UCDAVIS
Physics Newsletter

Number13 | A Newsletter for University of California, Davis, Physics Alumni | Summer 2008

A Message from the Chair

A Message from the Chair

The summer of 2008 sees the beginning of the Centennial celebration on the UC Davis campus. In the physics department, it marks the end of the five-year term of Shirley Chiang as chair. The academic year ends with 46 active faculty in place, and two more offers out to candidates. The department is vibrant with research activity in Condensed Matter, Cosmology, High Energy, and Nuclear, the relatively new thrust into Biophysics, and continuing activity in Physics Education spearheaded by Wendell Potter. The past several years have been a time of rapid growth for the department, mirroring the growth of the campus and of the UC system as a whole. The full Cosmology group is nearly in place (one offer is out), and HEFTI (the High Energy Frontier Theory Initiative) is in full gear and has been bringing top level people to campus for public lectures as well as colloquia. No doubt new emphases will join these in the near future.

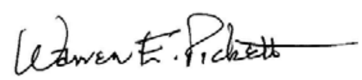
A department effort, headed by John Jungerman, has arranged a Physics Centennial Lecture Series by distinguished speakers. Freeman Dyson will visit in the last half of October. Nobel laureate Douglas Osheroff plans to visit during January 2009, and Edward (Rocky) Kolb will visit during the spring quarter. It is anticipated that each will give a public lecture as well as a department colloquium.

On the educational front, both the undergraduate program and the graduate program are undergoing their periodic review. Both programs are vigorous, and the growth in faculty is reflected in the growth in the number and variety of courses that are offered. The vigor is reflected in the student population as well: over 10,000 students

were enrolled in undergraduate courses during the year, and the graduate student number has been hovering near 150. Another positive sign is that the graduate program has risen to 29th in the ranking of U.S. News & World Report.

The UC system, the campus, and therefore the department, is entering a phase of much slower growth in number of students and faculty. It is our challenge to find new ways to enhance the visibility and the impact of our department. Our faculty members are rising to the challenge in a number of ways, several of which will be apparent in this newsletter and in following ones. Within two years we will expand into the space left behind by Geology as they occupy the new Earth and Physical Sciences Building. Certainly this will be one of our great opportunities.

As I begin my new position as chair, I look forward to the opportunity to further the progress of the past five years. I also invite feedback - suggestions and ideas - from all who read this newsletter, and I invite visits from those who may not have seen the department recently. You may be dazzled. ❖



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UCDAVIS
Physics Newsletter

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Department Chair: **Warren Pickett**; Department Vice Chair, Undergraduate Program and Administration: **Lori Lubin**; Department Vice Chair, Graduate Program: **Steven Carlip**

Thank You Party for Outgoing Department Chair, Professor Shirley Chiang

In their various official capacities, the past four Physics department chairs were together last spring for the casting of the Large Synoptic Survey Telescope mirror at the University of Arizona. From left: Shirley Chiang (Chair, Physics Department), Winston Ko (Dean, Mathematical and Physical Sciences), Barry Klein (Vice Chancellor for Research), and Robert Shelton (President, University of Arizona).

Outgoing Department Chair Shirley Chiang and Chair Designate Warren Pickett.

Professors Charles Fadley (on the left), and Xiangdong Zhu.

Left to right: Chair Designate Warren Pickett, Professor Andreas Albrecht, Professor Rajiv Singh, William Graves, Professor Lloyd Knox

Physics Club Officers 2007/2008

Faculty Advisors - Lecturer Randy Harris
Secretary/Treasurer - Alice Durand
President - Alexander Saw
Project Coordinator - Brooke Hunter
Vice President - Samantha Brovko
Webmaster - George Suarez

Astronomy Club Officers 2007/2008

Faculty Advisors - Associate Professor Christopher Fassnacht, Senior Lecturer Pat Boeshaar, Professor Emeritus Glen Erickson
Treasurer/Financial Officer - Allison Stevens
Outreach Organizer - Chelsea Meredith
Telescope Support - Lauren Bachman
Morale Officer - Sonia Ferrandiz
President - Elizabeth Shoemaker

Playing with Fire

by Alexander Saw

The Ruben's Tube creates a dramatic visual representation of the conversion of longitudinal waves into transverse waves...WITH FIRE! The tube is a 6-foot-long, 3-inch-diameter copper pipe, with about 100 small holes drilled along its length. We seal one end by a speaker and connect the other end to a propane tank. Then we open the tank valve and ignite the propane across the holes, creating flames several inches high. Next we activate the speaker to generate sound waves—longitudinal pressure waves—within the tube, and tune the frequency to a harmonic of the tube. At this point, the standing wave produces pressure that varies along the tube but is steady over time. The propane is expelled at different rates, depending on the local pressure inside the tube at each hole. This makes the flamelets vary in height and form a visible wave of fire!

