UC DAVIS

Physics Newsletter

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From The Chair

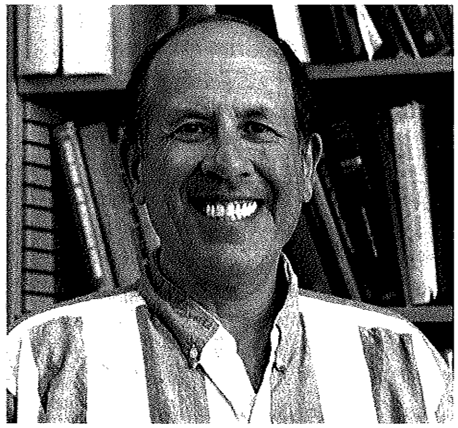
Dear Friends of UCD Physics:

It is a pleasure to welcome you to the beginning of an outreach campaign by our department to make contact with our alumni and other friends, with the goal of creating a sense of "family" among all of us. In these times of change it is perhaps more important than ever for us to renew contacts with our past and our roots. I hope that you feel that way, too.

I am starting my fourth year as department chair, having joined the physics faculty in September 1992 following a long career at the Naval Research Laboratory in Washington, D.C. I have become fully enamored with the West Coast, and Davis in particular, and the UC Davis campus life. Although there have been many changes in the world, I'm sure you will find that Davis has remained basically the same unique, wonderful place for students, faculty, and staff. One of our goals in this outreach campaign is to have you come back and visit us, but more about that later.

There has been significant change in the department's faculty, now totaling 28 plus emeriti, following major recruitment efforts and a number of retirements of long-time faculty members over the past 10 years. Many of the emeriti are still active in research and teaching and still call Davis their home. Retirees over the past ten years include Neal Peek, Bill True, John Jungerman, Bill Knox, Jim Hurley; and most recently Tom Cahill, Claude Garrod, Rod Reid, Glen Erickson, and Jim Draper. During this same period, we've added 15 new faculty members. Quite a turnover! Professors Reid, Erickson, and Jungerman have been recalled for teaching, and Glen is still the Astronomy Club leader.

The campus still looks very much the same, with some noteworthy new buildings, including three new academic buildings on south campus, a new alumni center across Old Davis Road from Mrak Hall, and an interesting new Social Sciences and Humanities building on north campus with very unconventional architecture. Bicycle traffic still prevails.



As we are all aware, the world is changing around us, and this includes the science world. Our department is trying to respond to these changes. The job market for physicists has become more difficult for our graduates, as it has for graduates in most other areas, and we are concerned about making our training of students both commensurate with the world situation and at the same time "true" to our discipline. Not easy issues to deal with. Your keeping contact with us and helping us to have a better view of the outside world is highly important, so please stay in touch with us and tell us what you are doing. In addition, we intend to hold a Spring '96 alumni get-together with a hopefully strong response from our alumni. Please come and join us — if you can make it here, we'll wine and dine you and make for a really good time.

Together with the rest of the faculty and staff, we are looking forward to hearing from you. Drop us a line with any questions you may have, and we'll be sure to respond.

My best wishes,

Barry M. Klein

Inside This Issue

Early History and Personal Recollections of the UCD Physics Department

by W. J. Knox, professor emeritus

Since there is no written history of the physics department, and no departmental archives, the history of the department becomes partly a subjective matter, i.e., open to personal interpretation. It is to some extent what those involved remember or imagine it to be.

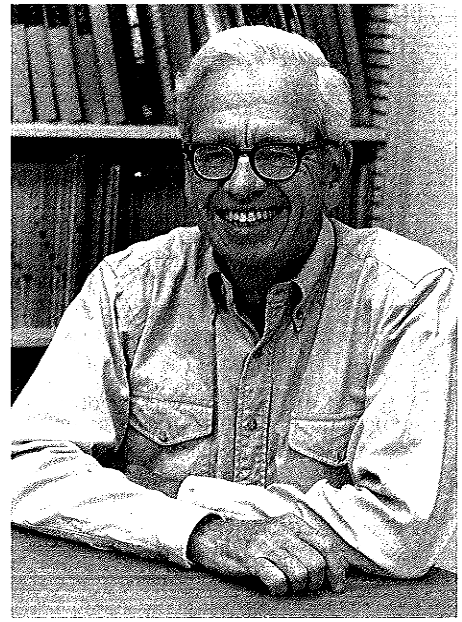
This is the first in a series of articles by me and my colleagues that will attempt to reconstruct the history of the UC Davis physics department. In this contribution, I will try to reconstruct the early history (before my time) of the department and relate some anecdotal material of the 1960's. Here I rely on: Proposal for an M.A. program in Physics, 1955, by C.G. Patten; Proposal for a Ph.D. program, 1960, by C.G. Patten; Review of the Graduate Program, 1973, by W. Knox (I think); A Short History of the Crocker Nuclear Laboratory, 1980, by J.A. Jungerman; History of the Department of Mathematics, UCD, 1994; Jungerman's reminiscences (see interview, this issue), and my memories and files. We will welcome comments, corrections, questions, or anecdotes from anyone interested. In this way, perhaps we can gradually build a more complete and accurate picture.

The Davis campus was established in 1905 by the California Legislature as a Field Station for the College of Agriculture at Berkeley, primarily through the efforts of Judge Peter J. Shields. (Shields Library, Shields Avenue, and Shields Grove and Gazebo on campus are named after him.) For many years the campus was known as the University Farm. In 1933 Ed Roessler (Roessler Hall) came from Berkeley to develop a Division of Mathematics and Physics at Davis that would offer courses and statistical services for agriculture. In 1951 the College of Letters and Science was established at Davis; in 1952 the A.B. degree in physics was offered; and in 1953 physics and mathematics were separated into two independent departments. Roessler was chairman of the combined departments from 1933 to 1953, and then continued as chairman of mathematics. Gordon Patten was the first chairman of physics from 1953 to 1963, when I became chairman. In 1956 the M.A. degree in physics (Plan I, requiring a research thesis) was authorized. In 1961 curricula and programs were approved for the B.S. degree, the M.A. degree — Plan II (by examination), and the Ph.D. degree.

The first appointees in physics were Milton E. Gardner (1937), C. Gordon Patten (1946), and Willard Berggren (193?). Milton got his Ph.D. from UC Berkeley in 1937 under L.B. Loeb in electrical discharge in gases. He worked during World War II on radar transmitters at MIT and returned to UCD in 1946. Gordon received his Ph.D. in 1933 from UCB in atomic physics (x-ray absorption) with R.B. Brode and S.K. Allison. He was a research associate at UCB, taught at College of the Pacific, and worked at the UC Radiation Laboratory on electromagnetic isotope separation during the war. I don't know the facts on Willard Berggren. He published some papers on transient heat conduction with engineering colleagues at Berkeley in 1941, probably after he had left Davis.

