their courses is critical. This course will facilitate that.”

The course was made possible through the efforts of the physics department’s Compass Project, the campus-wide Cal NERDS program (New Experiences for Research and Diversity in Science), the Department of Physics, and visiting researcher Dr. Melvin Pomerantz, who endowed the Isidore Pomerantz fund to benefit undergraduates in physics.

The two-unit, weekly class was, according to the course description “inspired by conversations with graduating transfer students, which made it clear that the first semester is a particularly challenging time for transfer students. They need to navigate unfamiliar academic expectations, develop new study groups and friendships, learn to get around Berkeley, and deal with culture shock. This class is designed to help students coming from a Community College or Junior College have an easier transition into science at Cal, and more quickly feel like a contributing member of their new scientific community, all while remembering the enthusiasm and joy that they find in science.”

The class is taught by undergraduate physics major and transfer student Derrek Coleman, along with physics graduate student John Haberstroh. The faculty sponsor is physics professor Holger Müller.

The class is designed to help students develop community, science skills, and research connections. “Community happens naturally when students with similar challenges are brought together in a safe space where they can talk through their difficulties,” the instructors point out. “Community is further fostered by a focus on healthy scientific discourse, where members of the class have opportunities to discuss science without the need for a facade of ‘knowing it all’ that so many other classrooms encourage.”

The course also teaches science skills students need to productively immerse themselves in a body of scientific literature and offers opportunities for exploring important, cutting edge physics research. Each student is paired with a mentor and offered help in making connections with research groups of interest. “Research is one of the most valuable experiences one can get out of Berkeley,” the instructors note, “and it is a great service to help students make the research connections they want.”

“Our student-centered classroom is fun,” they add, “and will provide a wealth of opportunities to interact with classmates as they build the skills and knowledge necessary for real research. We want to keep that flame of excitement about science alive, even through a challenging first semester.”

**Segré Summer Interns 2013**

**Cliff Chen,** one of this year’s Segré Summer Interns, took on the task of moving the pulsed nuclear magnetic resonance (NMR) experiment into the recently remodeled Donald A. Glaser Advanced Lab. But after assembling the experiment in its brand new home, he found it just didn’t work. “I spent 2 days reading papers, troubleshooting connections, learning the physics and the equipment,” Chen said, “and finally I got results that made sense. This was a great feeling!”

This kind of experience is typical of the Emilio Segré Internship, a program that provides three undergraduate students the opportunity to spend eight weeks during the summer to hone their research and technical skills by making improvements to the Physics 111 Advanced Laboratory. Recipients of this summer’s internships were Anthony Ransford and Cliff Chen, both of whom graduated in May, and continuing student Sergiy Nesterenko.

The Segré interns began their work as demolition began on phase 2 of the Physics 111 lab renovation. As carpenters, plumbers, and electricians renewed the facilities, the interns renewed the experiments. They also completed a changeover to new computers, which required revising many of the programs that interface between computers and experimental apparatus. As the new space opened up, fourteen experiments were set up in new locations and configurations.

All three interns enjoyed the chance to delve into many experiments beyond the four they each conducted when they took the course. “Setting up an experiment, tuning a laser, getting it to work is something I didn’t actually do before when I worked in a research lab,” said Nesterenko. Each intern took on several projects, yet they frequently pitched in to help each other. When an experiment was finished, another intern would test the setup and instructions and suggest further improvements.

Meanwhile, 111 Lab engineer Don Orlando coordinated the construction project, all the student projects, and the complicated move back into the newly renovated space. The transformation of the lab over the last two years culminated this fall with the dedication of the facility as the Donald A. Glaser Physics Advanced Lab (see p 24).

This fall, Chen is applying to graduate school while working as a lab technician in southern California. Ransford is a researcher in atomic physics in physics professor Hartmut Häffner’s lab, while he writes up his previous research and applies to graduate school.

Nesterenko is finishing his degree this fall as he continues research in Professor Bernard Sadoulet’s lab, simulating charge transport through Germanium in dark matter detectors. His ambition is to start a small company to build sensors such as the prototype 3D position sensor he designed for his Physics 111 BSC final project. “Think of it as indoor GPS,” he says with excitement.

The Emilio Segré Internships are made possible through the generosity of Arlene and Doug Giancoli. As part of the renovation of the Advanced Lab, a plaque commemorating every Segré intern is being placed in the corridor outside the lab. **Contributed by Tom Colton, Instructional Support Manager**
The Class of 2013

The UC Berkeley Departments of Physics, Astronomy, and the Physical Sciences celebrated the 2013 Commencement in Zellerbach Auditorium on May 21. Nobel laureate and UC Berkeley alumnus Robert B. Laughlin (’72), Professor of Physics at Stanford University, delivered the commencement address. Peter Kelly Blanchard was Student Speaker for Astronomy, and Andrew Michael Vanderburg was Student Speaker for Physics.