Physics Club at Picnic Day

by Professor Rena Zieve

The Physics Club organizes and staffs the department's annual Picnic Day efforts. For much of the day, people can wander over to the second floor of Roessler Hall to play with hands-on demonstration and laboratory equipment. Physics undergraduates explain how it all works, from optical illusions to gyroscopes. In addition, the club's 10 year-old Physics Show gives Picnic Day visitors a chance to see some of the more fragile or complicated lecture demonstrations. A box of golf balls poised on mousetraps gives a chain reaction; the electromagnetic waves from a Tesla coil light up a long fluorescent bulb held nearby; and a student lies down on a bed of nails. The popular one-hour show now runs twice each Picnic Day and fills 66 Roessler, a 160-person lecture hall. Last year the Physics Club also built a Ruben's Tube, described above.

Ph.D. Degrees Awarded

Juan Carlos Idrobo (2004) – *"A Study of the Electronic Structure and the Effects of Oxygen on the Superconducting Properties of MgB_2 by Electron Energy Loss Spectroscopy"*
*Research Assistant Professor, Vanderbilt University

Bobby Lau (2004) – *"A Complete Model of the Infrared Dielectric Function of a Low Density Silica Aerogel"*
*Postdoctoral Researcher, San Jose State University

Yong-Seon Song (2004) – *"The Application of Weak Lensing"*
*Senior Research Associate, Institute for Cosmology and Gravity, University of Portsmouth

Petros Thomas (2004) – *"Novel Optical Studies of Ion Erosion Growth and Diffusion on Metal Surfaces"*
*Research Associate, University of Virginia

Limin Zhao (2004) – *"Effect of Structure on Magnetic Properties"*

Albert Loui (2005) – *"An Experimental and Theoretical Study of Furan Decomposition on Pd(111) Using Scanning Tunneling Microscopy and Density Functional Theory"*
*Postdoctoral Fellow, LLNL

Sayandeb Basu (2005) – *"Perturbation Theory in Covariant Canonical Quantization"*
*Visiting Professor, University of the Pacific

Roppon Picha (2005) – *"Charged Hadron Distributions in 19.6-GeV Au+Au Collisions"*
*Nuclear Scientist, Thailand Institute of Nuclear Technology

Shon Prisbrey (2005) – *"Structural and Magnetic Fluence Dependence in $Co_{0.038}Ti_{0.962}O_{2-\delta}$ and $Co_{0.049}Ti_{0.951}O_{2-d}$ Thin Films Synthesized by Pulse Laser Deposition"*
*Staff Scientist, LLNL

Iwen Mike Chu (2005) – *"Cosmological Parameter Constraints via Gibbs Sampling and the Blackwell-Rao estimator"*
* NPP Fellow, NASA Goddard

Benjamin Gold (2005) – *"Cosmic Acceleration and the Theory of the Microwave Background"*
*Assistant Research Scientist, Johns Hopkins University

Tae-Seong Jeong (2005) – *"Computational Studies of Electronic Structures for Superconducting and Magnetic Materials"*

Kevin Kelley (2005) – *"Neutron capture and the production of ^{60}Fe in stellar environments"*
*Faculty, Brigham Young University-Idaho

Yu Sato (2005) – *"Thin film microscopy of Pb on Ge(111) phase transitions and $Fe_x Ni_{1-x}$ on Cu(111) magnetic surface alloy"*
*Postdoctoral Scholar, UC Davis Physics Department

Kristopher Andersen (2005) – *"Electronic structure of nanomaterials: computational methods and application to niobium clusters"*
*Assistant Professor, Northern Arizona University

Peter Salzman (2005) – *"Investigation of the Time Dependent Schrodinger-Newton Equation"*
*Analyst, Fisk Ratings (Wall Street)

Uriel Giveon (2006) – *"New catalogs of radio compact H II regions in the Milky Way"*
*Freelance Translator

Michael Anderson (2006) – *"Directed and elliptic flow in Au + Au collisions at a center of mass energy of 19.6 GeV per nucleon-nucleon pair"*
*Lecturer, UC San Diego, Physics Department

Austin Calder (2006) – *"Graduate teaching assistants in a reformed introductory physics course: Synthesis of quantitative analyses of instructor action and qualitative analysis of instructor action and qualitative analysis of instructor attitudes and perspectives"*
*Mathematical Analyst, Dept.of Defense

Paul DeMange (2006) – *"Laser-induced defect reactions governing the damage performance of KDP and DKDP"*
*Postdoc, LLNL

Samantha Fore (2006) – *"Development of single molecule optical techniques for the study of recognition and repair of DNA damage"*

Juan Lizarazo (2006) – *"A measurement of the gamma-ray spectrum from the Crab Nebula"*
*Postdoc, LLNL

Brian Maddox (2006) – *"Pressure-induced electronic phase transitions in transition metal oxides and rare earth metals"*
*Postdoc, LLNL

Sasha Baroiant (2006) – *"A search for doubly-charged Higgs bosons at the Tevatron"*
*Energy Analyst, ADM Associates

Stanley Forrester (2006) – *"Search for 3rd generation vector leptoquarks in the di-τ di-jet channel in pp^{-} collisions at $\sqrt{s}$ = 1.96 TeV"*
*Adjunct Professor, Roosevelt University

Deepa Kasinathan (2006) – *"Computational study of materials under pressure"*
*Postdoc, Max Planck Institute

Han-Oh Lee (2006) – *"Ferromagnetism in the Kondo lattice CeNiSb and GeZn[x]Sb (x = 0.64, 0.66)"*
*Postdoc, Los Alamos National Lab

Kwan-Woo Lee (2006) – *"Studies of correlation effects in layered transition metal oxides"*
*Postdoc, UC Davis Physics Department

Mark McKinnon (2006) – *"Gender-based performance differences in an introductory physics course"*
*Lecturer, UC Davis Physics Dept.

