UCDAVIS

Physics Newsletter

Number 10 *A Newsletter for University of California, Davis, Physics Alumni* *2002*

From The Chair...

It has been two years since our last newsletter. What changes we have had in these two years!

First of all, we have expanded the faculty significantly. Max Chertok (a high energy experimentalist) and Lloyd Knox (a cosmologist) joined us in 2000 and Kai Liu (a condensed matter experimentalist) joined us in 2001. They are being profiled in this issue. Chris Fassnacht, Nemanja Kaloper, and Lori Lubin (all cosmologists) have accepted our offers, and so has John Rundle, the new Director of the campus-wide Center for Computational Science and Engineering. They will be profiled in a later issue. With the retirements of Paul Brady and Doug McColm, we have a net gain of 4.5 faculty. With the three new cosmologists arriving, we have concluded our initial phase of building the Cosmology program — it was a cosmic inflation! Kai Liu's appointment is associated with the Nanomaterial in Environment, Agriculture, and Technology initiative. His appointment and John Rundle's make the Physics Department a full participant in the campus's interdisciplinary initiative process. Our current non-emeriti faculty (36) is the largest in the College of Letters and Science, including Biological Science ahead of English and History at 35 each and Chemistry, Mathematics and Psychology at 33 each.

We are delighted that the campus has come through with the $1.6 million needed to expand the fifth floor of our building by 4,400 square feet. Otherwise, we certainly would not be able to accommodate the new faculty and continue to grow. The expansion is expected to be completed by next spring. By then, all of our cosmologists will be on board. The timing coincides with the Davis Meeting on Cosmic Inflation 2003 (see ad on page 8) and Stephen Hawking's public lecture at the new Mondavi Center. It is a really fitting time to publicly launch our cosmology program. We plan to invite our alumni back to celebrate this happy occasion and the Golden Jubilee of the **UCDAVIS** Physics Department. Our next newsletter is also planned to coincide with these events.

Our growth is of course connected to the growth in student enrollment. In these two years we have seen our Physics 9 enrollment grow by a third. It is not only the quantity of our teaching that is noteworthy, but the quality as well. Members of our department have received the Academic Senate Distinguished Teaching Awards in *both* of these two years — Shirley Chiang in 2001 and Doug McColm in 2002. Our hats off to both of them!

In the research arena, we have had a few high profile events. Bob Becker's observation of the most distant quasar, probing the pre-ionization era of the early Universe, made the front page of the New York Times. Daniel Cox and Rajiv Singh's statistical mechanics work on prions also received extensive media coverage. Lloyd Knox determined the age of the Universe to be 14 billion years old, give or take half a billion years, a result much more precise than previous estimates, that had margins of error of more than 10 percent. He also garnered the NASA Long Term Space Astrophysics Award. James Wells received DOE's Outstanding Junior Investigator Award in high energy theory. The high energy group has now enjoyed 30 years of uninterrupted Department of Energy funding. Steve Carlip organized this year's Pacific Gravity Conference (see the neat poster on page 8). Ramona Vogt received the 2001 Academic Federation Excellence in Research Award. Luke Donev, who worked in Rena Zieve's lab, was the sole recipient of the 2001 Chancellor's Excellence in Undergraduate Research Award.

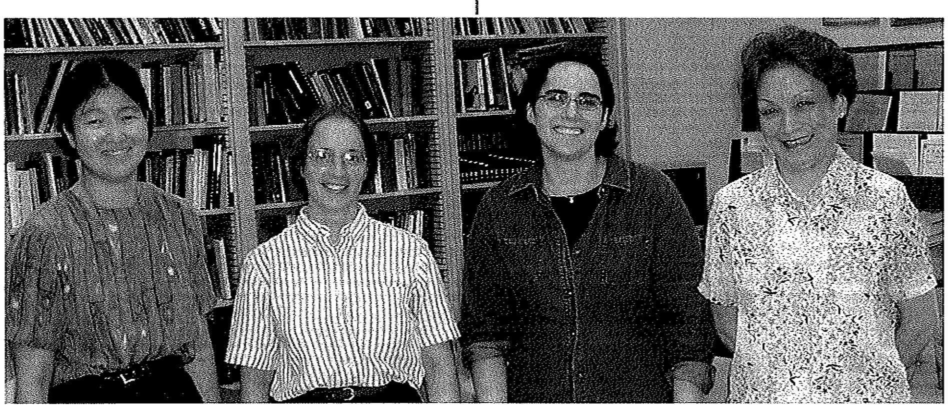
If you have a feeling that the Physics Department is on the roll, it is probably correct. Come on the Alumni Day this spring to see for yourself and to celebrate with us.