Commencement Ceremonies

Officiating at the commencement were Mark Richards, Dean of Physical Sciences in the College of Letters and Science; Imke de Pater, Chair of the Department of Astronomy; Frances Hellman, Chair of the Department of Physics; Robert G. Jacobsen, Vice-Chair of the Department of Physics; Michael R. DeWeese, Acting Head Faculty Undergraduate Advisor in the Department of Physics; and Eliot Quataert, Faculty Undergraduate Advisor in the Department of Astronomy.

For the 2012-2013 academic year, bachelor degrees were awarded to 99 students in Physics, and 45 students in Astrophysics, Engineering Physics, and Physical Sciences. Master degrees were awarded to eight students in Astrophysics and 12 students in Physics. PhD degrees were awarded to 12 students in Astrophysics and 36 students in Physics.

Commencement Address

Commencement speaker Robert Laughlin is the Ann T. and Robert M. Bass Professor of Physics at Stanford University. He is a theorist with interests ranging from hard-core engineering to cosmology. He received the Nobel Prize in 1998, along with Horst Stormer and Daniel Tsui, for their explanation of the fractional quantum Hall effect. Laughlin has also worked on plasma and nuclear physics issues related to fusion and nuclear-pumped X-ray lasers.

His technical work at the moment focuses on ‘correlated electron’ phenomenology – working backward from experimental properties of materials to infer the presence (or not) of new kinds of quantum self-organization. In this area, he recently proposed that all Mott insulators – including the notorious doped ones that exhibit high-temperature superconductivity – are plagued by a new kind of subsidiary order called ‘orbital anti-ferromagnetism.’

Laughlin is the author of several books for lay audiences, including Powering the Future, about solving the energy crisis, and A Different Universe, an accessible explanation of emergent law. In his words: “As our experimental understanding of nature has matured, we have come to realize just how artificial the distinction is between fundamental physical law—something that ’just is’—and other kinds of physical law that ’emerge’ through self-organization.”

Laughlin received his AB degree from UC Berkeley in 1972, and his PhD in 1979 from the Massachusetts Institute of Technology. He has been a Research Physicist at Lawrence Berkeley National Laboratory since 1982. His numerous awards include the E. O. Lawrence Award for Physics in 1984, and the Oliver E. Buckley Prize in 1986. He is a fellow of the American Academy of Arts and Sciences and the American Association for the Advancement of Science, and is a member of the National Academy of Sciences.
Christopher Smallwood, Student of Distinction

As a member of Lanzara’s research group, Smallwood works with high-temperature superconductors. “There’s a lot of interesting fundamental physics going on in these materials,” he says, “but at the same time it isn’t difficult to explain why they have real-world applications.” The group uses an experimental approach known as angle-resolved photoemission spectroscopy (ARPES) to investigate the behavior of electrons in a material. “It’s a bit like a microscope,” Smallwood explains, “but a microscope allows us to look only at the positions of electrons. ARPES allows us to look carefully at their momentum.

The relationship of energy versus momentum of the electrons can tell you a lot about why a material is a conductor, insulator, semiconductor, or superconductor. Essentially, we shine ultraviolet light on a material, electrons come out and we measure them, and then we use those measurements to calculate what the electrons were doing in the material.”

As an example, ARPES enables researchers to tease out information about how electrons pair up in superconductors. Superconductivity arises when electrons bind together to form Cooper pairs—pairs of electrons that act coherently. “With ARPES, we can see a band gap emerging in the data that roughly corresponds to the binding energy of pairs of electrons. This gives us fundamental information about how Cooper pairs are forming.”

Most of Smallwood’s work is done in a laboratory in the Materials Science Building at LBNL. There, Lanzara’s group has built their own experimental apparatus that augments ARPES data by adding a time component. “The technology allows us to make movies of non-equilibrium electron dynamics in solids,” Smallwood explains. “One of the most impressive aspects of the experiment is the incredibly short time scales we are able to resolve—on the order of a trillionth of a second.”

As a science writer, Smallwood has been a contributor to the Quest science blog (science.kqed.org/quest/). He authored a substantial article on the recent discovery of the Higgs boson, titled ‘Hunting Down the Higgs,’ which appeared in the Spring 2013 issue of the Berkeley Science Review. He expects to receive his PhD by the spring of 2014.
Lars Commins Award in Experimental Physics

Graduate student Christopher Smallwood has been awarded the 2013 Lars Commins Award in Experimental Physics. The award is given annually to the most deserving graduate research student in experimental physics.