By 1955, physics was an independent department offering a B.A. degree and about to offer the M.A. degree requiring a research thesis. There were five faculty: Gordon Patten (chairman), Milton E. Gardner, John A. Jungerman, Philip G. Lichtenstein, and David B. Beard. Jungerman got his Ph.D. in 1949 at UCB under Emilio Segré on fission excitation functions for charged particles. He had worked at UCRL and Los Alamos during the war. He was a postdoc at Cornell working on fission theory under Hans Bethe, a lecturer at Berkeley, and had worked on the electron model Thomas cyclotron at the Radiation Laboratory. Beard got his Ph.D. at Cornell in 1950 on meson theory of nuclear forces under Bethe. He was here from 1953 to 1956, worked at Lockheed from 1956 to 1958, returned here in 1958, and in 1964 went to Kansas as chairman of the department. Lichtenstein was a UCB Ph.D. (1952) in cosmic rays (meson spectrum at sea level) under Brode and came to UCD in 1952. I don't know when he left or what he did later.

Neal Peek was the first to enroll for an M.A. degree in physics. When he did, his first examination was before his draft board who grilled him on what good his M.A. degree would do for his country. Whatever he said was not convincing enough, so he was immediately drafted and sent off to Colorado to work on military nerve gases. He later returned to Davis and he, Harold Crafts, and Roy Squires received the first M.A. degrees awarded by the department in 1959. Squires' M.A. thesis was on the "Origin and Spatial Distribution of Comets"



under Dave Beard, so we have a long tradition of research in astrophysics. (Also, Gordon Patten had earlier worked at Dominion Astrophysical Observatory in Victoria and published a couple of papers with A. McKellar.)

Research activities in the earliest days emphasized the participation of physics faculty as collaborators in projects of the Agricultural Experiment Station. In the early 50's experimental work in nuclear physics and cosmic ray physics was conducted off-campus at Berkeley and Cal Tech, and theoretical work in nuclear physics at UCD. The first research equipment for physics built in the department was Jungerman's beta-ray spectrometer. I think it had a special grant from the Regents for design, and then a research grant from the Atomic Energy Commission in 1955 for construction and operation. It was a high precision spectrometer (axial solenoidal field corrected to ~10(-5)) for studying radioactive decay schemes. Visually it was one of my favorite pieces of research equipment. It had a big cylindrical vacuum tank mounted horizontally with a heavy edge-wound copper strap solenoid outside for its full length. Then it had big Faraday coils canceling the earth's field over its entire volume, a number of empirical correction coils in various locations, and orientations correcting residual field fluctuations. There was a transparent plastic dust cover over the solenoid and a heavy duty aluminum "cattle guard." It was a popular attraction on Picnic Day because it looked like a moon-landing vehicle or a Star Wars fighter (before they were invented), and the cattle guard was necessary to prevent the hordes of visitors from bumping it and misaligning the correction coils. When it was decommissioned, I tried to get it preserved as an outdoor campus sculpture in front of the physics building, but the Campus Committee on Arts and Monuments couldn't believe that a piece of research equipment could qualify as sculpture even with its complex spatial forms. It would have been quite waterproof and durable and already had its cattle guard to protect it from viewers, so it was just the lack of artistic imagination of the committee that prevented it. The first Ph.D. awarded was to Dick Mead (1965) and the second to Neal Peek (1966). Both dissertations involved experimental work on the beta-ray spectrometer.

Incidentally, the industrial contractor who was to wind the main solenoid of the spectrometer finally gave up, saying it couldn't be done with that heavy copper strap to the tolerances required. Whereupon our head machinist, Ralph Rothrock, designed a special jig and wound the coils in our own shops. He always liked working in the Physics Department because with research equipment no two jobs were ever the same, and some were impossible.

When I came in 1960, the department was housed in an old garage (remodeled, of course) that probably dated back to World War I. The building is still there, now used as an annex by the art department, south of the present Art Building. In it we had a lecture hall holding about 50 students for lower division classes, our offices, the beta-ray spectrometer, the machine shop, and the electronics shop. My office was in the southeast corner and was especially peaceful, looking out into the desert cactus garden of Buildings and Grounds. Every spring I would see various exotic cactus flowers outside my window, so I knew when the deserts were in bloom.

Natalie Fulk was the department's secretary, taking care of all records, class work, enrollments, contracts and grants, personnel actions, etc., and ensuring that we didn't violate University regulations too much. Emil Mrak was chancellor. He knew us all, came over to see us once in a while (he once had his picture taken with the spectrometer), and supported us strongly whenever he could.

Later we moved into a new annex to Young Hall. Chemistry occupied the old part, and geology and physics most of the new part, spread out over several floors. There we had much more space for labs, offices, shops, a large lecture hall, and a lecture demonstration preparation room. Best of all, we had our own branch library with a librarian, Frances Brown, supported by the main library. It was great to have all of the journals and monographs right across the hall. By the time we moved into our present building (Physics/Geology), university policy prevented our maintaining a departmental branch library unless we paid for it out of our own budget, so we were combined into the Physical Sciences Library.

In 1960 the population of Davis was about 8,000 and the campus enrollment was about 2,500. The physics faculty was then seven: Gardner, Patten, Jungerman, Beard, Shuki Hayashi (1958), William W. True (1960), and William J. Knox (1960). Shuki was a lecturer in the department, who later received his Ph.D. in biophysics from Berkeley, and in 1964 moved to Sacramento State. He retired recently and lives in Davis. Bill True got his Ph.D. from Indiana in 1957 in nuclear theory with Ken Ford, and he was an instructor at Princeton and a research associate at Los Alamos. I got my Ph.D. in 1951 at Berkeley under Ed McMillan in high energy (for those days) neutron production on the 184" cyclotron. I had been a plutonium chemist on the Manhattan Project during the war under Glenn Seaborg, research associate and Assistant professor in physics at Yale, and physicist in the Research Division of the AEC in Washington.

The 1960's saw the rapid growth of the department and the campus, development of the cyclotrons and the Crocker Nuclear Laboratory, and the diversification of the physics research programs. More about that later, perhaps.

In the early 60's we were approached by Edward Teller, a physicist at Lawrence Livermore National Laboratory, to provide a graduate program in physics for research employees or students at the laboratory working in fields of importance to the Livermore program, e.g., plasma physics, computer science, properties of materials at extreme temperatures and pressures, and nuclear physics. Students could already get degrees from Berkeley with research at Livermore, but had to meet all the regular Berkeley requirements. He wanted a more flexible program that was primarily based at Livermore. As I understood it, he wanted to choose promising students with undergraduate degrees in other disciplines but not necessarily physics, provide a program which was a compromise between undergraduate and graduate physics, and award graduate degrees in physics with appropriate research. We had just gotten approval for our Ph.D. program, had no experience with it, and were reluctant to modify it to the extent envisioned by Teller. We expressed our reservations to Chancellor Mrak, who passed them on to the system-wide administration. Dean Bainer of engineering was receptive to the proposed program, so the chancellor accepted our objections and the program was established in the College of Engineering with degrees in applied science instead of physics.

In the late 60's, to keep in touch with the spirit of the times, we had a memorable concert in the Crocker Nuclear Laboratory. I think it was when Jungerman was on sabbatical leave in 1966-67, and I was acting director of the Lab. John Cage, the avant garde composer, was a resident artist in the music department. Somehow he visited the cyclotron and was fascinated with its sounds, especially the deep thump of the shielding doors as they closed and the rumble of the massive overhead crane. He liked to put on "happenings," the more outrageous the better; so the music department arranged a concert, invited all the (modern) music lovers, and provided refreshments and chairs for the audience on top of the shielding in the great bay of the cyclotron. Cage wrote a special composition for sounds of the cyclotron with our operators as performers. Other electronic music was played, along with a piece by another modern composer in which the stipulation was made that performers could not be closer than about 30 feet to their instruments. This could be accomplished in the cyclotron bay, since the cab of the overhead crane was the right distance above the shielding. Performers could play wind instruments through garden hoses, objects could be dropped onto the strings of a piano, percussions could be struck from a distance, etc. Everyone was astounded and had a wonderful time. If anyone has a copy of the program of that concert, please send us a copy. So far I haven't been able to find one in the music department.