Sincerely,

❖

Winston Ko

Inside This Issue



From left to right: Physics professors Shirley Chiang, Rena Zieve, Lori Lubin, and Ling-Lie Chau at the reception to welcome Dr. Lubin.

Modeling Prion Diseases

by Daniel L. Cox and Rajiv R. P. Singh, professors

The outbreak of the Mad Cow Disease epidemic in the United Kingdom during the 1990's and the subsequent confirmation of transmission of the disease to humans has caused a significant public health scare. Hundreds of thousands of cows developed the normally rare, but deadly neuro-degenerative disease, and millions were slaughtered in efforts to control it. Over one hundred humans have died of a new-variant Creutzfeld-Jacob Disease (nv-CJD) believed to be caused by eating infected beef. Variants of this disease are widespread in other mammals as well. For example, as much as 30 percent of the wild deer and mink population in the United States may have such diseases.

How did this disease arise? What causes its transmission? How significant a public health threat is it? Can it be treated? These questions remain at the forefront of biomedical research today.

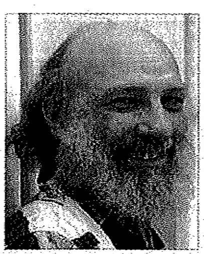
The 1997 award of the Nobel prize in medicine to Dr. Stanley Prusiner of UC San Francisco, the man who coined the name Prion for "protenacious infectious agent", shows a growing acceptance of his theory that these diseases are different from other transmissible diseases. Most diseases are spread by nucleic-acid-containing viruses and bacteria. The infectious agent in Prion diseases is a misfolded protein, which autocatalyzes its own misfolding. Prusiner's theory asserts that a rapid growth in the number of misfolded proteins, or prions, is responsible for the disease onset and death, although the detailed mechanism by which prions cause neuronal death is not known. How significant is the threat to public health? Epidemiologists estimate the number of potential human deaths from 1990's Mad Cow epidemic to range from a low of a few hundred to a high on the order of a million. One reason for this very large uncertainty is the decades-long incubation time, during which the disease silently incubates inside a body without any apparent symptoms. What causes such long incubation times? Do they have a well-defined statistical distribution? Can they be made longer than the normal lifetime, thus preventing the onset of the disease altogether?

It is these questions that motivated our group to develop a model for incubation times in prion diseases. Our model is built upon the idea that the misfolding of proteins is tied to their aggregation into clusters. Indeed, no misfolded protein monomers are ever observed. A common post-mortem feature of these diseases is the presence of plaques consisting of clusters of misfolded proteins. Our model provides a simple explanation for the long incubation times in terms of a slow stochastic aggregation process, which needs to reach a critical size before a more castastrophic exponential growth takes over. We calculate the distribution of incubation times, which corresponds rather closely with the observed distributions in the epidemiological data. Our model also leads to clear predictions for dose dependence of the incubation times and their distributions.

One of the striking aspects of the prion diseases is the "species barrier." It is as if transmission of the disease within a species is much easier than transmission between species. This fact can be rationalized at a simple level by the idea that the proteins in different species are not identical. Although the particular protein implicated in prion diseases is 90 percent homologous in all mammals, it still varies from species to species, and that difference gives rise to a barrier for transmitting the disease across species. An intriguing aspect of the species barrier is its asymmetry. Mouse prions readily infect hamsters for instance, but hamster prions do not cause the disease in a mouse. In our work, we suggested a treatment protocol for these diseases exploiting this asymmetric species barrier. Our idea is that adding a normal form of suitably chosen alien-proteins can help coat any infectious seeds with alien prions which will then become relatively immune to further incubation times, thus prolonging the disease onset. This idea of fighting prions with prions has resonated in the popular reporting of our work, though it remains to be seen if it will actually help in developing treatments for these diseases.

In closing, we note that as various sciences approach the molecular level, the strict boundaries between disciplines are bound to disappear. Thus it should be possible for individuals to contemplate problems ranging from medicine to biology to environment to material science to basic physics and chemistry. Our department and our university has a commitment to grow in this nanoscale science. ❖

Quasar Discovery



UCDAVIS professor and astronomer, Dr. Robert Becker, helped discover the most distant matter ever observed by humans. The object discovered was a quasar, an incredibly radiant, mysterious object with the mass and energy of an entire galaxy, hypothetically powered by a black hole. The finding was part of an $80 million global astronomical collaboration dubbed the Sloan Digital Sky Survey. Using light from the most distant object known, Dr. Becker and other astronomers have been able to find traces of the first generation of atoms in the universe, 14.5 billion light years from Earth. The observations are the first of the cosmic "Dark Age," between the Big Bang and the first visible stars and galaxies, and allow astronomers to set a date for the complete reionization of the universe. The observations mark the point when radiation from the first stars and quasars tore apart and reionized neutral hydrogen atoms that filled space after the Big Bang. The Physics Department plans to create a cosmology research center in the near future. Faculty members are Drs. Andreas Albrecht, Robert Becker, Christopher Fassnacht, Nemanja Kaloper, Lloyd Knox, and Lori Lubin.