Smallwood’s research advisor, physics professor Alessandra Lanzara, nominated him for the award because of his “pioneering work on the study of transient electronic properties of high-temperature superconductivity,” she says. “His work constitutes a milestone in the field of superconductivity, and he is one of the pioneers of time – and angle-resolved photoemission spectroscopy experiments.” One of Smallwood’s research papers, published in *Science* (Smallwood et al, 2012), “represents the first time that anyone has directly measured the transient dynamics of a superconducting gap in any material,” Lanzara adds.

Lars Commins, the son of Berkeley emeritus physics professor Eugene Commins and his wife Ulla, was an accomplished engineer with a deep interest in experimental physics. The Lars Commins Award was created in 2004 as a lasting tribute to Lars, and to help perpetuate the strong tradition of experimental physics that has always existed at UC Berkeley.

Jackson C. Koo Award

Graduate student Gil Young Cho received the 2012-2013 Jackson C. Koo Award in Condensed Matter Physics. The award is given annually to a high-achieving physics graduate student in condensed matter who has advanced to PhD candidacy. Cho came to Berkeley as a graduate student in 2009, after receiving his AB in physics from Korea Advanced Institute of Science and Technology.

As a member of physics professor Joel Moore’s research group, Cho co-authored a number of papers on topological insulators and a variety of related topics. Cho received his PhD this spring, and moved to a post-doctoral fellowship at University of Illinois Urbana–Champaign this fall. During his graduate career at Berkeley, he was awarded a fellowship from the Kavli Institute for Theoretical Physics, a Samsung prize, and a partial scholarship from Berkeley’s International House.

The Jackson C. Koo Award was created in 2009 by Mrs. Rose Koo in honor of her husband Jackson Koo, a bright and hard-working alumnus who received BS and MS degrees in electrical engineering and a PhD in physics from UC Berkeley, under the guidance of physics professor Erwin Hahn. Koo was a member of Phi Beta Cappa and the Honor Students Society of UC Berkeley. After graduating, he worked at AT&T Bell Laboratories, then moved to Lawrence Livermore National Laboratory. During his career he published numerous papers and was listed as an inventor on eight patents.

Tomkins Thesis Prize

In June, the Department of Physics received word that Lindsay Glesener, who received her PhD in Astrophysics in 2012, was selected to receive the Patricia Tomkins Thesis Prize for 2013 by Britain’s Royal Astronomical Society. The announcement was made by Professor David Smallwood, President of the RAS.

Glesener, whose thesis advisor was Robert Lin, was nominated for the award by physics professor Stuart Bale. Glesener works in high energy solar physics and led the detector development effort for the NASA Focusing Optics X-ray Solar Imager (FOXSI) sounding rocket experiment.

“She also led the integration of the spectrometer into the payload. She commanded the spectrometer, in real-time, during the brief but exciting rocket flight, and is now analyzing the science data.”

According to the RAS, the award is given annually to encourage student interest in instrumentation science for astronomy and geophysics. Glesener has been invited to present her work and receive the award, which comes with a $1000 cash prize, at an upcoming RAS General Meeting.

Watanabe Wins Japanese Prize

Graduate Student Haruki Watanabe has won the Eighth Annual Makoto Nakamura Taro Award from the Physical Society of Japan. Watanabe works with Berkeley physics professors Ashvin Vishwanath and Hitoshi Murayama. He was recognized for his paper “Unified Description of Nambu-Goldstone Bosons without Lorentz Invariance”, co-authored with Murayama and published in *Physics Review Letters* in 2012.

An award ceremony will be held in March, 2014, during the 69th annual meeting of the Physical Society of Japan at Tokai University.

Helmholz Award at International House

The Carl and Betty Helmholz Gateway Fellowship has been granted to Sean Ressler for 2013-2014. Ressler is interested in theoretical astrophysics and came to Berkeley this fall from North Carolina State University at Raleigh. As a Gateway Fellow he will receive full room and board at International House. The award also pays tuition, fees, and a $5,000 stipend through a special matching program established with UC Berkeley’s Graduate Division.

Over thirty donors stepped forward jointly to establish this $250,000 endowment in the name of Carl and Betty Helmholz. It provides an International House room and board award each year for an entering UC
Berkeley first-year doctoral student, preferably in physics.

Carl Helmholz was a nuclear physicist and former Chair of the UC Berkeley Department of Physics. His wife, Betty, has provided distinguished service to both International House and the Department of Physics.