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Ph.D. Degrees Awarded

Long Pham (2006) – *"Fine tuning the heavy fermion ground state: a new handle on $CeCoIn_5$"*
*Process TD Engineer, Intel

Master's Degrees by Exam

Andrew Baldwin
Scott Brisbin
Daniel Collins
Perry Gee
Owen Gross
Steven Hess
Ming Hong
Donna Jolliff
Letian Lin
Naomi Luce
Leilah McCarthy
Dana Nuccitelli
Steven Oliver
Marina Papenkova
Peter Quinliven
David Ring
David Santo-Pietro
Tyana Stiegler
Jerry Vigil
Meng Wei

Master's Degrees by Thesis

Paulo Afonso (2006) – *"Gamma-Ray Astrophysics with CACTUS and the flux of the Crab Nebula"*
*Graduate Student, University of Munich

Jennifer Neureuther (2006) – *"Chandra Observation of the Gravitational Lens B0712+472"*

Bachelor's Degrees Awarded

Honors at graduation are awarded to students who have a grade point average near the top of the college. The Departmental Citation award is given to students in recognition of their excellent academic record and undergraduate accomplishments. The Saxon-Patten Prize in Physics goes to students who have achieved an excellent academic record and plan continued study in physics.

Legend
x: Graduation with Honors
+: Graduation with High Honors
*: Graduation with Highest Honors
$: Saxon-Patten Prize
◊: Department Citation

Summer 2004

BS in Physics
xMatthew Graham

Fall 2004

BS in Physics
Leah Johnson
Scott Martinez

BS in Applied Physics
Daniel Hurt

Winter 2005

BS in Physics
Daniel Hartman
x◊Nathan Labadie

BS in Applied Physics
Jessica Gray

Spring 2005

BS in Physics
+◊Ryan Applegate
xPatrick Bocash
Michael Colson
Michael Countis
◊Michael Dann
Bryn Feldman
Alexander Glavtchev
Erik Lee
Kristina Liang
Bryan Loyola
*◊Sho Maruyama
Leticia Moran
Michael Quilici
x◊Rachelle Richmond
Zane Starkewolfe
Matthew Searle
Alexander Sheynis

BS in Applied Physics
Michael Indrajana
x◊William Johnson
Bryan Richter
Thomas Weldon

AB in Physics
Harry Leung

Fall 2005

BS in Physics
Etai Adam
Leon Duan

Winter 2006

BS in Physics
xTony Beukers
Kyle Wilson

Spring 2006

BS in Physics
Gregory Bowers
John Felde
x◊William Gaggioli
*$◊Nikolas Hoepker
*$◊Tia Miceli
x◊Evan Odabashian
Garry O'Neill
+◊Scott Peuse
x◊Katherine Stalder
Ryan Theiss-Aird

BS in Applied Physics
Matthew Gandara
xRyan Leverenz
Jared Wong

BAS in Physics
Emily Rostel

Summer 2006

BS in Physics
x$◊Daria Eiteneer
xDavid McGrogan
xMichael Sutherland

Fall 2006

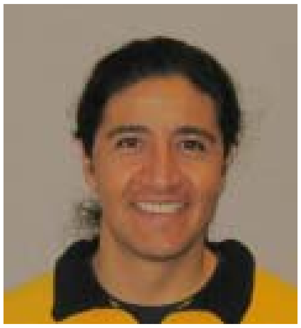
BS in Physics
*$◊Damien Deltoro
Lindsey Laughlin
Stou Sandalski
Scott Sennello
David Tolan
Oscar Valenzuela
Megan Yarbrough

AB in Physics
Forest Kirk

BS in Applied Physics
Niels Cooper

Introducing...

Manuel Calderón de la Barca Sánchez



Ph.D. - Yale University, 2001
Assistant Professor in Nuclear Experimental Physics
Professor Manuel Calderón de la Barca Sánchez joined the department in November 2005.

Dr. Calderón de la Barca's research is in the field of high energy nuclear experiments. Any nucleus is composed of protons and neutrons (collectively called nucleons). The nucleons are bound together by the nuclear force. Protons and neutrons, in turn, are composed of yet more fundamental constituents called "quarks." The Strong Force that binds the quarks inseparably together is mediated by "gluons." The nuclear force that binds nucleons is the remnant of the Strong Force between quarks—analogous to the chemical force that binds molecules being the remnant of the electromagnetic force in the atoms.

