UC DAVIS Physics Newsletter

Number 3 | A Newsletter for University of California, Davis, Physics Alumni | Fall 1996

From The Chair

Dear Friends of Physics,

A major effort is under way by our department to examine our curricula, both undergraduate and graduate, with an eye toward making the changes needed to improve our delivery of instruction and better prepare our physics majors (and other UC Davis students) for the post-university world.

What is driving us to do this?

Since the end of World War II, there has been a tremendous explosion of scientific progress in nearly all fields of physics. This is not because the recent generations of students and professional scientists are smarter or more hard working than previous generations, but I believe it's largely because of three factors: (1) the dramatic increase in the number of scientists being trained and entering the work force — for instance, we are turning out approximately 1,400 Ph.D. physicists per year in the U.S. in recent years; (2) the advances in technology that have fostered a non-linear growth in capabilities (computing, for instance) for studying heretofore inaccessible phenomena; and (3) the great advances in information access through the proliferation of efficient methods for information exchange (currently Internet and Web communication, for instance).

Because of this knowledge explosion, students are faced with a daunting and often confusing challenge to gain familiarity with, no less become proficient in, a vast knowledge base of physics, far beyond what past generations had to contend with. The balance between teaching traditional physics (say, mechanics) and what we call modern, or 20th century physics, has become increasingly difficult to manage. Students are forced to specialize in focused areas of physics, even more so than before — the so-called "generalists" are becoming few and far between.

On top of all of these issues, the growth in the number of scientists and the decrease in basic research support (at least per capita) has created a situation where an increasingly larger number of students develop careers in non-traditional areas, from computer software industry scientists to analysts on Wall Street.

Students are perhaps being overwhelmed, and this can lead to frustration and lack of motivation to pursue science studies.

Although our departmental plans for curriculum changes are at an early stage of development, an approach that we are giving serious consideration involves major changes in our lower division (first two years) curriculum for physics majors (and eventually physical science and engineering majors), restructuring our courses in a way to free up the sophomore year for more in-depth studies of modern physics, and increased motivation for the students. We hope to

(Continued on page 12)

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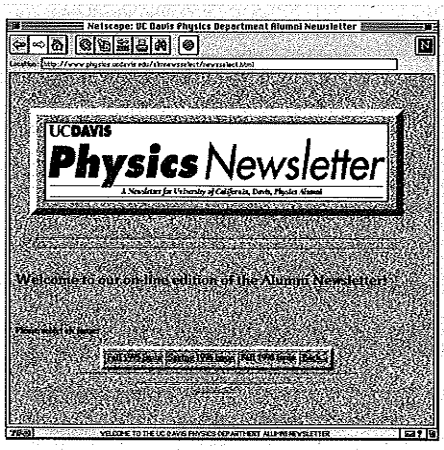


Visit the Newsletter, Now Online!

In early June of this year, the electronic version of the Alumni Newsletter went online. The content of the electronic newsletter will be identical to the printed newsletter. For those of you already familiar with the Physics Department's homepage, simply select "Newsletter" under the "Physics Dispatch" heading. The newsletter can also be reached directly at: <http://www.physics.ucdavis.edu/almnewsselect/newsselect.html>. Please drop us an e-mail and let us know what you think!