**Graduate Student Poster Session**

Thirty-five graduate students shared their research at the Department of Physics Annual Graduate Student Poster Session, held Friday November 16, 2012 in the Helmholz room, 375 LeConte. The session was organized by graduate students Matt Jaffe and Jesse Livezey. This year’s judges were physics professors Beate Heinemann and Hitoshi Murayama. Poster exhibits covered a wide variety of topics in physics and astrophysics. Best in Show honor went to four graduate students: Matt Jaffe and Jesse Livezey, from James Siegrist’s group, for their poster titled “Direct Dark Matter Detection with the LUX Experiment” Jaffe and Jesse Livezey. This year’s judges were physics professors Beate Heinemann and Hitoshi Murayama. Poster exhibits covered a wide variety of topics in physics and astrophysics. Best in Show honor went to four graduate students: Matt Jaffe and Jesse Livezey, from James Siegrist’s group, for their poster titled “Direct Dark Matter Detection with the LUX Experiment”

**Gheorghe Chistol**, a member of Carlos Bustamante’s research group, whose poster was titled “High degree of coordination and division of labor among subunits in a homomeric ring ATPase”

**Samuel Penwell**, a member of Naomi Ginsberg’s group, for his poster, “Beneath the Bulk: Domain-Specific Efficiency and Degradation in Organic Photovoltaic Thin Films”

**Henoch Wong**, from Kam-Biu Luk’s group, for “Measurement of Neutrino Mixing Angle Theta13”

In addition to sharing their research at the annual poster session, held each fall semester, graduate students also have an opportunity to talk about their work and practice for oral exams at student-only seminars held throughout the academic year. These seminars are open only to physics graduate students.

**Student Service Awards for 2013**

Six students in the Department of Physics were honored with Student Service Awards for 2013. Steven Anton, Gabriel Dunn, and Joseph Thurakal were recognized for their service to the Department with the creation of Career Development Initiative for the Physical Sciences (CDIPS). Their program fills a niche for students to explore various career paths. It connects alumni with current graduate students, and the CDIPS newsletter keeps students informed about campus and Bay Area events pertaining to science careers.

**Joel Corbo** and **Dmitri Dounas-Frazer** received the Student Service award in recognition of their service to the Department in the leadership roles they took with Compass. Compass would not be where it is today without their continuous involvement and dedication, especially at its inception. Compass has become one of the Department’s successfully student-run programs.

**Jessica Kirkpatrick** received the Student Service award in recognition of her service as a leader of SWPS (Society of Women in the Physical Sciences). SWPS would not be the successful program it is today without her involvement. We are grateful for the enthusiasm and spirit these students have brought to the Department of Physics, and the department acknowledges their many contributions to the physics community with the Student Service Award.

**Graduate Student Fellowships 2013-2014**

**Chilean Scholarship CONICYT-BECAS CHILE**

Dan Mainemer-Katz

**Department of Energy Computational Fellowship**

Hannes Roberts

Sydney Schleppner

**Ford Foundation Dissertation Fellowship**

Miguel Daal

**Allan and Kathleen Rosevar Gateway Fellowship**

Zhenglu Li

**Adrian Hao Yin U Gateway Fellowship**

Hoi Chun Po

**Betty and Carl Helmholz Gateway Fellowship**

Sean Ressler

**NASA Graduate Student Research Fellowship**

Nicole Duncan

**Hertz Foundation Fellowship**

Mollie Schwartz

**Honjo International Scholarship Foundation (Japan)**

Haruki Watanabe

**LAM Research Corporation Fellowship**

S. Matthew Gilbert

Gregory Affeldt

Steven Drapcho

**National Defense Science and Engineering Graduate Fellowship**

Aaron Bradley

Jonathan Kohler

Derek Vigil-Fowler

Dillon Wong

**Natural Sciences and Engineering Research Council of Canada Scholarship**

Kyle Boone

Eric Thewalt

**National Science Foundation Graduate Research Fellowship**

Yasaman Bahri

Daniel Lecoanet

Halleh Balch

Jackie Brosamer

Nityan Nair

Nathan Carruth

Diana Qiu

Kayleigh Cassella

Vinay Ramasesh

Parker Fagrelius

Tess Smidt

Tova Holmes

Kelly Swanson

Hilary Jacks

Dayton Thorpe

Trinity Joshi

Nesty Torres Chicon

Kate Kamdin

David Yu

**Thai Scholarship**

Chayut Thanipirom

**University of California Fellowship**

Emily Duffield

Caroline Sofiatti Nunes

Anthony Lo

Jessie Otradovec

Leigh Martin

Alejandro Ruiz

Sarah Marzen
PHD DEGREES FALL 2012

Andre M Bach
Advisor: Marjorie Shapiro
Search for Pair Production of a New b’Quark that Decays into a Z Boson and a Bottom Quark with the ATLAS Detector at the LHC

Steven J.F. Byrnes
Advisors: Feng Wang and Yuen Ron Shen
Studies in Optics and Optoelectronics

Kevin Timothy Chan
Advisor: Marvin L Cohen
First-principles studies of carbon nanostructures and spin-phonon and electron-phonon coupling in solids