New Computer Lab and Teaching Facilities

by Richard Scalettar, Vice Chair for Graduate Matters

Winter Quarter 2001 marked two important events in improving instructional resources for physics courses and research—the completion of a new computer laboratory in Room 106 of the Physics/Geology building, and the opening of a new room, 266 Everson Hall, for Physics 7 laboratory sections. Both of these were crucial to maintaining a high level of undergraduate education for our students.

In Spring Quarter 2002, we opened a second room—114 Walker Annex—for additional Physics 7 laboratories. A third room in TB 114 was ready for classes by Fall Quarter 2002.

With the expansion of the UC**DAVIS** Engineering program and the further development of laboratories for the Physics Honors sequence, the traditional space for undergraduate instructional labs in Roessler Hall became increasingly inadequate. Winston Ko and Wendell Potter worked hard to convince the campus to allocate the additional space for these rooms. A lot of hard work went into converting this space for Physics 7 lab sections. Features include special tables to facilitate active discussions between students and with the lab TA's, as well as imaginative new equipment and demonstrations emphasizing the key conceptual ideas on which Physics 7 focuses.

The use of these new rooms has freed up space in Roessler Hall, which, for the moment, now has room for Physics 9 and 9H. With growth on campus, combined with continued expansion of our course offerings like a second quarter of upper division optics, we anticipate that the problem of laboratory space will be a recurrent one.

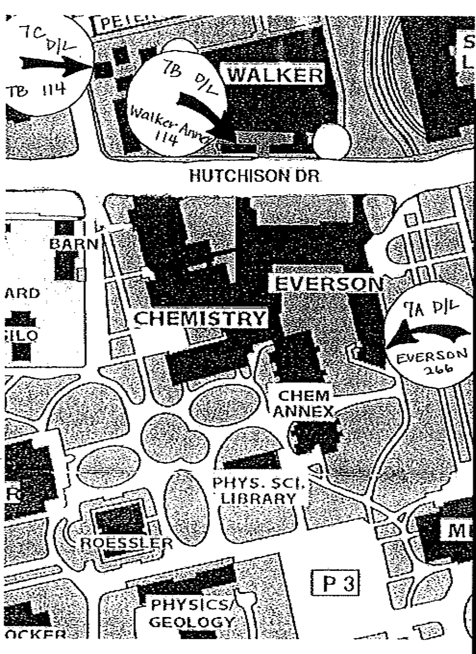
Meanwhile, room 106 of the Physics/Geology building now houses a modern computer laboratory for our graduate and undergraduate students. The new facility replaces room 505 and the original linux server, "Lifshitz," and the ten color x-terminals which provided access, with a modern cluster of sixteen high performance Dell PC's.

All files are stored on the "new" Lifshitz, a 733 MHz Pentium III, 133 MHz front-side-bus, 256 MB RAM. It has a 17" Trinitron monitor, two 9.1 GB, RAID-1 internal disk drives that mirror one another, and an external, RAID-5 disk array which serves as the "home" file system. Lifshitz has a PERC2, dual-channel RAID controller so that the disk redundancy for both the internal and external drives is managed in hardware, not by the operating system. Lifshitz also has a redundant power supply and a UPS. In short, the server has been configured to be especially stable and to keep the cluster well afloat. An HP 4050N printer completes the room's hardware.

Also available is the full range of linux supported software commonly used in physics research. The C and fortran compilers along with the BLAS and LAPACK libraries provide a core set of utilities for serious computational work. Mathematica is currently available only on lifshitz because of license restrictions.

One additional computer running windows has been put in the fourth floor printer room to provide access to that operating system. The color X-terminals from room 505 have been moved into first year graduate student offices.