Does anyone remember Christmas parties at Jungerman's house for all of Crocker Lab and physics? Or excursions for picnics and visits to wineries in Napa Valley? I repeat that we would like to receive information and contributions from anyone regarding the early days up to the present. These can include sketches of your career; comments on classes, instructors, and others in the department; your research; anecdotes; photographs; etc. There is a campus archivist in Shields Library with whom we would deposit original materials. We hope to hear from you.

His physics career began with a boom

By Dana Oland, staff writer, Sacramento Bee *(Reprinted with permission.)*

Overlooking ground zero, atop a cinder cone near Alamogordo, N.M., John Jungerman and a friend sat waiting to see what would happen in the pre-dawn hours of July 16, 1945.

They could see lights on the next hilltop from the camp that held J. Robert Oppenheimer and the rest of the inner circle of scientists and military brass who developed the atomic bomb. Having them so close was reassuring, he says.

"We didn't know where this thing was going to be set off. We were lucky, actually. The limit on retinal damage turns out to be about 20 miles and we were just about that distance."

It was rainy, the UC Davis physics instructor recounts. He remembers thinking that maybe they would postpone the test. Then it happened.

"It was an unforgettable, awesome experience. An incredible radiation of light, brighter than the sun. All the mountains, everything around, lit up like a giant flashbulb went off. We saw the huge mushroom cloud.

"We got pretty excited when that cloud went up because we knew it was full of bad stuff. So we got out of there fast," Jungerman says.

They ran to their car, threw their gear inside and headed back to Los Alamos, N.M. The drive gave him time to think about his mixed emotions.

"The first thing was a feeling of pity for the Japanese people because it was going to be used on them. That was the whole idea at that point.

"Then there was a sort of dim realization that the world had changed in some way. It was a new age, sort of like the discovery of fire. We had brought a power into the world that wasn't there before," Jungerman says.

"And then there was the thought, 'Geeze, we made it work.' "

Jungerman, 73, worked on the Manhattan Project from 1943 to 1945. He was a graduate student at the University of California, Berkeley, when he began thinking about joining the Navy.

"It was a different kind of war than we've gotten into since. We were all working together, and I felt I wasn't doing enough."

Photo by John Trotter, Bee Photographer. Copyright, The Sacramento Bee, 1995.

John Jungerman

When he told the chair of the department of his decision, he told Jungerman that if he wanted to help the war effort he should go work for Ernest Lawrence, the developer of the cyclotron, a machine that separates atomic particles. During World War II, Lawrence headed the part of the Manhattan Project that sought to separate isotopes of Uranium 235.

Jungerman began working in Berkeley and then was sent to Oak Ridge, Tenn., where the cyclotron experiments continued on a larger scale. In May 1945, he was sent to Los Alamos.

He was one of the few who saw the Trinity test explosion. The blast vaporized the tower and fused the desert floor. Jungerman has a sample of the sand from Alamogordo safely stored in a lead container in his UC Davis office.

"It'll make a Geiger counter go off, but it's not too bad. It's up there on the shelf somewhere. (Alamogordo is) not the place to eat your lunch, still. That's the legacy of nuclear weapons," he says.

He co-wrote "Nuclear Arms Research and Technology" (McGraw Hill, 1990) with colleague Paul P. Craig, which chronicles the arms race, its effect on society and the effect of nuclear energy on the environment.

After World War II, Jungerman returned to Berkeley to complete his doctorate in 1949. He married his wife, Nancy, who is a clinical psychologist with a practice in Davis, in 1948. They have four children, Mark, Eric, Roger, and Anne.

Since 1951, Jungerman has been at UC Davis, where he helped to found the university's physics department.

The university has changed dramatically, he says.

"There were 250 students then, now there's 10,000. It was a wonderful opportunity to develop the department, to be on the wave of the development of the Davis campus."

In the mid-1960's, Jungerman received a government contract to build a small cyclotron on campus and then a larger one that is still running.

"That's kind of gratifying," he says. "Most of the cyclotrons of that era are closed down now."

Although Jungerman is retired, he is teaching two classes this semester. One of them is Environmental Physics and Society, a class that studies the effects of science on the planet.

"The development of the bomb kind of awakened us. It was clear we had a lot of impact on society. Throughout my career, I have been worried about that. I felt a responsibility, since I helped start the bomb, to be part of the solution."

Ph.D. Degrees Awarded

June 1994

Cemal Duyar
"An Experimental Study of High Spin States of 117, 118Te"

William Mosley
"An Investigation of the Superconducting and Normal State Properties of Ba1-xKx Bi03 Single Crystals"
*Engineer II, Micropolis, Chatsworth CA

Martin Partlan
"Collective Flow in 'Au & Au' Collisions with Incident Energies from 0.25 to 1.15 A GEV"
*Postdoc, Lawrence Berkeley Laboratory

September 1994

John Dykes
"Physical and Chemical Investigations of Selected C60- Based Materials"
*Physicist, National Institute of Standards & Technology

Anthony Lee
"Surface Diffusion of Hydrogen and Deuterium on Ni (100) and Ni (111) Investigated by Linear Optical Diffraction"
*Teaching Assistant
University of New Orleans

Steven White
"Dipolar Magnetic Order on a Diamond Lattice"
*Assistant Professor, Fresno State University

December 1994

David Gettman
"Evidence of Spin Glass Ordering in Sputtered YTbSi Metallic Glasses"
*Lecturer, University of California, Davis

Chris Ray
"A Small Piece of a Large System"
*Postdoc and Lecturer
University of California, Davis

March 1995

Timothy Goodwin
"The Role of Praseodymium in the Suppression of Superconductivity and Onset of Magnetism in (R1.5-xPrxCe0.5) Sr2Cu2NbO10- d; R=Nd, Sm, Eu"
*Research in quantum dots of (Al1-x Gax)N semiconductors, Department of Chemical Engineering and Material Science, University of California, Davis

Gary Oas
"Normal Matrix Models"
*Postdoc, University of California, Davis

Giulio Ruffini
"Quantization of Simple Parametrized Systems"
*Postdoc, University of California, Davis

Jesus Del Castillo
"Magnetic and Specific Heat Studies of the Compounds A14MnX11 where A=[Ca, Sr, Ba] and X=[Bi, Sb, As]"
*Lecturer, University of California, Davis

June 1995

Robert Porter
"Measurement of Dielectron Production in CA + CA Collisions at 1.05 GeV/Nucleon Beam Kinetic Energy"
*Postdoc, Lawrence Berkeley Laboratory

September 1995

Charles Joseph DeLeone
"Mean-Field Theories in Low-Dimensional Spin Systems"
*Lecturer, University of California, Davis

Rodney L. Glenister
"The Properties of the t-J Model through High-Temperature Expansions and their Relevance to High-Tc Cuprates"

Bachelor's Degrees Awarded

Honors at graduation are awarded to students who have a grade point average in the top 8 percent 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 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.