Dmitri R. Dounas-Frazier
Advisor: Dmitry Budker
Atomic Parity Violation and Related Physics in Ytterbium

William J. Gannett
Advisor: Alex Zettl
Electronic Transport in Novel Graphene Nanostructures

Lindsay E. Giesener
Advisors: Stuart Bale and Samuel Krucker
Painstakingly hard X-rays from Accelerated Electrons in Solar Flares

Jennie S. Guzman
Advisor: Dan Stamper-Kurn
Explorations of Magnetic Phases in F=1 87Rb Spinor Condensates

Jedediah E.J. Johnson
Advisor: John Clarke
Optimization of Superconducting Flux Qubit Readout Using Near-Quantum-Limited Amplifiers

Kwanpyo Kim
Advisor: Alex Zettl
Structural Characterization, Manipulation, and Properties of Graphene Membranes

Jessica A. Kirkpatrick
Advisors: Saul Perlmutter and David Schlegel
Searching for Quasars and Beyond

Jonas A. Kjall
Advisor: Joel Moore
Low Dimensional Magnetism

Joshua E. Meyers
Advisor: Saul Perlmutter
Improving Type Ia Supernova Standard Candle Cosmology Measurements Using Observations of Early-Type Host Galaxies

Erin E. Quealy
Advisor: Adrian Lee
The POLARBEAR Cosmic Microwave Background Polarization Experiment and Anti-Reflection Coatings for Millimeter Wave Observations

William R. Regan
Advisor: Alex Zettl
Screening-engineered Field-effect Photovoltaics and Synthesis, Characterization, and Applications of Carbon-based and Related Nanomaterials

Louise A. Skinnari
Advisor: Beate Heinemann
A Search for Physics Beyond the Standard Model using Like-Sign Muon Pairs in pp Collisions at sqrt(s)=7 TeV with the ATLAS Detector

David A. Strubbe
Advisor: Steven Louie
Optical and Transport Properties of Organic Molecules: Methods and Applications

Anthony J. Tagliaferro
Advisor: Bruno Zumino
On Freudenthal Duality and Gauge Theories

Stephen M Wu
Advisor: Robert Dynes
Properties of Jets Electronic and Magnetic Properties of Multiferroic Based Magnetolectric Field Effect Devices

Anna M. Zaniewski
Advisor: Alex Zettl
Probing Nanostructures for Photovoltaics: Using atomic force microscopy and other tools to characterize nanoscale materials for harvesting solar energy

Xiaowei Zhang
Advisor: Mike Crommie
Probing Atomic-Scale Properties of Magnetic and Optoelectronic Nanostructures

Joel L. Zylberberg
Advisor: Michael DeWeese
From Scenes to Spikes: Understanding Vision from the Outside In

PHD DEGREES SPRING 2013

Thierry C.M. Botter
Advisor: Dan Stamper-Kurn
Cavity Optomechanics in the Quantum Regime

Georghe Chistol
Advisor: Carlos Bustamante
Dissecting the Operating Mechanism of a Biological Motor One Molecule at a Time

Gilly Elor
Advisor: Lawrence Hall
Journeys Beyond the Standard Model

Aditya A. Joshi
Advisor: Richard Packard
Superfluid 4He interferometers: construction and experiments

Hsien-Ching Kao
Advisor: Edgar Knobloch,
Spatially Modulated Structures in Convective Systems

Nathan A Leefer
Advisor: Dmitry Budker
Search for variation of the fine-structure constant and violation of Lorentz symmetry using atomic dysprosium

Peter V. Loscutoff
Advisor: Marjorie Shapiro
Search for resonant WZ to three lepton production using the ATLAS detector at the LHC

Shannon R. McCurdy
Advisor: Bruno Zumino
Variations on Quantum Geometry

Keith G. Ray
Advisors: Steve Louie, and Mark Asta
van der Waals Corrected Density Functional Theory Calculations on Zeolitic Imidazolate Frameworks

David A. Rubin
Advisor: Saul Perlmutter
E. Pluribus Unum: Cosmological Analysis of Heterogenous Supernova Ia Datasets

John G. Sample
Advisors: Robert Lin, Steven Boggs and David Smith
The MINIS Balloon Campaign: Duskside Relativistic Electron Precipitation

Kevin A. Schaeffer
Advisor: Mina Aganagic
Black Holes, Branes, and Knots in String Theory

Alexander Selem
Advisors: Joel Moore and Birgitta H. Whaley.
Topics in Topologically Ordered Phases of Matter

Hai Siong Tan
Advisor: Ori Ganor
Quantum Gravity in Three Dimensions from Higher-Spin Holography

Luyi Yang
Advisor: Joseph Orenstein
Doppler Velocimetry of Current Driven Spin Helices in a Two-Dimensional Electron Gas
Joshua A. Miele (BA ’97, PhD ’03 Psychology)

With innovative technologies that range from talking pens to virtual Braille keyboards, Dr. Josh Miele is making a difference in the lives of the visually impaired. A feature article about Miele and his childhood story, published in the March 2 NY Times, prompted the Department of Physics to follow up on the valuable work he’s doing today. Here’s what we learned.