Dr. Calderón de la Barca's particular research interests lie in the frontier of nuclear physics: experiments with relativistic heavy-ion collisions. In these experiments, two atomic nuclei are forced to collide head-on at high energy; they reach speeds very close to that of light. In these collisions, the nuclear matter is excited or heated to very high temperatures. The collisions of nuclei which carry quarks and gluons are our only means of trying to study the behavior of the Strong Force in an extended volume. The matter created in the collision exists in this excited state only briefly, and eventually cools down to a gas of 'debris,' particles that are sufficiently stable that we can observe in our experiment. The particles provide information on the evolution of the matter created in the collision. Such information is also relevant for early Universe cosmology. About one microsecond after the big bang, the energy density of the Universe was close to the energy density achieved in a relativistic heavy-ion collision. Nuclear physicists use the experimental results to develop an equation-of-state in the gas of elementary particles (the relationship between temperature, pressure and density) on very short time scales, and this provides some of the most fundamental information about our Universe. At the highest energy densities achievable in the current accelerators, it is predicted that a phase transition will occur, and the quarks and gluons will mix into a quark-gluon plasma losing the identities of individual nucleons.

The research that Dr. Calderón de la Barca performs is highly fundamental in nature and provides information on some of the basic issues we face in understanding our Universe. During his postgraduate work, Dr. Calderón de la Barca became a member of the Solenoidal Tracker At RHIC (STAR) collaboration at RHIC (Relativistic Heavy Ion Collider) at Brookhaven National Laboratory. RHIC is widely considered to be *the* frontier of high energy nuclear physics, providing the high collision energies needed for the most fundamental studies relating to the nature of matter and our understanding of the Universe. Dr. Calderón de la Barca has developed a large fraction of the STAR simulation and embedding software, which is an essential tool for all of the data analyses for this large project. He has also been a key person in doing the physics analyses for STAR, particularly as related to measurements of hadron p_T spectra and the development of triggers for J/ψ particles, which will be important in studying the physics of charm quarks. Dr. Calderón is working on the Barrel EM Calorimeter, the Level 3 trigger, and the Endcap EM Calorimeter, all devices which enable electron identification in the decay of J/ψ $e^{+}e$ in STAR. He is also currently working on completing the measurement of the Upsilon (Υ) meson production in STAR. ❖

Hsin-Chia Cheng

Ph.D. - University of CA, Berkeley, 1996
Assistant Professor in High Energy Theory Physics
Professor Hsin-Chia Cheng joined the department in July 2005.

I am originally from Taiwan. I got my Bachelors degree in Electrical Engineering at National Taiwan University in 1988. After military service, I came to the U.S. to study Physics. I received my Ph.D. in Physics from the University of California at Berkeley in 1996. I did my postdoctoral research at Fermilab, The University of Chicago, and Harvard University before I joined U.C. Davis as a faculty member in 2005.

My research field is Theoretical High Energy Physics; in particular, my major interest is in physics beyond the Standard Model. Although the Standard Model is successful in describing all known properties and interactions of the existing particles, it is only a low-energy effective description of a more fundamental theory as it leaves many questions unanwsered. One of the most prominent questions is the origin of electroweak symmetry breaking. The simplest picture for electroweak symmetry breaking through a scalar Higgs doublet suffers from the naturalness problem if we try to extrapolate the theory to higher energies. The mysteries of the flavor sector and CP violation also call for explanations. In addition, new forms of matter and energy are required to account for many cosmological observations. My current interests include supersymmetry, extra dimensions, and new strong dynamics. ❖

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Nicholas Curro

Ph.D. - University of Illinois at Urbana-Champaign, 1998
Assistant Professor, Experimental Condensed Matter Physics
Professor Nicholas Curro joined the department in July 2007.

Nicholas Curro got his Ph.D. from the University of Illinois at Urbana-Champaign in 1998, where he did his thesis on nuclear magnetic resonance (NMR) of high temperature superconductors with Charlie Slichter. After leaving Urbana, he went to Los Alamos National Lab, where he was a postdoc, and later a permanent staff member in the Condensed Matter and Thermal Physics group from 2000. At Los Alamos, he expanded the NMR effort and continued to work on superconductors and other interested correlated electron systems. At Los Alamos, Nick continued to work on high-Tc, as well as related cuprate oxides, and in recent years he has focused on several heavy fermion systems, including the newly discovered plutonium-based superconductor. While at Los Alamos, Nick realized that he would like to switch to academia and teach students, and he moved with his family to Davis in late December of 2007.

At Davis, Nick plans to build up a solid state NMR laboratory capable of investigating novel materials under extreme conditions. These include simultaneously high magnetic fields (~ 14T), low temperatures (~ 10 mK) and high pressures (~ 3 GPa). Some of the most interesting problems in condensed matter are focused on the unusual behavior exhibited by materials at or nearby a quantum phase transition. At a conventional phase transition, the dominant fluctuations are thermal in nature and give rise to the usual critical phenomena associated with thermal phase transitions. At a quantum phase transition at zero temperature, zero-point quantum fluctuations become important. The nature of the excitations at a quantum critical point are determined by the underlying quantum superposition of states and the degree of entanglement; such issues are at the forefront of current understanding. These excitations manifest themselves experimentally as a breakdown of conventional Fermi liquid theory, one of the most robust successes in condensed matter physics. NMR studies of the microscopic fluctuations present in these materials as a function of phase space surrounding a quantum critical point are the focus of Nick's research. ❖

Markus Luty

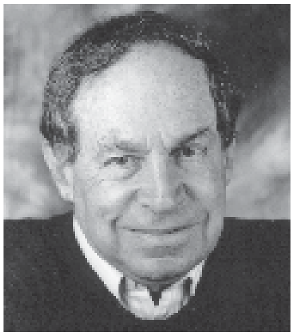
Ph.D. - University of Chicago, 1992
Professor in High Energy Theory Physics
Professor Markus Luty joined the department in July 2007.