Fall Quarter 1993

Cecilia Chang .... BS
Edward Chow .... BS
David Iverson .... AB
Jonathan Link .... BS
Sean McCarthy .... BS
Kyle Noderer .... AB
Matthew Wetzel .... BS

Winter Quarter 1994

Jolyon Beliz .... BS
Craig Burden .... BS
Pierre Rennette .... BS
Graduated with Honors

Spring Quarter 1994

Craig Bryant .... BS
James Burke .... BS
William Caskey .... BS
David Eigner .... AB
Adeliza Flores .... BS
Amy Holton .... BS
(Degree in Applied Physics)
Andy Lau .... BS
Graduated with Honors
Departmental Citation
Saxon-Patten Prize in Physics
Trevor Marshall .... BS
Departmental Citation
John Miller .... BS
(Degree in Applied Physics)
Graduated with Honors
Departmental Citation
Saxon-Patten Prize in Physics
Patrick Murray .... AB
Micah Myers .... AB
Richard Poy .... BS
Carrie Scafe .... BS
Kris Skinkard .... BS
Scott Tooker .... BS
Daniel Werner .... BS
Graduated with Honors

Summer Quarter 1994

Charles Hammer .... BS

Fall Quarter 1994

Jamie Heckman .... AB
Graduated with Honors
Christine Smith .... BS

Winter Quarter 1995

Danny Banks .... BS
Efram Burlingame .... BS
Buchanan Rouse .... BS

Spring Quarter 1995

Michael Anderson .... AB
Luke Campbell .... BS
Graduated with Honors
Departmental Citation
Saxon-Patten Prize in Physics
Robert Cid .... BS
(Degree in Applied Physics)
Terry Cumpston .... BS
Kim Dykeman .... BS
Alan Farrell .... BS
David Gardner .... BS
(Degree in Applied Physics)
Charles Krauter .... BS
Roger Kylin .... BS
Graduated with Honors
Departmental Citation
Matthew Nelsen .... BS
Graduated with Honors
Departmental Citation
Rajesh Ojha .... BS
Samuel Schnell .... AB
Peter Virador .... BS

Life as a First Year Grad Student

by John Pask and David Everitt

Both Dave and I came to grad school after about six years of teaching. A few days before classes began, we got our office assignments. At first I thought there might be some mistake, as there were nine nameplates already outside the door of my new office. Upon investigating, however, I noticed ten desks — no mistake. Though perhaps not as spacious as we had grown accustomed to over the past six years, these accommodations did offer a distinct advantage: lots of other grad students to interact with on a daily basis.

On the first day of class, I remember one of the TA's saying, "I think you'll find that you won't have a lot of time to curl up with your textbooks; you'll be spending most of your time working problems." I thought to myself, "Maybe he couldn't find the time, but I will." Boy, was I wrong. The utterly continuous problem sets took an enormous amount of time. Our class quickly realized that the key to success was to work together. We will probably be forever known as the class that took over the physics library for group study. At any given moment first-year students could be found somewhere in the Physics/Geology building, arguing and struggling to understand elliptic integrals of the third kind, Floquet theory, things that don't commute with themselves, or just how to send e-mail.

As undergraduates, neither Dave nor I benefited much from working with others. As graduate students, however, we found it invaluable. In some cases, you need a good reference to get started on a problem (in the absence of all the time in the world). Invariably, if neither of us had found it, someone else had. Also, because of our differing strengths and weaknesses, we all benefited enormously from one another in our discussions of concepts, ideas, and approaches to problems — over lunch, after the day's lectures, and into the wee hours of the morning.

Also invaluable to the learning process, of course, were the faculty. The first couple of weeks, before I caught on to the fact that there was not a lot of time for extra reading, I read way ahead in my mathematical methods course. Having a master's in mathematics, I was particularly interested in the connections between my previous coursework and the formalism of quantum mechanics. I went to the professor's office hours to discuss the many questions that I had accumulated. He was more than happy to discuss anything and everything, even though we had not yet covered most of (and were not going to cover some of) what I was asking about. More impressive still were the depth and clarity of his explanations, especially considering the kinds of questions I was asking.

The first year was intense, often exhausting. My wife once commented that all she ever saw of me any more was the back of my head. The key to happiness, I think, was the realization (with the help of my advisor) that there was so much material being covered, and in so much depth, that I couldn't possibly master it all in every detail. With this realization, I was able to strike a happy balance between academic and non-academic life and eventually settled into a routine, which included dinners and at least a couple of evenings a week with wife, family, and friends. Dave eventually came to the same realization. In fact, by the middle of winter quarter he was able to keep his Tuesdays completely physics-free.

Both Dave and I have lived in Davis before, and when we finally did start getting out more, we noticed a few changes around town. Sadly, Davis' vegetarian cooperative restaurant, the Blue Mango, went out of business. The new hot spots are the brewpub Sudwerk and the Mexican food hangout Dos Coyotes. The Farmer's Market is bigger than ever. And all the newest movies can now be seen right here in Davis at the new Holiday Cinema/multi-level parking complex.

All things considered, the first year was indeed demanding; but its demands were more than compensated by its rewards.

Physics Graduate Students Plunge Into Student Government

By Bennett Corrado, chair, and Alan Wong, external chair, UC Davis Graduate Student Association

For the past two years, physics graduate students have become actively involved in campus issues through the Graduate Student Association. We have been working to address issues of concern to all graduate students, as well as those which affect the sciences. The campus as a whole is addressing some of the problems in the job market and the obvious economic changes by beginning to reconsider how we as a university educate graduate students.

Other issues we have been addressing at the campus level include a review of student services offered by the university for graduate students. Such non-academic issues are important not only in making our years of graduate study more enjoyable, but also because of their relevance to the non-academic skills we may acquire to better prepare ourselves for the changing job market. We are also reviewing graduate student funding issues to ensure that graduate education remains affordable in the face of state and federal budget constraints.

On the systemwide level, we play a leadership role in safeguarding the fee remission programs which have been protecting teaching and research assistants from fee increases since 1990. Proposals for eliminating the remission programs were rejected because of strong opposition from students and faculty. We fight the proposed fee increase with other campuses through the University of California Student Association (UCSA). We also advocate long term financial support systems, such as fee waivers to provide steady funding for graduate students. For the first time in official UC documents, graduate students are recognized for their contributions to university research and undergraduate teaching. This comes at a critical time in response to a public report recommending a halt to some UC graduate admissions, including all admissions at UC Davis.

Finally, at the department level, we are working with the faculty to investigate new ways in which the department may help to prepare its graduates for a changing and uncertain job market.