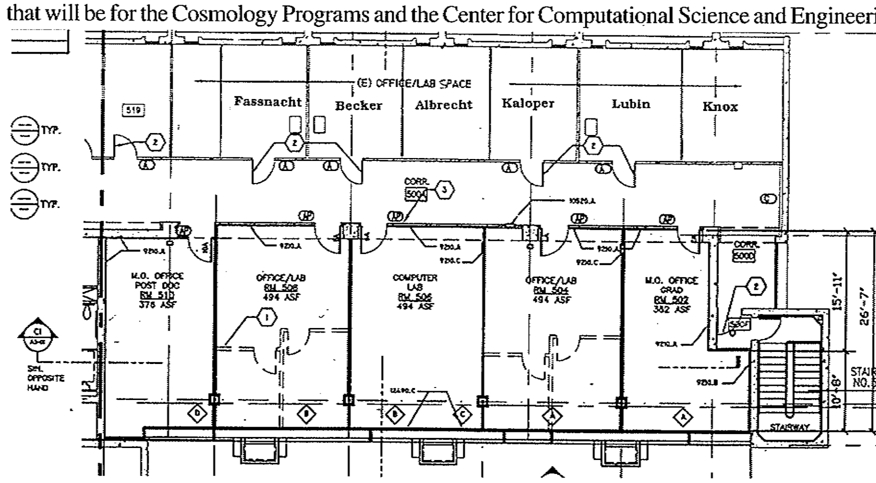
Student use of this cluster is steadily increasing. Indeed, for the last few months, all sixteen machines have typically had numerically intensive, computational physics programs running in background. Besides use for homework assignments associated with courses, research projects have ranged from lattice gauge theory and high energy physics detector design simulations to studies of hysteresis and flux line motion in solids. In addition, the new room has also already provided temporary internet access for a Higg's Workshop held in the Physics Department and to the summer "COSMOS" high school science program. While we anticipate the great majority of the use of this facility will be for students, it will also simplify the task of hosting such conferences and other educational events. ❖



New locations of Physics 7 laboratory classrooms.

5th Floor Expansion Project

The fifth floor of the Physics/Geology building is being expanded to provide much needed space for the Physics Department. The drawing indicates the layout of half of the new space that will be for the Cosmology Programs and the Center for Computational Science and Engineering.



Ph.D. Degrees Awarded

Spring 2000—Spring 2002

Joonhee An - *"Microscopic Theory of Magnetic Clusters and Superconducting Materials"*
*Postdoctoral Researcher at UC Davis and Lawrence Berkeley National Lab

Stephen Chamberlain - *"Magnetic Properties of Rare-Earth Fluorides with KY_3F_{10} Structure"*
* Applications Engineer with Boxer Cross, Inc, Menlo Park, CA

Robert Cohen - *"Magnetic and Resistivity Studies of Compounds: $A_{14}MnPn_{11}$ where A = [Ca, Sr, Ba] and Pn = [Sb, Bi]"*
*Senior Process Engineer with Intel Corp., Santa Clara, CA

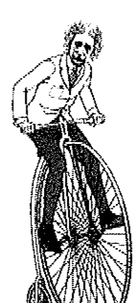
Charles Consorte - *"A New, Highly-Transferable, Interatomic Potential for Silicon"*
*Senior Process Engineer with Intel Corp., Santa Clara, CA

Christie Devlin - *"The Structure and Dynamic of Metal and Polymer Surfaces and Thin Films"*
*Research Physicist at the Air Force Research Lab, Wright-Patterson AFB, OH

Matthew Enjalran -*"A Study of Magnetic Phenomena in Frustrated Spin Systems and the Effects of Disorder in Correlated FermiSystems"*
*Postdoctoral Research at the University of Waterloo, Ontario, Canada

Paul Freitas - *"Numerical and Analytical Studies of Physical Properties of 2D Antiferromagnetic Spin Systems"*
*Senior Technical Writer for Borland Software Corp., Scotts Valley, CA

Don Futaba - *"Observations and Calculations of Adsorbed Organic Molecules and Surface Reactions on Metal Surfaces Using Scanning Tunneling Microscopy"*
*Postdoctoral Researcher at the University of Tsukuba, Japan



Thomas Gutierrez - *"Higher Twist Contributions to Charm and Light Gluino Production"*
*Postdoctoral Researcher at UC Davis.

Michael Heffner - *"Hadron Spectra in Au + Au Collisions at the BNL AGS"*
*Postdoctoral Researcher at Lawrence Livermore National Laboratory

Christopher Hill -*"Measurement of the production cross-section ratio in 106.0 ± 4.1 pb^{-1} of data collected by CDF during RunIA+1B of the Tevatron"*
*Postdoctoral Researcher at the University of California, Santa Barbara

Scott Johnson - *"The Effects of Crystal Size on the Lattice Dynamics of $BaTiO_3$ and $SrTiO_3$ Thin Films"*
*Temporary Lecturer at Sonoma State University