Dr. Josh Miele demonstrates a prototype of the WearaBraille virtual keyboard he is developing. Users tap their fingers to send wireless commands to a computer or smartphone.

Miele has been blind since the age of 4. He began developing accessibility software and devices during his undergraduate years at UC Berkeley. Today, he is Principal Investigator of the Miele Lab at Smith-Kettlewell Eye Research Institute in San Francisco, California, where he leads the design and development of accessible technology for the blind.

Among Miele’s innovations is the Livescribe Pulse Pen, the heart of an audio tactile system that enables users to hear information contained in specially designed graphics, such as the Periodic Table. The user can feel the Braille imprint of each element on the table, and with each tap of the pen access additional information about that element. The system makes it possible to include far more information than would fit on a typical Braille version of the Periodic Table.

He is also developing WearaBraille, a wireless device that functions like a virtual Braille keyboard input for a computer or smartphone. The user wears a device that places a small accelerometer on each finger. Tapping the fingers on a table or other surface sends out a wireless signal. Different combinations of finger taps signal different letters or commands. Users can not only type text, but also move the cursor and perform other system functions.

Perhaps the most exciting challenge Miele has taken on is the creation of new cloud-based, crowd-sourced software called the Descriptive Video Exchange (DVX). It allows anyone to narrate a description of the visuals from video content for the benefit of those who can’t see. The DVX automatically records and synchronizes the verbal descriptions and plays them back along with the video. There is no need to modify the video itself. An initial version was released earlier this year.

More information on Miele’s innovative technologies can be found at www.mielelab.org.

Ling Lie Chau (PhD ’66)

Ling-Lie Chau, physics professor emeritus at University of California Davis, has created a new fellowship at Berkeley for female graduate students studying theoretical physics. Chau was one of the earliest female graduate students in Berkeley’s Department of Physics, and the only female student in her graduate physics classes. She established the Ling-Lie Chau Excellence Award Fund as a way of giving back to the department, she said. She wants to help women specifically because she received so much support herself.

The number of female physicists has increased over the past several decades but, Chau notes, “the number of female theoretical physicists remains extremely low worldwide. Efforts should be made to encourage more women to enter the intellectually exciting field of theoretical physics and add diversity in making progress.”

Chau received her PhD from Berkeley in 1966, under the guidance of Geoffrey Chew. She received a two-year IBM Fellowship when she arrived on campus, which she credits for a good start as a graduate student. She subsequently joined the Institute for Advanced Study, where she did research in theoretical physics from 1967-1969, then went to Brookhaven National Laboratory, where she stayed until 1986. She was a professor in the Department of Physics and the Graduate Group of Applied Physics from 1986 through 2006, and is now professor emeritus there.

Alumni News and Awards

Congratulations to five alumni who recently became Fellows of the American Physical Society. Here they are, with their citations:

Andre Luis De Gouvea (PhD ’99), Northwestern University

For exceptional service to the field of neutrino physics through innovative studies of possible neutrino properties and their experimental implications

Robert W. Carpick (PhD ’97), University of Pennsylvania

For his outstanding contributions to developing atomic-level understanding of the tribological phenomena of friction, adhesion, and wear

Heidi Jo Newberg (PhD ’92), Rensselaer Polytechnic Institute

For her contributions to our understanding of the structure of the Milky Way galaxy and the universe and for the development of software and hardware infrastructure for measuring and extracting meaningful information from large astronomical survey data sets

Max Tegmark (PhD ’94), Massachusetts Institute of Technology

For his contributions to cosmology, including precision measurements from cosmic microwave background and galaxy clustering data, tests of inflation and gravitation theories, and the development of a new technology for low-frequency radio interferometry

Xiaowei Zhuang (PhD ’96), Harvard University

For her seminal contributions to the development of biophysical techniques involving super-resolution fluorescence microscopy and single molecule fluorescence resonance energy transfer, and her successful applications of these techniques to many critical biological problems
In Memory

DON R. SWANSON, (1924-2012)

Don R. Swanson (PhD ’52), died November 12, 2012, at the age of 88. A trailblazing information scientist, he pioneered the field of literature-based discovery, which uses existing research to create new knowledge, particularly in biomedical fields. Three times dean of the University of Chicago’s Graduate Library School and professor emeritus in that university’s Humanities Division, he believed that unearthing unseen links between two distinct areas of study could yield new discoveries—what he called “undiscovered public knowledge.”