For more information about the work being done by the Graduate Student Association, take a look at our World Wide Web page at:

http://pubweb.ucdavis.edu/Documents/GSA/homepage.html

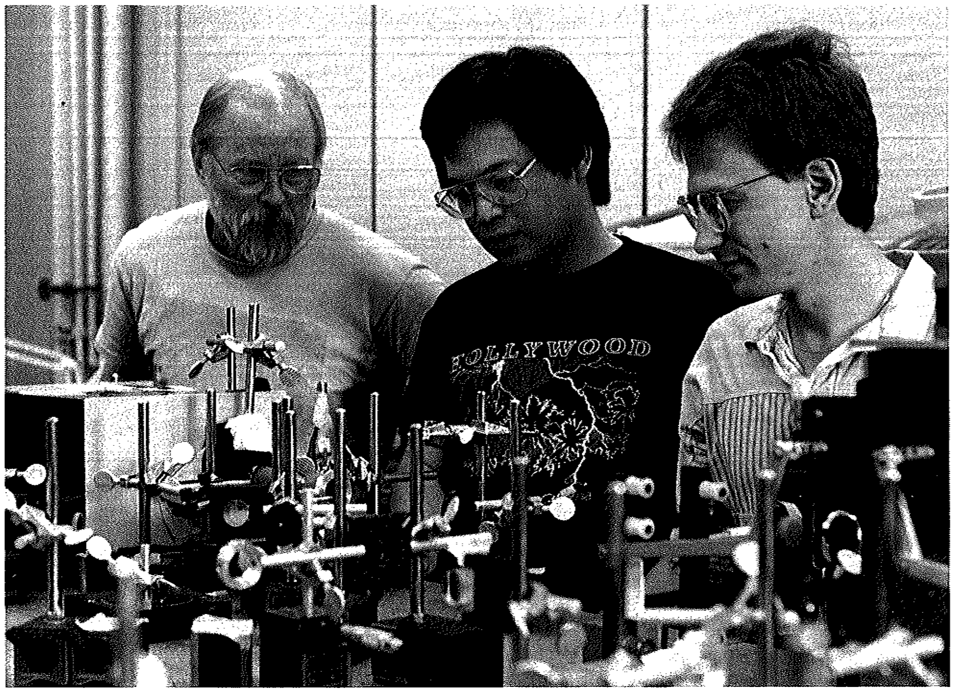
Graduate Program

By Richard Scalettar, associate professor and chair, Graduate Admissions

The graduate program in physics at UC Davis has evolved greatly over the last 10 to 15 years, reflecting changes in the size and research emphasis of the faculty. Before 1985, the average graduate enrollment was around 45. Over the last 5 years, it has been typically 85. Since the mid-1980's the department has significantly added to its programs in high energy physics, increasing from 7 to 11 faculty, and in condensed matter physics, increasing from 5 to 13 faculty.

The UCD graduate program offers students opportunities to participate in leading high energy experiments around the world, from Fermilab to SLAC to CERN, and also to model these experiments using the latest theories. Graduate students in high energy theory also continue to ask questions of the most fundamental nature: For example, how does one reformulate the traditional differential equations which give the time evolution of physical systems if time itself, the "independent variable" of those equations, is allowed to evolve in strange and complicated ways?

UCD physics graduate students now have a diverse set of opportunities in condensed matter physics as well. On the theoretical end, these range from esoteric theories of superconductors to "designing" new materials on the computer. In experimental condensed matter physics, UCD graduate students grow some of the largest and most defect-free crystals in the world, measure the novel properties of C60 "buckyballs," explore surfaces at the Advanced Light Source at the Lawrence Berkeley Laboratory, and use tunneling microscopy to locate the position of individual atoms on surfaces.



Graduate students William Thornburg, Gary Cao and Bennett Corrado ponder the optical path in professor Xiangdong Zhu's laboratory.

The main focus of the graduate program in our department has been, and will continue to be, the education of students to be able to do what physicists have always strived to do, namely to explain the beautiful and puzzling way nature reveals itself to us.

Despite the excitement we share as a department at the opportunities for graduate research, we must also face the reality of a decreasing emphasis in our society on supporting such activities. It is impossible to have a physics degree and not be aware of recent discussions about the "job crisis" in physics. Over the next decade, we expect continued changes in our graduate program and recruitment of graduate students, partly driven by this issue.

Should the department cut back on its graduate enrollment? Cornell University recently advocated (and carried through) a 30% decrease in graduate enrollment, with teaching assistant positions filled by post-doctoral researchers. The motivation was not only to decrease the supply of new graduates in response to the job market, but also to expand the number of post-doc positions and give post-docs important additional teaching experience.

How does the department continue to recruit graduate students? A department like ours at Davis, which has only recently grown and expanded, might be particularly vulnerable if potential students focus their applications on "traditionally premier" institutions.

Should the department alter its courses to respond to a decreased availability of basic research positions in academia, industry, and at national laboratories? Would offering courses in numerical methods, encouraging industrial internships, etc., make those students who do not continue in basic research careers more employable, or would it only dilute their ability to become top-notch physics researchers?

Without a doubt, these are exciting times to be a physics graduate student. The discovery of high temperature superconductors, the top quark, giant magnetoresistance, and the quantum Hall effect have challenged high energy and solid state physicists, experimentalist and theorist alike. The prospect of looking at phase transitions in the quark-gluon plasma created by smashing heavy nuclei together will help us understand similar events that occurred in the early universe. The Physics Department welcomes the opportunity to share the news, and some of its thoughts, with its alumni.

New Graduate Students

This fall, the UC Davis Department of Physics will welcome eight new students beginning studies in our graduate program:

Michael Anderson from UC Davis

Matthew Enjalran from San Francisco State University

Thomas Farris from UC Berkeley

Daniel Goldin from UC Santa Cruz

Michael Heffner from Purdue University

Eric Minassian from California State University, Long Beach

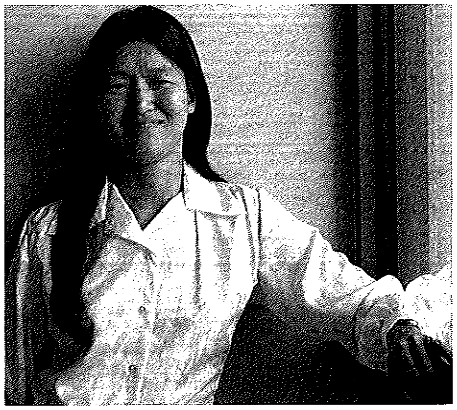
Bong Mun from University of Maryland

Raymond Verda from Occidental College

Welcome Our New Faculty . . .

July 1994

Professor Shirley Chiang
Ph.D, University of California, Berkeley, 1983
Research Area: Experimental condensed matter physics and surface physics



The study of the properties of solid surfaces has important implications for the development of new materials, the fabrication of electronic devices, improvement in magnetic storage devices, and the understanding of chemical reactions at surfaces. Professor Chiang's research interests have recently centered on two major types of systems: (1) the study of nucleation and growth phenomena of thin metal films on clean single crystal substrates, and (2) the observation of small molecules on metal surfaces, with the goal of observing chemical reactions on a surface. All studies are performed in ultrahigh vacuum systems in order to reduce sample contamination. The major experimental technique used for her studies is the scanning tunneling microscope (STM), which permits real-space measurements of solid surfaces down to the atomic level. Other more conventional surface preparation and analysis techniques, such as electron beam sample heating, argon ion sputtering, Auger spectroscopy, and low energy electron diffraction are used for careful sample preparation.

Professor Chiang's STM studies of the nucleation and growth of metals on metals have shown that surface alloying occurs in a surprisingly large number of cases. Her work on magnetic thin films will investigate the connection between the magnetic and structural properties of materials. Her recent studies on small molecules adsorbed on Pt(111) have shown that the (STM) is able to distinguish among isomers on the surface and that molecular orbital theory can be used to calculate the expected STM images. She plans to study the adsorption and diffusivity of molecules on surfaces and to observe reactants and products in simple chemical reactions. She is also developing a variable temperature STM/atomic force microscope, which will enable the fabrication of small nanostructures, investigation of phase transitions in adsorbed layers, and study of the low temperature mechanical properties of materials.