Jennifer Klay - *"Traverse mass and rapidity spectra of poins and protons from Au+Au collisions at the Alternating Gradient Synchrotron"*
*Postdoctoral Fellow at Lawrence Berkeley National Lab

Alexander Kay - *"Multi-Atom Resonant Photoemission and the Development of Next-Generation Software and High-Speed Detectors for Electron Spectroscopy"*
*Senior Process Engineer with Intel Corp., Hillsboro, OR

Jonathan Link - *"Study of the Decay* $D^0 \rightarrow K^+\pi^-$ in FOCUS "
*Postgraduate Researcher at UC Davis working at Fermilab

Bongjin Mun - *"Probing Surfaces and Buried Interfaces by Core-Level Photo emission Excited by Soft X-ray Standing Waves"*
*Postdoctoral Researcher at Lawrence Berkeley National Lab

Brandon Murakami - *"Low Energy Probes of Standard Model Extensions"*
*Postdoctoral Researcher at Argonne National Laboratory in Illinois

David Muzzall - *"Design and construction of low-temperature ultrahigh vacuum STM/AFM and the effect of dosing pressure on coverage and ordered structure of Oxygen on W(110)"*
*Quantitative Analyst at DRW Trading, Chicago, IL

Edward Nabighian - *"Linear Optical Studies of Metal Surfaces: Diffusion, Growth and Surface Dynamics"*
*Senior Process Engineer with Intel Corp., Santa Clara, CA

Thomas Nielson - *"Magnetic, Electrical Transport, and Hydrostatic Pressure Studies of the Heusler Alloy* $(Fe_{1-x}V_x)_3Al$"
*Senior Staff Physicist with Magne Sensors Inc., San Diego, CA

Philip Rogers - *"Structural and Magnetic Studies of the Spin Chain/Spin Ladder* $(Na_{1-x}Ca_x)V_2O_5$"
*Logic ProductDesign Engineer with Intel Corp., Hillsboro, OR

Constantinos Skordis - *"The Accelerating Universe: Models and Consequences"*
*Postdoctoral Researcher at Oxford University, United Kingdom

Alexander Slepoy -*"Topics in Computational Statistical Mechanics"*
*Postdoctoral Researcher at Sandia National Laboratory

Gayle Thayer - *"The Role of Stress in Thin Alloy Films: A Scanning Tunneling Microscopy Investigation of CoAg/Ru(0001)"*
*Postdoctoral Researcher with IBM, Yorktown Heights, New York

MarcusWatson-*"Investigations of the Reconstruction and Growth on the Si(100) Surface, and Studies of an Interelectronic Correlation Function"*
*Postdoctoral Research at UC Davis

Bachelor's Degrees Awarded

Honors at graduation are awarded to students who have a grade point average in the top eight percent of the college. The Departmental Citation (DC) award is given to students in recognition of their excellent academic record and undergraduate accomplishments. The Saxon-Patten Prize (SPP) in Physics is a monetary award given to a student who has achieved an excellent academic record and who shows interest and promise in continued work in physics and/or related physical sciences.

March 2000—June 2002

Ben Anderson .... BS
Ryan Anderson .... BS
Jonathan Arredondo .... BS
Michael Barnard .... BS
Adwarded DC
Jeanne Bonner .... BS
August Bosse .... BS
Awarded DC and SPP
Aaron Brayton .... BAS
Alexander Clausen .... BA
Daniel Clayton .... BS
Richard Curras .... BS
Matthew Dey .... BS

(continued on page 5)

Bachelor's Degrees Awarded

(continued from page 4)

Paul Dimitriadis .... BS
Luke Donev .... BS
Awarded DC and SPP
Ryan Easton .... BS
Justin Ferranto .... BS
David Franciosi .... BS
Raymond Friddle .... BS
Adam Conrad Getchell .... BS
Degree in Applied Physics
Jamie Kane .... BS
Kevin Kelley .... BS
Awarded DC and SPP
Alvin William Laille .... BS
James Landry .... BS
Awarded DC and SPP
Brian Marsteller .... BS
December Martin .... BS
Timothy McIntosh .... BS
Benjamin Meiselman .... BS
Tzvetan Metodiev .... BS
Awarded DC
Daniel Micsunescu .... BS
David Mobley .... BS
Awarded DC and SPP
Sara Morenc .... BA
Shawn Olson .... BS
Shawn Robert Olson .... BS
Degree in Applied Physics
Lawrence William Pack .... BS
Awarded SPP
Brian Patterson .... BS
Degree in Applied Physics
Long Pham .... BS
Awarded DC and SPP
Christina Pierce .... BS
Gabriel Prochter .... BS
Awarded DC and SPP
Ram Anand Puri .... BS
Daisy Ramondson .... BS
Awarded DC and SPP
Ivan Rankenburg .... BS
Awarded DC
Matthew Renquist .... BS
Stephenie Ritchey .... BS
Leigh Ann Ryder .... BA
Jason Sare .... BS
Samuel Schnell .... BA
Jacob Shine .... BS
Jodi Smith .... BS
Degree in Applied Physics
Jodi Lynn Smith .... BS
Degree in Applied Physics
Ingrid Helene Stoltman .... BS
Amy Tan .... BAS
Zlatko Tanovic .... BS
Degree in Applied Physics
Allen Knute Thoe .... BS
Aaron Thompson .... BS
Adwarded DC and SPP
Charles Thomsen .... BS
Brian Trimble .... BS
Degree in Applied Physics
Kevin Vandersloot .... BS
Awarded DC and SPP
Kevin Welch .... BS
Davis Whitbeck .... BS
Awarded DC
Brian Wilson .... BS