Swanson received a bachelor’s degree in physics from California Institute of Technology in 1945, his MA in physics from Rice University in 1947, and his PhD in physics from UC Berkeley in 1952. He worked as a computer systems analyst at Hughes Research & Development and as a research scientist at Ramo-Woolridge Corp & TRW, Inc., before joining the University of Chicago faculty as Dean of the Graduate Library School in 1963. At the time of his appointment, it was believed that Swanson was the first physical scientists to head a professional library school in the US.

BERNARD R. COOPER (1936-2013)

Bernard (Barry) R. Cooper, Claude W. Benedum professor emeritus at West Virginia University, passed away at age 77 on June 10, 2013 in Morgantown, West Virginia. A fellow of the American Physical Society, Barry was a theoretical condensed matter physicist best known for his contributions to the fundamental understanding of the magnetic and electronic properties of transition, rare earth, and actinide metals. He also contributed to early efforts to accurately calculate and predict the properties of materials using first-principles methods.

Barry was born on April 15, 1936 in Everett, Massachusetts. He received his BS degree in Physics from MIT in 1957 and his PhD from the University of California, Berkeley in 1961 where he worked with Charles Kittel. After completing his PhD, he held positions at the Atomic Energy Research Establishment in Harwell, England, Harvard University, and the General Electric Research Laboratory (GE). During this time his research focused on the magnetic properties of transition and rare earth metals. While at GE he developed a band parameterization scheme using a Green’s function method that allowed an efficient calculation of band structures of transition metals. He also developed models that explain the unusual magnetic behavior of antiferromagnets, many of them containing cerium, that have strong magnetic anisotropies.

In 1974 he left GE to become the Claude W. Benedum Professor of Physics at West Virginia University (WVU). At WVU his research focused on magnetic ordering and associated properties of correlated electron systems as well as the thermo-mechanical properties, phase separation, and interfacial behavior of structural and magnetic metallic systems.

—excerpted from West Virginia University’s In Memoriam by David Lederman

has been established at Foothill College by a group of his friends, who describe it as a combination of “his love of physics, his appreciation of learning, and his fondness for Foothill College. It honors him in a way he would have approved of.” Contributions to the David A. Pripstein Memorial Scholarship Fund can be sent to FHDA Foundation, 12345 El Monte Road, Los Altos Hills, CA 94022, with the notation ‘Prip Award.’

DAVID Pripstein

DAVID PRIPSTEIN, (1964-2012)

David Pripstein (PhD ’97) died of heart failure last December. After receiving his PhD in high energy physics under the guidance of physics professor Kam-Biu Luk, he went to CalTech as a postdoctoral fellow. He subsequently worked for JDS Uniphase Corporation and Harmonic Inc., both Silicon Valley companies.

Physicist Peter Mastromarino, in his 2004 PhD thesis, wrote: “A special acknowledgement must go to David Pripstein, the postdoctoral scholar in our group at the time, and the person who was no doubt largely responsible for my decision to come to CalTech in the first place. Dave is one of the most unique characters I have ever known, with enough catch-phrases and idiosyncrasies to fill a notebook, and he is also one of the most dedicated, intelligent, and genuine people I am ever likely to meet.”

Pripstein, also known as ‘Prip’, was a racecar enthusiast. Also, for several years he helped produce annual, community-wide physics outreach programs at Foothill College in Los Alamos, California. A scholarship fund in his name
Renata Wentzcovitch was elected to the American Association for the Advancement of Science. She is a Professor of Chemical Engineering and Materials Science at the University of Minnesota, as well as a Principal Investigator with the Minnesota Supercomputing Institute. Renita was a graduate student of Professor Marvin Cohen.

Steven Wilkinson is a Senior Engineering Fellow and Chief scientist for Precision Communication, Navigation, and Timing Systems at Raytheon Corp. In 1997, he joined Hughes Aircraft, which became Raytheon later that year. Steve recently won “Technical Honors” for outstanding technical contributions and was granted a patent for precision frequency distribution and time synchronization. In his spare time, he is an International Measurer for the J80, which is an international, one-design sailboat.

Fred Kral reports that he and his wife Audrey have moved to Mill Valley. After teaching math for 10 years in independent high schools, Fred is teaching Physics at the Marin School in San Rafael, CA.

David Piehler has been Chief Scientist at NeoPhotonics Corporation in San Jose, CA since 2010.