July 1993

Assistant Professor Tao Han
Ph.D., University of Wisconsin-Madison, 1990
Research Area: Theoretical particle physics

What are the most elementary building blocks that our world is made of? What are the fundamental laws that the elementary particles follow? These old, and seemingly naive, yet most profound questions belong to the category of particle physics or high energy physics.

As a theorist in high energy physics, Professor Han studies the interactions and relationships among elementary particles, such as electrons, photons, and quarks. His work emphasizes the theoretical interpretations of high energy experiments, and suggests directions for experiments to uncover the fundamental laws. High energy physics is at an interesting stage: the so-called Standard Model works beautifully to describe the known particle world thus far; yet, it is clear that it will not be a final theory. Much theoretical and experimental work needs to be done in further understanding our microscopic world.

July 1992

Assistant Professor Daniel Cebra
Ph.D., Michigan State University, East Lansing, 1990
Research Area: Experimental nuclear physics

Professor and Chairperson Barry M. Klein
Ph.D., New York University, 1969
Research Area: Theoretical condensed matter physics and materials science

July 1990

Associate Professor Steven Carlip
Ph.D., University of Texas, Austin, 1987
Research Area: Theoretical particle physics; quantum gravity

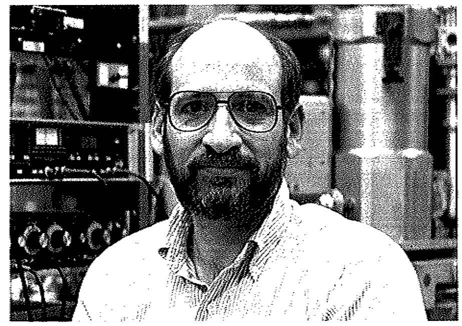
Professor Charles S. Fadley
Ph.D., University of California, Berkeley, 1970
Research Area: Experimental condensed matter physics; surface physics and photoelectron spectroscopy

Associate Professor Sudhindra Mani
Ph.D.,University of Pittsburgh, 1986
Research Area: Experimental particle physics

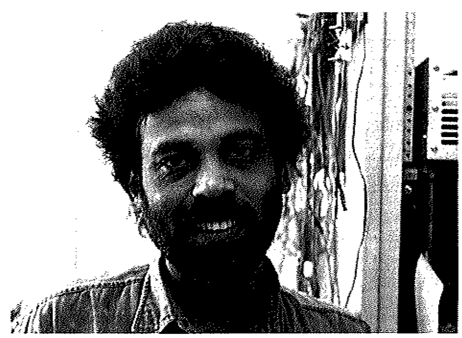
Assistant Professor Forest Rouse
Ph.D., University of California, Berkeley, 1987
Research Area: Experimental particle physics

Faculty Highlights

Congratulations to **Shirley Chiang**, professor, recently elected a Fellow of the American Physical Society. Professor Chiang has also been elected to fellowship in the American Vacuum Society this past year.



Larry Coleman, professor, has been appointed Chairperson of the Davis Division of the Academic Senate. The appointment is for two academic years starting September 1, 1995. Professor Coleman will represent the Academic Senate with campus and systemwide administration, lead the Senate in it's responsibilities for the design and maintenance of courses and curricula, and chair meetings of the Executive Council and Representative Assembly of the Academic Senate.



UC President J. W. Peltason has appointed **Sudhindra Mani**, associate professor, director of the University of California Study Center in India beginning July 1, 1995 and continuing through June 30, 1997. Professor Mani will commute several times a year to the Davis campus to maintain his active research program.

Congratulations to **Richard Scalettar**, associate professor, for his election to the position of Member-at-Large of the Executive Committee of the Division of Computational Physics of the American Physical Society. **Barry M. Klein** is currently chair-elect of the division.

Gergely Zimanyi, associate professor, was recently named associate editor for *Philosophical Magazine*, the oldest running journal in physics (since 1798).

Recent Faculty Retirements

Tom Cahill retired in July 1994, but you wouldn't know it from the pace of research activities he still keeps. **Jim Draper** also retired in July 1994, and still keeps up his highly active research program in nuclear physics.

Glen Erickson and **Rod Reid** continue to teach some of our key graduate courses despite their retirements in July 1994. **John Jungerman** has remained active in undergraduate teaching since his retirement in July 1991.

Neal Peak does a great deal of public service work on campus since his retirement in July 1991. **Bill True** also retired in 1991, but keeps active in theoretical nuclear physics. **Claude Garrod** continues to be active in his textbook writing enterprises since he retired in July 1994.

Interestingly enough, the "Davis magnet" has kept all of the above retirees in Davis; they seem to be around the Physics Department all of the time!

Professor Linton Corruccini and former graduate student Steve White prepare dilution refrigerator for experimental run.

Alumni News

Joseph Alward received his Ph.D. in 1976. He is a professor of physics at the University of the Pacific, Stockton, California.

John W. Dykes received his Ph.D. in 1994 and is currently a physicist at NIST in Boulder, Colorado. His work includes investigations of novel magnetic structures relevant to magnetic recording materials.

Louis A. Hemstreet Jr. received his M.S. in 1972. He is at the Naval Research Laboratory in Washington, D.C., working on electronic properties of semiconductor superlattices.

James Jadrich received his Ph.D. in 1991 and is currently a physics education program leader at Fermi National Accelerator Lab in Batavia, Illinois.

Insook Lee received her Ph.D. in 1990 and is doing research in semiconductors at the Research Institute in Korea.

Tony Lee received his Ph.D. in 1994 and is currently a postdoc at the Department of Mechanical Engineering at the University of Virginia in Charlottesville, working on the development of laser diagnostic techniques.

Guy Letteer received his Ph.D. in 1988. He is teaching at Archbishop Mitty High School in San Jose, California, and also at the University of Santa Clara.

Roger McNeil received his Ph.D. in 1986. He is an associate professor at Louisiana State University. Professor McNeil will be spending the next year on sabbatical at CERN in Geneva, Switzerland.

Rajamani S. Narayanan received his Ph.D. in 1990 and is now a postdoc at the Institute for Advanced Study in Princeton, where he is working on lattice field theories, and chiral gauge theories in particular.

Jeffrey S. Nelson received his Ph.D. in 1987. He is at Sandia National Laboratories, Albuquerque, New Mexico, as a group leader of semiconductor research.

Carol Nichols received her Ph.D. in 1987 and is an assistant professor in materials science at Cornell University, Ithaca, New York.

Parhat Niyaz received his Ph.D. in 1993 and has held the position of postdoc at the physics department at Arizona State University from 1993-1995. He recently accepted a position as postdoc in the chemistry department at the University of California, Berkeley.

Craig Perlov received his Ph.D. in 1982 and is working for Hewlett Packard in Palo Alto, California, designing magnetic heads for reading and recording.

Dennis Rogers received his Ph.D. in 1979 and is working for IBM in Yorktown Heights, New York, on electronic device designs.