Faculty Highlights

Professor Paul Brady retired from University service November 1, 2001, after 39 years of service. He was the longest serving faculty member in the division of Mathematical and Physical Sciences. Paul plans to remain active in research and was recently appointed as Research Professor.

Shirley Chiang received the 2001 Distinguished Teaching Award for her outstanding contributions to teaching on the Davis campus.

Physics lecturer **Rod Cole** was honored during the Chancellor's Achievement Awards for Diversity and Community on May 23, 2001. The first annual event was held to recognize significant achievement or exemplary service in the areas of diversity and community building.

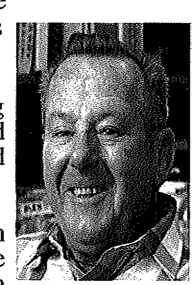
Larry Coleman was appointed as Vice Provost for Research in the University of California Office of the President effective July 1, 2001 after serving as "interim" since January 1, 2001. His primary responsibilities will be to provide coordination of research matters among the Office of the President, the ten UC campuses, and the three national laboratories that UC manages for the federal Department of Energy.

D. McColm

Doug McColm retired from University service on July 1, 2002. Prior to retirement, Doug received the 2002 Distinguished Teaching Award for his outstanding contributions to teaching on the Davis campus. Doug plans to continue teaching in the department on a volunteer basis.

Barry Klein began a three-year term as Vice Chancellor for Research on July 1, 2001. Upon accepting his new appointment Dr. Klein said, "My goal is to work with the campus community in developing and implementing ideas that will enhance our research enterprise to the benefit of faculty, staff, and students."

Robert Shelton accepted a position as Executive Vice Chancellor and Provost at the University of North Carolina, Chapel Hill. Robert left UC**DAVIS** on January 31, 2001. Robert had been serving as Vice Chancellor for Research at the Office of the President since 1998, but maintained an active research program in the Physics Department.



W. True

William True passed away on October 13, 2001, after a long illness. Dr. True arrived at UC**DAVIS** in 1960 to teach Quantum Mechanics and Electricity and Magnetism. He retired from the University in 1991, after 31 years with the Physics Department. He will be greatly missed by his colleagues and friends in the Physics Department.

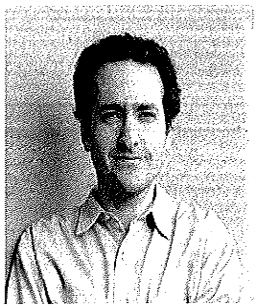
Introducing...

Maxwell Chertok

Ph.D. - Boston University, Boston MA, 1997,

Assistant Professor, Experimental Particle Physics

Professor Maxwell Chertok joined the department in July 2000.



My research employs the world's largest scientific apparatus to study the tiniest objects in the universe: the fundamental building blocks of matter. These include the constituents of the atom—the electrons and quarks—that make up everyday objects. But, strangely, nature provides us siblings of the commonplace electron: the muon, tau and three super light neutrinos; we refer to these six particles collectively as leptons. Similarly, we observe six types of quarks where only two are used to produce your body, a table or a laptop computer. These extra particles are hidden unless we have enough energy to produce them, either in our particle colliders or when a cosmic ray interacts in our atmosphere. Then, they are produced in abundance but travel only a short distance before decaying quickly back to more standard matter. Interestingly, the large energy density needed to produce these particles was also prevalent in the very early universe. Thus, experimental particle physics and cosmology are intimately related.