Vijay S. Iyer, a New York-based jazz pianist, composer, bandleader, and producer, was recently awarded a MacArthur Genius Grant from the John D. and Catherine T. MacArthur Foundation. A self-taught pianist who earned a Masters in Physics and a PhD in the cognitive science of music at Berkeley, Iyer is known for his fascinating musical collaborations including the recent, “Holding It Down: The Veterans’ Dream Project.” In January, Vijay will join Harvard University as its first Franklin D. and Florence Rosenblatt Professor of the Arts. “A life in the arts is a life of service, Yo-Yo Ma once told me,” Iyer says. “That sits well with me.”

Xiaowei Zhuang, a student of Professor Ron Shen, was elected to the American Association for the Advancement of Science. She is a Howard Hughes Medical Investigator, Professor of Physics, Chemistry and Chemical Biology at Harvard University. In her lab, Xiaowei develops advanced optical imaging techniques, in particular single-molecule and super-resolution imaging methods, to study problems of biomedical interest. Some of these problems include gene expression regulation and virus-cell interactions. More recently, she has extended her interest into neurobiology.

Jenny Hoffman is an Associate Professor of Physics at Harvard University. The research in her laboratory revolves around scanning probe microscopies of exotic correlated electron materials.

Toyoko Orimoto is an assistant professor of physics at Northeastern University in Boston. She recently gave a TEDx talk titled, “The Art of the Higgs Boson.” In her talk, Toyoko explains to a lay audience why the discovery of the Higgs boson is both useful and beautiful. She was a fellow at CERN from 2009-2012 and a Robert A. Millikan fellow at the California Institute of Technology from 2006-2009. Yury Kolomensky was her research advisor here at Cal.

Lydia Wilson is finishing up her Master’s in Medical Physics at Louisiana State University. She was awarded a Fulbright Fellowship and will spend a year in Croatia studying disparities in radiotherapy cancer treatment. Lydia is a Chicago native, but her family has many relatives on the Croatian island of Korcula. She maintains that she is Cal Bear and always will be!

After completing her dissertation work on Bose-Einstein condensates in the group of Dan Stamper-Kurn, Jennie Guzman applied her atomic physics skills at a postdoctoral research position at Sandia National Laboratories. While there from November 2012-August 2013, she built an experiment aimed at using cold trapped atoms as remote sensors. In September, Jennie will become the newest member of the physics faculty at Cal State University East Bay (joining Derek Kimball ’05), teaching modern physics and physics for non-majors, and recruiting undergraduates to build her lab.

Joshua Evan Meyers has started a postdoctoral research position at Stanford where he now studies weak gravitational lensing. He is currently working to characterize wavelength dependence of atmospheric point spread functions and to propagate this dependence into uncertainties on cosmological parameters inferred from large ground-based imaging surveys. Saul Perlmutter was Josh’s PhD advisor.
CALENDAR OF EVENTS

Start of Fall Semester 2013
Thursday, August 29

First Department Tea
Monday, September 9, 4:00 pm
1 LeConte Hall Annex

The Bay Area Science Festival
Thursday, October 24 – Saturday, November 2
www.bayreascience.org

The 116th Big Game
Saturday, November 23
Stanford Stadium
Stanford, CA

Emilio Segrè Distinguished Lecture
David Wineland (’73),
2012 Nobel Laureate,
NIST, University of Colorado, Boulder
Monday, November 4, 5:00 pm
Chevron Auditorium at IHouse

Graduate Student Poster Session
Friday, November 15 at 3:00 pm
A. Carl Helmholz Room,
375 LeConte Hall
Berkeley Campus

Stuart J. Freedman Symposium: “Measuring ‘Nothing’ and Getting It Right”
Friday, January 10 – Sunday, January 12
Stanley Hall
Berkeley Campus

The 2014 West Coast Conference for Undergraduate Women in Physics (CuWIPS)
Friday, January 17–Sunday, January 19
Berkeley Campus
cuwip.physics.berkeley.edu

Start of Spring Semester 2014
Tuesday, January 21

The Regents Lecture
John Mather,
Nobel Laureate and Senior Astrophysicist, NASA
Monday, February 24 at 5:00 pm
Chevron Auditorium at IHouse

J. Robert Oppenheimer Lecture in Physics
S. James Gates, Jr.,
John S. Toll Professor of Physics and Director, Center for String & Particle Theory
University of Maryland
Monday, March 17 at 5:00 pm
Chevron Auditorium at IHouse

Undergraduate Poster Session
April 2014
375 LeConte Hall

Cal Day
Saturday, April 12, 9:00 am – 4:00 pm
Berkeley.edu/calday

Commencement 2014
Monday, May 19
Zellerbach Auditorium

Start of Summer Session
Monday, May 19
summer.berkeley.edu
For the latest information from the Berkeley Physics Department—news on current research, special events, lecture/demos, and student activities—visit the UC Berkeley Physics Home Page.

physics.berkeley.edu