Mark Roser received his Ph.D. in 1990 and is currently a scientist at the Naval Ocean Systems Center in San Diego, California (name changed to NRaD, the research and development division of the Naval Comand, Control, and Ocean Surveillance Center).

Greg Spooner received his Ph.D. in 1992 and is a senior development engineer at Coherent Medical in Palo Alto, California.

Robert Walraven received his Ph.D. in 1972 and currently has his own software firm here in Davis, California.

Alan F. Wright received his Ph.D. in 1991. He is at Sandia National Laboratories, Albuquerque, New Mexico, working as a staff researcher in semiconductor research.

Lin-Hung Yang received his Ph.D. in 1988 and is at Lawrence Livermore National Laboratory, Livermore, California, working on electronic properties of solids.

Nancy Y. Jia received her Ph.D. in 1992 and is a Miller Research Fellow at the University of California, Berkeley. Her work includes physical properties measurements on the giant negative magnetoresistance compounds R1-x, Mx, Mn, O3.

Lu Zhang received her Ph.D. in 1992 and is currently an assistant professor in the Department of Physics at California State University, Stanislaus.

What are you doing now?

If you are interested in sharing your current activities in future editions of *The Phyics Newsletter*, please complete and return the information form included in this newsletter.

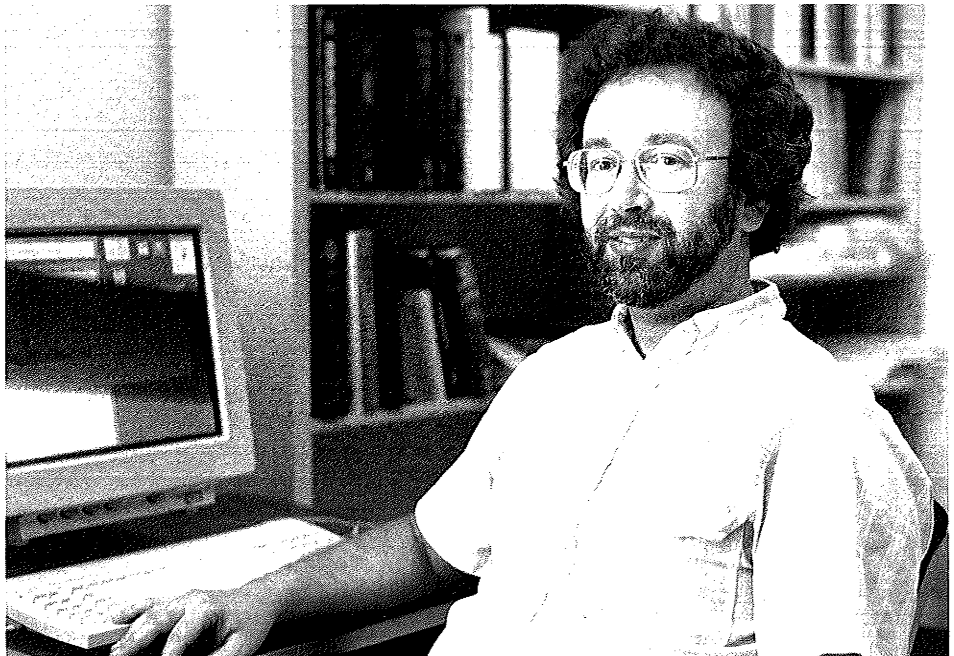
Gravitation and Quantum Mechanics

by Steven Carlip, associate professor of physics

The relationship between gravitation and quantum mechanics is one of the most compelling mysteries of modern physics. Everything we understand about the physics of small distances — from atomic spectra to superconductivity to the decays of elementary particles — is based on quantum mechanics. The physics of large distances, on the other hand — gravitation and cosmology — is described (very successfully) by the general theory of relativity. But despite sixty years of research, every attempt to unite these two theories into a quantum theory of gravity has failed.

To understand the problem, it is helpful to go back to the conceptual foundations of the two theories. General relativity describes gravity as an effect of spacetime curvature. As an analogy, think of two ships at the equator, both heading due north. They will find themselves drawn towards each other until they eventually meet at the North Pole, not because of any force, but simply because the Earth is curved. According to general relativity, the effects we think of as a "force" of gravity are a consequence of a similar curvature of spacetime. This curvature is in turn determined by the presence of matter — in the words of John Wheeler, "Spacetime tells matter how to move; matter tells spacetime how to curve."

Quantum mechanics, on the other hand, has as one of its fundamental principles the Heisenberg uncertainty relation, which asserts that it is impossible to simultaneously specify the position of an object and its rate of change to an arbitrary accuracy. The usual picture of classical dynamics, in which we describe motion by giving positions and velocities, emerges only as an approximation; at small enough scales, the classical picture becomes "fuzzy" and probabilistic.



To combine these two theories, we must apply the uncertainty principle to the structure of space and time themselves. In a very deep sense, we do not understand what this means. For example, a quantum theory of gravity cannot contain "local observables" — we cannot talk about the value of a quantity like the electric field at a definite position if positions are blurred by the uncertainty principle. The idea of "a fixed time," needed to make sense of probabilities in quantum theory, becomes obscure if time is quantized. Even causality becomes ambiguous — quantum fluctuations of spacetime could suddenly flip the temporal order of a "cause" and its "effect." A successful quantum theory of gravity will necessarily require radical changes in our understanding of space and time.

Rather than trying to tackle these problems head on, I have been working for several years on a simplified model of "(2+1)-dimensional gravity," that is, general relativity in two dimensions of space plus one of time. The reduction of the number of spatial dimensions from three to two drastically simplifies the physics and mathematics of general relativity, making it possible to actually write down a self-consistent quantum theory. In fact, we suffer an embarrassment of riches — there are many consistent quantum theories of gravity in 2+1 dimensions, and they are not all equivalent. My research has focused on the question of what these models can tell us about the conceptual problems of real (3+1)-dimensional quantum gravity: what does it mean to quantize the structure of spacetime?

My most recent project has been to explore the characteristics of black holes in 2+1 dimensions. Jacob Bekenstein and Stephen Hawking showed in the early '70's that black holes are actually thermodynamic objects, characterized by a temperature, an entropy, and the emission of black body radiation. But unlike ordinary thermal systems, for which these properties are a consequence of the microscopic physics, we do not have a "statistical mechanical" explanation of black hole thermodynamics. I showed last year that in 2+1 dimensions, some of the thermal properties of black holes could be explained by quantum gravity; one of my main projects for the future is to try to extend these results to our real (3+1)-dimensional universe.

Congratulations!

Congratulations to Luke Campbell, June '95 graduate, and Chad Leidy, senior Applied Physics major. Both were elected to Phi Beta Kappa in 1995.

The Phi Beta Kappa Society is the oldest and most prestigious national academic honorary society in the United States. Its Handbook for New Members begins, "For over two hundred years election to Phi Beta Kappa has been a recognition of intellectual capacities well employed, especially in the acquiring of an education in the liberal arts and sciences."

Kappa Chapter recognizes, by election as Members in Course, juniors and seniors who have compiled outstanding academic records in a curriculum including the humanities, natural sciences, and social sciences. Election and initiation take place in late May and early June.