The Tevatron accelerator, at Fermilab near Chicago, collides intense beams of protons and antiprotons at 2 trillion electron volts of energy. Antiprotons are negatively charged protons, and the two annihilate when they collide. This frees up all this energy and, thanks to Einstein's $E=mc^2$, immediately recondenses back to particles. When this occurs, any particles, including the "siblings" can be produced. We therefore construct our particle detector in the volume around this collision point, and we measure what takes place in each of the million or so collisions every second. This detector, called CDF, discovered the top quark several years ago. Top is the sixth quark and has very unusual properties. It is extremely heavy, with about the mass of a gold atom, and decays almost instantaneously.

The Standard Model of particle physics, which accounts for the various particles and forces we observe, has serious theoretical flaws. These problems relate to how the particles obtain the masses that they evince, masses that we can measure at CDF. Theorists have therefore postulated extensions to the Standard Model which might explain this properly. These new models predict more fundamental particles exist in nature than observed up until present. In fact, we may have only seen half of them! One particularly appealing theory, Supersymmetry, ties together the matter particles (leptons and quarks) and the force particles (photons, W and Z bosons, gluons). By doing so it provides an elegant explanation for the mechanism that generates the masses of these particles: the Higgs mechanism. At CDF we have spent considerable effort searching for Supersymmetric partners of the leptons, quarks and force carriers. Unfortunately, no such "exotic" particles have been observed, but we have used the null results of our searches to set stringent limits on the production cross sections and masses of squarks, sleptons and gauginos.

In 2001, the CDF experiment resumed data taking after a five year upgrade. This new run will continue for the next six years and constitutes an unprecedented opportunity for high energy physics measurements and discovery. During the upgrade, our group has helped rebuild the vertex tracker. Comprised of 750,000 channels of silicon detector positioned right around the collision point, it resolves the hundreds of particle tracks that emanate from every proton-antiproton annihilation. The data from this device are read out with state-of-the-art electronics and combined with those from other parts of the detector so that every event can be reconstructed on dedicated computers and analyzed in real time. Our group is using these data in searches for new physics, such as that predicted by Supersymmetric and the Higgs models. This promises to be an exciting time, since observing these particles would dramatically deepen our understanding of nature at the smallest scale. It would be the discovery of the millennium! ❖

Lloyd Knox

Ph.D. - University of Chicago, 1995

Assistant Professor, Cosmology

Professor Lloyd Knox joined the department in July 2000

Cosmology is entering a golden age where exciting new ideas interact with technologically innovative observations. The age is marked in particular by rapid progress in our observational knowledge of the large-scale structure of the Universe and in our theoretical understanding of the evolution of this large-scale structure from its probable quantum mechanical origin in the first fractions of a second of the big bang. This theoretical understanding includes physics that is beyond the particle physicist's (otherwise) successful standard model. The past decade has seen the establishment of a basic paradigm for the formation of structure in the Universe. The Universe used to be highly homogeneous, with spatial variations in the density no larger than about one part in a hundred thousand. Over time these initial perturbations grew by gravitational instability (denser regions attracted more matter, growing even denser, attracting even more matter...) to become the diversity of structures we see in the Universe today such as stars, galaxies and galaxy clusters. The success of such a simple picture provides encouragement that we are on the right track.

(continued on page 7)

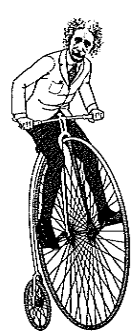
Introducing...

Lloyd Knox

(continued from page 6)

Future observational and theoretical advances will allow for a more thorough understanding of the evolution of structure and provide insight into the fundamental laws of physics. Fortunately for the active researcher, the challenges that remain are varied and formidable. Despite the progress of the past decade there are many questions left unanswered, and many that were answered have led to new ones. What is this weakly interacting dark matter that appears to be the dominant form of matter in the Universe? What is the nature of the 'dark energy'? Why is the expansion rate accelerating now? What is the origin of the tiny deviations from homogeneity that were the initial seeds of structure in the Universe? Other pressing questions are: What are the observable signatures of answers to the above questions? How can we best exploit available technology to shed light on them? How can we optimally make use of the tremendous amounts of data that are now and will be available? Does a global analysis of all available data reveal any inconsistencies in our models? Are these inconsistencies due to systematic error in the data, or must we rethink the basic paradigm? I look for opportunities to address all of the above questions.