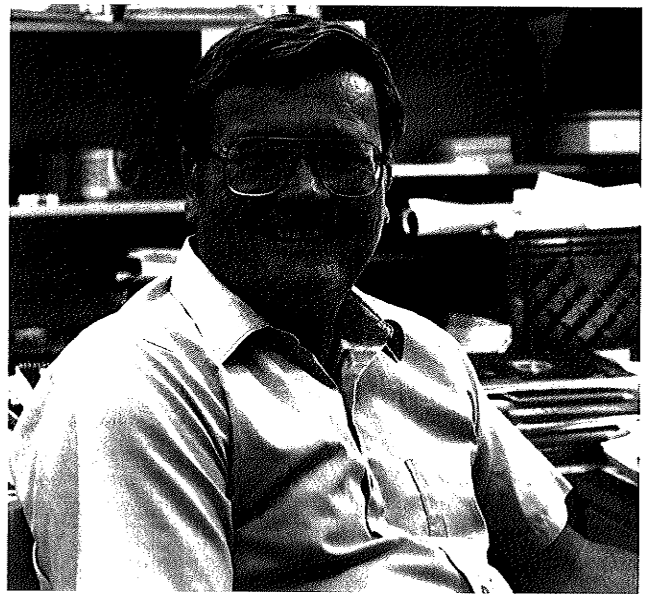
Birth of an Environmentalist

by Tom Cahill, professor emeritus

I had pretty much told the University of British Columbia that I would accept their offer when I got a telephone call from Jim Draper at some ungodly hour of the morning. Would I accept an assistant professor appointment at UC Davis? It was 1967, and I was in France at the time working at the nuclear laboratory at Saclay south of Paris. Ginny (my wife) and I had had a great year, but I was becoming a little panicky at my inability to interview for jobs. I was excited by the thought of working to build the large TRIUMF cyclotron at the University of British Columbia, due for completion in five years, but attracted by the idea of coming to a working cyclotron at Davis. John Jungerman, who was on sabbatical at Saclay, had told me lots of good things about Davis. I accepted the job offer on the spot, without a very clear idea of where Davis actually was.

We landed at Long Beach and drove up to Davis through the Central Valley just before Labor Day. The heat was stifling in our non-air-conditioned Volkswagen, and I kept thinking, "What have I done? This could have been Vancouver!" I was greatly relieved when, arriving at Davis, there were lots of trees. The Department of Physics was at that time located in Young Hall, and we had new semi-subterranean offices on the south side. Each had a slit-like horizontal window high in the wall, so designed that any students who entered would get the sun directly in their eyes. Sort of an instant "third degree" interrogation.

But the Crocker Nuclear Laboratory (CNL) was great, with an all-inclusive grant that covered students, staff, summer money, travel, etc. No worries about funding. All I had to do was do physics. There was a slight problem in that one key component of the cyclotron was wired in backwards (the plans were very hard to read), and we had no proton beams. But I was able to help resolve this problem, partly due to my extensive cyclotron building experience. I started a large program in few nucleon physics and worked with Paul Brady in neutron physics. We had a bunch of super graduate students, including Bob Eldred and some others from Chile on the Convenio exchange, especially Roberto Morales. I remember fondly the fall weekends at Bill Knox's cabin at Upper Echo Lake, and the smell of hiking up a trail behind Bill True, whose favorite bottle of scotch had spilled into his pack. And all these brilliant theoreticians trying to explain the splashes they got throwing rocks into Upper Echo Lake (including, I believe, Claude Garrod). It was generally an exciting and successful period. I didn't regret coming to Davis at all.



By 1970, we had worries. Many nuclear laboratories were being closed as funds became scarce, as the Atomic Energy Commission (AEC) was pouring cash into Los Alamos. UC Davis was no longer growing under the difficult governorship of Ronald Reagan. There were no new hires in nuclear physics and our salaries were frozen for a couple of years. A group of us approached John Jungerman about going into some physics applications, and he encouraged us greatly. When, without warning, AEC funds were pulled in 1971, we already had some grants from the Air Resources Board (ARB), and this helped us survive a brutal transition. Two of the key co-founders of the Air Quality Group were Bob Flocchini and Pat Feeney, who are with us still. For a while, Bob was the department chair at LAWR, and he is still director at CNL.

During this period, Governor Reagan sent auditors onto the campus to determine how many hours professors were actually working. The department chair had the auditor record my time for one week, and he documented 85 hours of university work. He told me that he couldn't submit such a number to Sacramento because "that was not what they expected to find."

Crocker Nuclear Laboratory survived, but at the expense of some really good physics that could have been done. The department also survived lean times, helped by the new building and the equipment funds that came with it. By 1978, things were looking brighter fiscally, and the atmospheric physics and chemistry were becoming both well known and well funded. Our work gradually moved away from urban studies into non-urban work. I became director of the Institute of Ecology in 1972, the first (and last) nuclear physicist to ever run this eclectic group of ecological free spirits. One day, while examining ARB data from Lake Tahoe, I mentioned to Charles Goldman, the pre-eminent limnologist, that the lead values in the air at South Lake Tahoe were higher than in downtown Los Angeles. Somehow, this found its way onto the front page of the Sacramento Bee, and there was hell to pay. Thus it was that I became committed to (what is now) 22 years of research on air quality at Lake Tahoe. In 1978, I was asked to work at Owens (dry) Lake, and used the opportunity to "borrow" an air sampler and take the first air samples at Mono Lake. Bingo. Bad problems. Happily, after 18 years of hard work, much by students Bruce Kusko and Tom Gill, we were able to help "Save Mono Lake".