Science is in my blood: my father is a physicist (now retired), and behind him stands a long line of German chemistry professors. I fell in love with physics during my last year in high school. Up until then, I was not a very good student, so I believe in giving students every chance to succeed!

I got my undergraduate education at the University of Utah and my Ph.D. from the University of Chicago. My research is in theoretical particle physics and cosmology. Many people think of modern scientific research as being very specialized and arcane, but for me the excitement of physics is that we don't know the answer to some really basic questions. We don't know what makes up 95% of the universe---we call it "dark matter" and" dark energy." We don't know why gravity is so much weaker than the other forces (like the ones that bind atoms into solids)---this is the "hierarchy problem." We don't know why vacuum energy does not curl up the universe so that it is less than a millimeter across---this is the "cosmological constant problem." Every day I get to think about these problems, and I even get paid for it!

My own research has been split between thinking about new big ideas to address these problems, and finding ways to test these ideas in the lab. The Large Hadron Collider (LHC), a giant particle collider on the French/Swiss Border, will begin operation in 2008, and will finally give us long-awaited experimental information about many of these fundamental questions. Because of this, my current work emphasizes what we can learn from the LHC. Like most workers in my field, I am expecting great discoveries in particle physics in the coming years. ❖

David Pines



Ph.D. - Princeton University, 1950
Professor, Condensed Matter Theory Physics
Professor David Pines joined the department in July 2005.

David Pines is Founding Co-Director of the Institute for Complex Adaptive Matter (ICAM), a Multicampus Research Program of the University of California; Distinguished Professor of Physics at UC Davis, where he teaches one quarter/year; and UIUC Research Professor of Physics and

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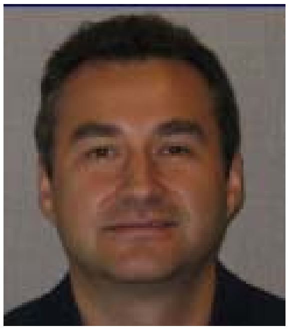
Center for Advanced Study Professor of Physics [emeritus]. His contributions to the theory of many-body systems and to theoretical astrophysics have been recognized by two Guggenheim Fellowships, the Feenberg Medal, Friemann, Dirac, and Drucker Prizes, and by his election to the National Academy of Sciences, American Philosophical Society, American Academy of Arts and Sciences, Russian Academy of Sciences, and Hungarian Academy of Sciences, and Visiting Professorships at the College de France, Caltech, and Trinity College, University of Cambridge. He has written over 260 papers and four books, was editor of Reviews of Modern Physics (1973-96), and is the Founding Editor of the series "Frontiers in Physics," which began in 1961 and saw its 100th volume appear in 1998. He was the Founding Chair of the Board on International Scientific Exchange and the US/USSR Cooperative Program in Physics of the National Research Council. He is a Co-Founder of the Santa Fe Institute, where he has served as Vice-President, Co-Chair of the Science Board and Science Steering Committee, and member of the Board of Trustees, is a member of the Board of Overseers of Sabanci University, an exciting new university in Istanbul, and continues his active participation in the Aspen Center for Physics as an Honorary Trustee and summer researcher

At UC Davis and ICAM he currently divides his time between what seem like two full-time jobs, each of which is going wonderfully well —continuing his research on emergent behavior in matter and looking after ICAM, an international "Institute without Walls , whose scientists study emergent behavior in both living and inanimate matter, that has been experiencing a period of remarkable growth, from 9 domestic branches in 2002 to 31 domestic and 25 branches abroad six years later.

His research concerns the search for the organizing principles responsible for emergent behavior in materials where unexpectedly new classes of behavior emerge in response to the strong and competing interactions among their elementary constituents. Among his recent results on correlated electron materials are: the development of a consistent phenomenological description of protected behavior in the pseudogap state of magnetically underdoped materials that shows these contain a mixture of an insulating spin liquid and a Fermi liquid that becomes superconducting through their mutual coupling; the discovery in heavy electron materials of the protected emergence of itinerancy in the form of a novel state of matter, the Kondo liquid, a non-Landau Fermi liquid state; and the demonstration that Kondo liquid behavior is controlled by a single parameter, the local Kondo coupling between the f-electron moments and the background conduction electrons. He continues his interest in the superfluidity of neutron stars revealed by pulsar glitches, and in elementary excitations in the helium liquids.

His latest ICAM-based efforts involve establishing an international educational network, the Emergent Universe Alliance, that seeks to create public understanding of what is arguably the most significant scientific challenge of this new century, understanding our Emergent Universe, and setting up the Distributed Center for Heavy Electron Materials, an international research network on heavy electron materials. ❖

Sergey Savrasov



Ph.D. - Lebedev Physical Institute, Moscow 1994

Professor, Condensed Matter Theory Physics

Professor Sergey Savrasov joined the department in July 2005.