Most of my time now and in the near future is spent on what I call "cosmological phenomenology"; that is, predicting observables, developing methods for exploiting data, and deriving the theoretical implications of data. I expect this emphasis to continue to be rewarding given the quantity and quality of data which we expect to be generated by planned observational missions. For more information please visit http://bubba.ucdavis.edu/~knox. ❖

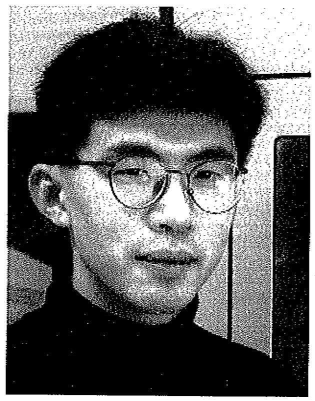


Kai Liu

Ph.D. - The John Hopkins University, 1998

Assistant Professor, Experimental Condensed Matter Physics

Professor Kai Liu joined the department in July 2001

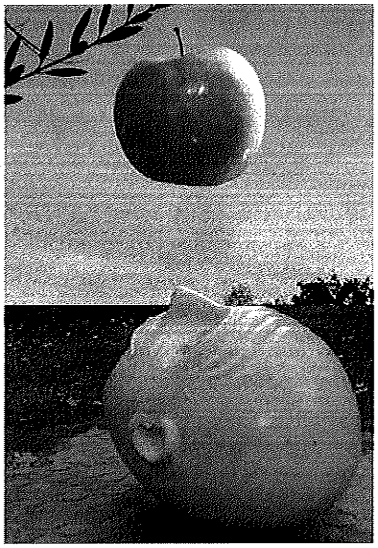


The ability to manipulate matter at the atomic scale and to artificially tailor the material properties is at the heart of nanoscience and nanotechnology. Nanostructured materials provide the ideal arena for such explorations. They typically have structural or chemical restrictions on the nanometer scale along one or more of the dimensions, artificially designed and realized. Examples include 2-dimensional ultrathin films, 1-dimensional nanowires, 0-dimensional nanodots/nanoparticles, and more complex patterned structures that could have a combination of these characteristics. Due to their intricate nanostructures, extremely small length scales, low dimensionality, and interplay among constituents, nanostructured materials often exhibit new and enhanced properties over their bulk counterparts. These novel properties can also be tailored through extra degrees of freedom, such as structure and materials, etc. Our research focus on the study of magnetism and spin-dependent transport, particularly in nanostructured materials, to investigate the key issues of the interactions amongst spin, charge, and lattice of the material. We hope to understand how to preserve the coherence of electron spin over space and time, and try to devise mechanisms to encode and decode information using the electron spin, as well as its charge.

One area of research is magnetism in reduced dimensions, where surface and interfacial effects as well as single-domain behaviors are dominant. The magnetization reversal processes are complex and fascinating. The interplay between size confinement and proximity effect is particularly interesting. For example, in ultrafine nanomagnets, each particle is smaller than the typical magnetic domain size, so all its magnetic moments are aligned in one direction. A high-density array of such nanomagnets may be used to store information, as a magnetic storage media. How will the magnets behave individually and collectively? Can we use such arrays to push the present magnetic recording density up another decade? Will the magnetization be stable enough to overcome thermal fluctuations? How will the proximity to other materials, such as an antiferromagnet or a superconductor, influence the assembly?

Along the transport front, we are interested in novel materials and mechanisms that allow us to transfer information via the electron spins. Particularly desirable are materials with high spin polarization, or large imbalance between "spin-up" and "spin-down" electrons. Using such spin-polarized electrons, one can easily turn on/off the conduction by a magnetic field, just like manipulating the charge flow of electrons by an electric field. We are also interested in discriminating mechanisms for electron transport, such as spin-dependent scattering or tunneling effects. These materials and properties may be used to realize novel devices such as non-volatile magnetic random access memories (MRAM) that do not need constant power feed.

Typically we synthesize materials using magnetron sputtering, e-beam and thermal evaporation, electrodeposition, arc melting, and high temperature sintering. Additional processing is done by photo-, e-beam lithography and self-assembly nano-lithography. Further characterizations are done by X-ray diffraction, SEM, TEM, AFM, EDX, SQUID, VSM, AGM, MOKE and transport measurements. More information at: http://www.physics.ucdavis.edu/faculty/kliu. ❖



18th Pacific Coast Gravity Meeting

University of California at Davis

March 29-30, 2002

The Pacific Coast Gravity Meeting brought more than 100 researchers to Davis in March 2002 to give talks, listen, and chat in the halls.

In March 2003 leading physicists and astronomers will gather at the Davis Meeting on Cosmic Inflation to discuss cosmic inflation theory in light of new data and theoretical developments. More about the meeting at: http://inflation03.ucdavis.edu/

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Department Chair: **Winston Ko**; Department Vice Chair, Undergraduate Program and Administration: **Wendell H. Potter**; Department Vice Chair, Graduate Program: **Richard Scalettar**

Physics Department
University California, Davis
Davis, CA 95616