Surface Physics Research at the Advanced Light Source

by Charles Fadley, professor of physics

I joined the U.C. Department of Physics in 1990, with an Advanced Light Source Professorship that is a joint appointment with the Lawrence Berkeley Laboratory (LBL). Although my group carries out experimental studies in a laboratory in Davis, a principal interest is to use the Advanced Light Source (ALS) that has just been completed in Berkeley for various types of state-of-the-art surface physics and materials physics research.

The ALS is the first of the so-called "third-generation" synchrotron radiation sources to be completed in the world. It makes use of an extremely finely focused 1.5 GeV electron beam in a 67 meter diameter storage ring to produce the brightest ultraviolet and soft x-ray radiation that is presently available. This source is approximately 100 times brighter than any previous storage rings used to produce synchrotron radiation. Special magnetic devices called wigglers and undulators are used to magnify the radiation intensity by subjecting the electron beam to multiple accelerations along a generally straight path. LBL has long been a leader in the development of such devices, and the ALS was successfully brought on line about 18 months ago.

My group has just completed construction of a beamline and experimental station for use at the ALS that will permit studying surfaces, interfaces, and other structures of nanometer dimensions grown on surfaces in several unique ways. The principal experiment carried out is photoelectron emission, which yields photoelectron spectra containing information on atomic composition, electronic structure, and magnetic structure. These spectra can be measured at resolutions of 1:10,000, and also with final spin resolution of the outgoing electrons for studies of magnetic materials. The beamline also permits excitation with circularly polarized radiation, in which case the spin-orbit interaction yields spin polarized electrons even from non-magnetic atoms. A further aspect of this work pioneered by the Fadley group involves measuring the angular and energy dependences of photoelectrons emitted from core levels in the various atoms of the sample; such data exhibits strong photoelectron diffraction effects that can be used as an atom-specific probe of local atomic and magnetic structure. It has also recently been realized that such photoelectron diffraction data can in addition be analyzed in a Fourier-transform approach so as to yield direct holographic images of atoms, a new and exciting development that will be pursued at the ALS. Other special features of this experiment permit preparing surfaces in situ via ultrahigh vacuum techniques, including molecular beam epitaxial growth, and characterizing them with other methods such as low-energy electron diffraction (a modern variant of the Davisson-Germer experiment) and scanning tunneling microscopy.

The problems of interest to us include the growth of magnetic oxides and magnetic metals on metal and semiconductor substrates. A better understanding of such growth phenomena and the structures they produce is key to new technologies for integrated circuit fabrication, magnetic storage media, and chemical catalysis at surfaces. Some of the phenomena studied are: metastable and/or strained surface structures that do not exist in the bulk, surface-specific structural and magnetic phase transitions, and quantum-size effects in which objects on the surface of nanometer dimensions can have vastly different properties from the corresponding bulk properties.

Other News

Physics Club

By Tara Ingram and Dana Le, 94/95 co-presidents

The 94/95 UCD Physics Club has primarily been involved in the social support of group members, providing graduate school and career resources, and supporting elementary school science education.

The focal point of our social interaction is the Physics Club room, where members have access to a quiet place for homework and study groups and a centralized meeting place between classes. The club also organized a large informal social meeting once each quarter. Our goal was to draw students together outside of school and to take advantage of the small size of the department. We also took an informative and fun field trip to the Exploratorium.

This year the club administrators began to access electronic communication with club members. We established an address list for electronic mail. We also began to develop a home page for the World Wide Web that will include activities and resources for science and career information. Aside from being a meeting place, the club room provides room to display and organize information. At the beginning of the year, club members meet with an administrator from the Physical Sciences Career Center to learn about resources and opportunities outside of the department.

The club spent significant time and energy in support of several science education opportunities at local and distant elementary schools. Twice we participated with other science-oriented organizations in outside school science fairs. We presented several demonstrations to groups of children in an effort to stimulate their curiosity and provoke them to ask questions in the spirit of scientific inquiry. Once we traveled alone to a Yuba City school to present demonstrations to each of the grade levels. Several

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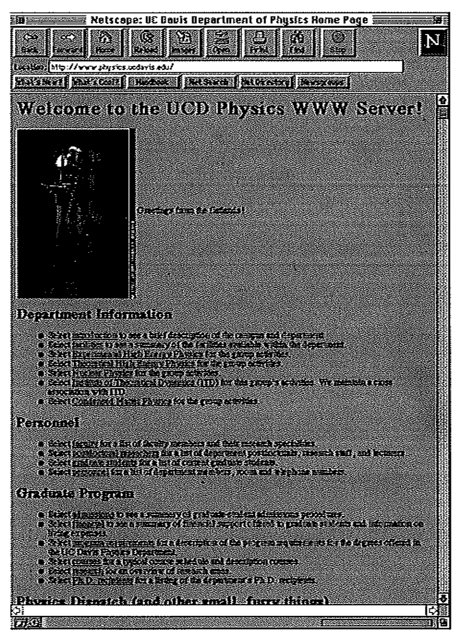
Physics Home Page



For more information about the UC Davis Physics Department, browse through our recently completed World Wide Web homepage at: http://www.physics.ucdavis.edu

Physics Club

(continued from page 11)

members also judged student science projects at another school in Yuba City.

Of course the Physics Club also organized an exhibit room at the annual Picnic Day. Along with physics demonstrations we also presented information about our club and general history of science information.

Several of the most involved club members will run the club during their senior year next year. They were excited by our elementary school involvement and, in spite of our overwhelming course work, showed significant dedication to the club.

95-96 Physics Club Officers

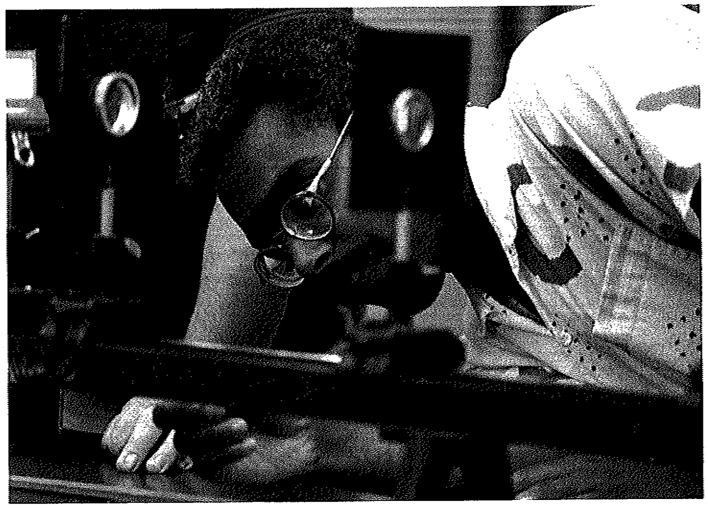
Co-President — Al Loui

Co-President — Tim Ratto

Vice-President — Steve Mitani

Secretary — Dave Griffith

Treasurer — Kelly Campos



Assistant professor Forest Rouse adjusting optical bench in Physics 9 laboratory.

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I am interested in attending a Physics Department Alumni get-together tentatively planned for Spring, 1996:

❑ **yes** ❑ **no**

I am interested in being included in a UC Davis Physics alumni database available on a gopher server:

❑ **yes** ❑ **no**

I am willing to be part of an informal informational Physics network in my area for Physics Graduates:

❑ **yes** ❑ **no**

Please include the following news in the next issue of the Physics Newsletter:

Please fold, seal with tape, attach postage and mail back. Thank you.

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