Theoretical understanding of the behavior of materials is a great intellectual challenge and may be the key to new technologies. We now understand quite well simple materials such as noble metals and semiconductors. The scientific frontier that I would like to explore is a category of materials, which falls under the rubric of strongly correlated electron systems. These systems have frustrated interactions, reflecting the competition between different forms of order, and their excitation spectra cannot be described in terms of well-defined quasiparticles. The promise of strongly correlated materials continues to be realized experimentally. High superconducting transition temperatures were totally unexpected. A surprisingly large dielectric constant, in a wide range of temperature, was recently found in Mott insulator $CaCu_3Ti_4O_{12}$. Enormous mass renormalizations are realized in heavy fermion systems containing rare earth and actinide elements. Their large orbital degeneracy and large effective masses give exceptionally large Seebeck coefficients and have the potential for being useful thermoelectrics in the low-temperature region. Colossal magnetoresistance, a dramatic sensitivity of the resistivity to applied magnetic fields, was discovered recently in many materials including the prototypical $LaSrMnO_3$. A gigantic non-linear optical susceptibility (χ_3) with an ultrafast recovery time was discovered in Mott insulating chains. Novel spintronics and hydrogen storage materials may revolutionize modern semiconductor and energy industries.

This non-comprehensive list of remarkable materials and their unusual physical properties are meant to illustrate that discoveries in the areas of correlated materials occur serendipitously. Unfortunately, lacking the right theoretical tools and daunted by the complexity of the materials, there have not been success stories in predicting theoretical directions for even incremental improvement of material performance.

In my view, study of strongly correlated systems is a promising research direction, and the prospects for their applications are exciting. We now move from various semiphenomenological and model theories proposed in the past, to building a modern computational approach to material design which can be based on traditional electronic structure theory of solids coupled to recently developed dynamical mean field algorithms accounting for the effects of local electronic correlations. ❖

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Robert Svoboda

Ph.D. - University of Hawaii, Manoa, 1985
Professor, High Energy Experimental Physics
Professor Robert Svoboda joined the department in July 2006.

I am happy to have joined the faculty at UC Davis after moving from Louisiana State University with my wife Juilien and daughter Jasmine. We are an increasingly more common "two body problem" couple - so are very happy to both be able to be working in the same locale. We temporarily relocated from New Orleans following Hurricane Katrina in 2005 - but have since decided to make this area our permanent home.

My research specialty is in particle and nuclear physics - but with an emphasis on neutrinos and dark matter. Over the last twenty years I have done experiments in deep mines in Cleveland (IMB) and in Japan (Super-Kamiokande and KamLAND), in space as a guest observer on the Compton Gamma Ray Observer, and at the KEK particle physics lab in Japan. These experiments showed that neutrino particles are not massless as was originally thought, but indeed have a mass that must be greater than about 60 meV. They also violate lepton family number via a mechanism known as "flavor oscillations." Along the way we also discovered neutrinos from the SN1987A supernova and learned how to make neutrino detectors that can measure plutonium production in operating reactors (of great interest in verifying treaties for controlling the spread of nuclear weapons).

Currently, I have three projects going. Firstly, I am the U.S. co-spokesman for Double Chooz - an experiment to further investigate the very weird "oscillation" phenomenon mentioned above. This experiment uses anti-neutrinos from a pair of nuclear reactors in northern France and two identical neutrino detectors to look for a seeming departure from the inverse square law in the anti-neutrino flux. Such a "seeming" departure would be expected if neutrinos oscillated (i.e., changed their interaction probability) on short as well as the long distance scales already seen.

Secondly, I am working with Professors Mani Tripathi and Dick Lander to build a new experiment at the new Deep Underground Science and Engineering Lab (DUSEL) in South Dakota. The Large Underground Xenon (LUX) experiment will try and make the first direct detection of dark matter in the laboratory. It will look for a theoretically-predicted form of dark matter called a WIMP (Weakly Interacting Massive Particle) by building a liquid xenon detector almost a mile underground - then looking for WIMP's to collide with the xenon to produce very small ionization signals at the level of 5-30 keV (about 100 times lower energy than typical background radiation!). To date nobody has ever seen a WIMP - so we hope to confirm (or refute at a sensitive level) their existence within the next few years.

Lastly, I am working with a research team at LLNL to develop practical neutrino detectors for reactor monitoring. Such tools would be useful for UN inspectors from the IAEA, who have the responsibility to monitor the operating cycles and plutonium production in civilian nuclear power plants worldwide.

My family and I enjoy skiing, hiking, and camping and are still exploring the local area. To inquiries from other physics faculty members - yes, I WILL make gumbo again this coming Mardi Gras!

Laissez les bon temps rouler. ❖

David Wittman

Ph.D. - University of Arizona, 1997
Assistant Professor, Cosmology
Professor David Wittman joined the department in July 2006.

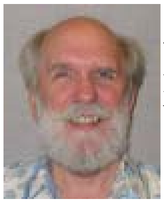
I received my PhD in 1997, worked at Bell Labs for seven years, and then came to UCD as a researcher in 2004. In 2006 I became assistant professor. My graduate work was in adaptive optics, a method of correcting for turbulence in the atmosphere in real time to yield sharper images from ground-based telescopes. Since then I have worked on wide-field imaging, surveying the sky at various wavelengths.

These surveys can serve many different astrophysical science goals, but my main focus is on gravitational lensing, which yields a direct measurement of the mass of a system. This is important because mass clustering is what can be predicted given a cosmological model, but generally we can observe mass only very indirectly, as most of the mass in the universe does not emit light. Lensing needs only a random background source of light to directly probe the mass distribution.

The two surveys I am working on now are the Deep Lens Survey (dls.physics.ucdavis.edu) , which has more or less concluded observations and is in the analysis stage, and the Large Synoptic Survey Telescope, which is in the design phase (lsst.org). You can find more information and some pretty pictures at my home page www.physics.ucdavis.edu/~dwittman/. ❖

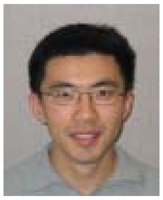
Faculty Highlights

Our faculty have garnered awards for research and teaching, for promise and achievement. These include:



UC Davis Distinguished Teaching Award: Wendell Potter, 2005.
Professor Potter became the third physics recipient in five years. His work on Physics 7, the introductory sequence for bioscience majors, has also received national recognition, as described on page 11.

Professor Wendell Potter

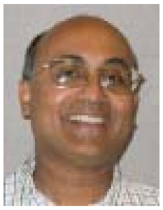


Professor Kai Liu

Sloan Research Fellowship: Kai Liu, 2005.
The Sloan Foundation's prestigious national award for early-career scientists boasts 35 Nobel Prize recipients among its past Fellows. Professor Liu's research is on magnetism in nano-structured materials. His group has pioneered first-order reversal curves, a measurement technique involving nested hysteresis loops, as a way to probe magnetic microstucture.

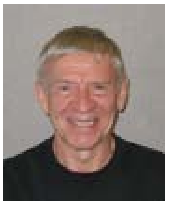
Fellow of American Vacuum Society: Shirley Chiang, 2006.
Professor Chiang's election as fellow is for her scanning probe microscopy, including work on adsorbates, chemical reactions, and frictional forces.

Professor Shirley Chiang



Professor Rajiv Singh

Fellow of American Physical Society: Rajiv Singh, 2006.
Professor Singh's election stems from his development of series expansion methods and his results on quantum phases in lattice models and real materials.



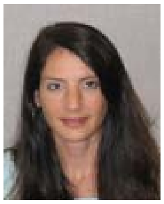
Professor Chuck Fadley

Professor Warren Pickett

Medard W. Welch Award of American Vacuum Society: Chuck Fadley, 2005.
The award to Professor Fadley is for his development of novel techniques based on photoelectron spectroscopy and synchrotron radiation, and their application to the study of the atomic, electronic, and magnetic structure of surfaces and buried interfaces.

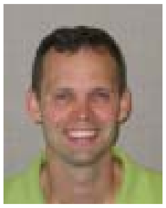
Humboldt Research Awards: Warren Pickett (2005-06) and Chuck Fadley (2006-07). These awards fund sabbatical years with collaborators at German universities. Professor Pickett studies electronic structure theory, Professor Fadley surface science.

Professor Hsin-Chia Cheng



Professor Robin Erbacher

Department of Energy Outstanding Junior Investigator Awards: Hsin-Chia Cheng and Robin Erbacher, 2006. About eight high-energy physicists receive these awards each year. Professor Erbacher works in the CDF collaboration at Fermilab and on the CMS detector at the LHC in Geneva. Professor Cheng, a theorist, studies models of electroweak symmetry breaking; he has also recently looked at how to analyze LHC events with missing energy.



Professor Lloyd Knox

Professor Lori Lubin

UC Davis Chancellor's Fellows: Lloyd Knox (2004-05) and Lori Lubin (2006-07).
The award goes to outstanding faculty near the start of their careers. Professor Knox does theoretical and phenomenological cosmology, with recent focus on understanding the acceleration of the universe and dark energy. Professor Lubin is an observational cosmologist, studying large-scale structure formation through x-ray astronomy.

UC Davis Research Experience for Undergraduate Research Program

by Professor Rena Zieve

The Physics Department's Research Experiences for Undergraduates (REU) program, funded by the National Science Foundation, is entering its fifth year. Each summer ten to twelve undergraduates from other universities spend ten weeks at Davis working in one of the department's research groups. The program also includes recreational events, as well as presentations and field trips related to different aspects of scientific careers.

With over 200 applicants, admission is extremely competitive. Most REU students do excellent work, and every year several coauthor publications from their brief time at Davis. Last year's projects included simulating how robots can ``learn" new behaviors, analyzing whether mass distributions of galaxies affect measured values of the Hubble constant, and testing the magnetic properties of nanowires made from alternating layers of magnetic and nonmagnetic materials. At the end of the summer, students write papers describing their work; these are available through the Past Program link at http://www.physics.ucdavis.edu/REU.

REU Research Group 2007

The department's theoretical faculty deserve special mention. As some applicants point out, our program offers far more theory projects than most other REUs. While hands-on tasks often provide an entry point to experimental labs, enabling sophomores or occasionally even freshmen to start research, theory demands more physics and math coursework as background. Designing theory projects so that undergraduates can participate productively takes extra effort, but many of our faculty have done so successfully.

We introduced several new field trips in 2007: a trip to the nuclear reactor at McClellan Air Force Base, which is now run by UC Davis; a tour of Hitachi Global Research; a visit to the Hat Creek Radio Observatory and Lassen Volcanic National Park; and a demonstration of the KeckCAVES three-dimensional visualization environment in the basement of the physics building. Others were old standbys: the Stanford Linear Accelerator Center, the San Francisco Exploratorium and Muir Woods, and an overnight stay with Professor Chiang's family at Lake Tahoe, who very generously hosted the entire REU group for a fourth straight year.

Since we try to give students a sense of the career paths available with a physics degree, we also rely on department alumni who work at local small businesses. In previous summers we visited the Davis-based companies Z-World and Kiff Analytical and heard about how physics training led to careers in mini-computer manufacturing and environmental testing. If other alumni working at small businesses would be willing to spend a couple of hours giving a tour to next year's REU group, please contact Professor Zieve, zieve@physics.ucdavis.edu.

Physics 7 Honored by CEPR Best Practice List

by Sr. Lecturer Emeritus Wendell Potter

Physics 7A and 7B have been identified as two of the top five examples of best practices in a national study of Physics courses conducted by the Center for Educational Policy Research (CEPR) on behalf of the College Board. A total of 139 courses from across the nation were reviewed. In addition to being identified as being best practices overall, Physics 7A and 7B were each designated as "*exemplary practice*" courses by a panel of national experts in Physics. This is the highest designation awarded, and only a very few courses in the study met this standard of distinction and excellence.

The study sought to identify best practices college courses that could inform the redesign of AP courses in Physics. CEPR assembled a panel of national experts to analyze the top five courses from a wide range of institutions. Wendell Potter and David Webb submitted hundreds of pages of discussion/lab worksheets, quizzes, and textual materials for Physics 7A and Physics 7B, which were evaluated separately. The panel reviewed the nominated courses and identified the critical components of best practices present in each course. The College Board then convened a commission in Physics to develop new AP course descriptions, new AP exam specifications, and professional development guidelines for AP teachers. The final result of the commission's work will be AP courses that closely reflect the

(continued on page 13)

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Private Support has always been important in providing the margin of excellence for our students and faculty. In today's challenging economic times, UC Davis relies even more on our alumni and friends who make a vital investment in the future. Funds or equipment donated to the Physics Department will be used to enhance our teaching program and facilitate scientific discoveries that shape the future. For more details, see http://www.physics.ucdavis.edu/finance.html

If you would like to make a tax-deductible gift to the UC Davis Physics Department, please complete the form below and return it with your contribution to Warren Pickett, Chair, Department of Physics, University of California, One Shields Avenue, Davis, CA 95616-8677. For other ways of giving, see the College of Letters & Science web site at http://www.ls.ucdavis.edu/friends/supportthecollege.aspx

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3-PHY0004/09003

We'd Like to Hear From You!

We are very interested in how you are doing and where your career has taken you. What do you remember most from your time at UC Davis? What is your current employment? What would you like to see in future newsletters? Email Bill Tuck, tuck@physics.ucdavis.edu, with your answers or other news. Please include your name, degree, and graduation year.

Department Highlights

(continued from page 11)

best practices of college courses in Physics. To see exactly how Physics 7 exemplified best practices in content knowledge, habits of mind that students should be developing, and instructional practices go to http://epiconline.org/apbestpractices/physics.php. The Physics 7 courses are the first and fourth of the five listed.

The initial development of Physics 7 in 1994-96 by Potter, Coleman and colleagues was based on the implications for course design available at that time from the fields of cognitive science, science education, and the emerging field of physics education research, so it is not surprising that it was singled out as exemplifying best practices in this study. It differs from traditional courses in the extent to which almost every element of the course is focused on encouraging students to make sense of and really understand the material they are studying, rather than relying on memorization and rote algorithmic problem solving. Major differences include: only half as much lecture time, but five hours per week in discussion/lab; content organized by important and general models rather than by topics; emphasis on frequent quizzes requiring demonstration of understanding and the ability to formulate logical scientific explanations. ❖

UCDavis Department of Physics, June 2008

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Manuel Calderon de la Barca Sanchez
Hsin-Chia Cheng
Maxwell Chertok
Thomas Cahill*
Steven Carlip
Daniel Cebra
Ling-lie Chau*
Shirley Chiang
Lawrence Coleman
John Conway
Linton Corruccini
Daniel Cox
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Nicholas Curro
James Draper*
Robin Erbacher
Glen Erickson*
Charles Fadley
Christopher Fassnacht
Daniel Ferenc
Ching-Yao Fong
Claude Garrod*
John Gunion
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Barry Klein
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William Knox*
Winston Ko
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Kai Liu
Lori Lubin
Markus Luty
Douglas McColm*
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Warren Pickett
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Rajiv Singh
Robert Svoboda
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Mani Tripathi
Tony Tyson
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Dong Yu
Xiangdong Zhu
Rena Zieve
Gergely Zimanyi

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Eckart Lorenz
Michael McElfresh
Harry Radousky
Ramona Vogt

Lecturers

Rod Cole
Randy Harris

Legend

*Emeriti/a Professors

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Michael Hannon
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