In 1977, after six years of repeated rejections, my proposal to study air quality at national parks was funded (modestly). One year later came the energy crisis of 1978, and my grant was re-issued at \$250,000. The first national non-urban air quality-visibility network was a reality, and I was firmly committed to atmospheric optics, a path on which I continue today. Our continued success is due, I believe, to the constant incorporation of new techniques and procedures, largely derived from optical, atomic, and nuclear physics that keeps us ahead of the competition. Our group also benefits from a real love of hard data, a characteristic that all physicists share.

Only at a university could one do work in very different disciplines (and not get fired). Our air quality techniques led to the fun collaboration with Dick Schwab in the UC Davis Department of History. The recent Yale Press book on the Vinland Map, in which Bruce Kusko and I are among the authors, was the April selection of the History Book Club.

No regrets about choosing Davis these days! ❖

Alumni Dinner

by Jeff Heffernon, M.D.

The UC Davis Department of Physics alumni dinner was held on Saturday, April 13, 1996. It's been 24 years since I graduated. I had visited the campus several times over the years but never made it over during the work week when I might have been able to look up some of my old professors. Over the years I felt regretful that I had not made the effort. I had always wanted to let my former teachers know just how much I enjoyed being their student and being a part of the UC Davis physics program. I am living in Wisconsin now, and it's a long trip back to Davis. But I was so pleased to see that an alumni dinner was being planned that I could not pass up the opportunity to attend.

Richard McDonald, Janet McDonald, Neal Peek, Robert Shelton, Adrian Shelton

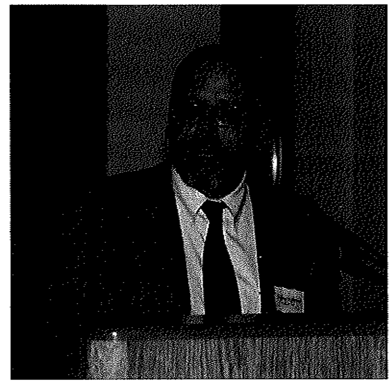
My wife, Ursula, and I attended both the dinner and a luncheon at Dr. Barry Klein's home that same afternoon. We had never met Dr. Klein, but found him and his wife, Gail, gracious hosts, and were treated as old friends. Dr. Reid, one of my favorite professors, was at Dr. Klein's for lunch and it was really fun seeing and talking to him on a personal basis again after so many years.

After a delicious luncheon and brief meeting, we headed over to the campus and visited what is for me the "new" physics department. I spent most of my time studying in Young Hall, which is where most of my memories reside. The new department seemed so new when I graduated, it seems strange that now it looks so well worn. There are some beautiful photographic murals there from famous gatherings of physicists from the past. We visited the roof of the Physics/Geology building to overlook the campus. What a vista! Dr. Klein also took our group to the remodeled main library, which has been expanded and tastefully remodeled, and for a walk through the campus. The arboretum has continued its maturation and is a real treasure. Several of the graduates, Ursula, and I finished our afternoon with a visit to the campus bookstore and the Memorial Union.

UC Davis now has an alumni center where we were served a wonderfully prepared salmon and beef filet dinner with excellent California wines. It is a lovely facility across Putah Creek from Mrak Hall. The attendance at dinner was much larger than the attendance at the luncheon. Most of my former professors are now "professors emeritus." When I graduated in 1972, I remember only Drs. Gardner and Patton being emeriti. Now Drs. Cahill, Draper, Erickson, Garrod, Hurley, Jungerman, Knox, Peek, Reid and True are all emeriti faculty. Unfortunately, Dr. Cahill was out of town and could not make the gathering, but if I remember correctly, the other emeriti were all present.

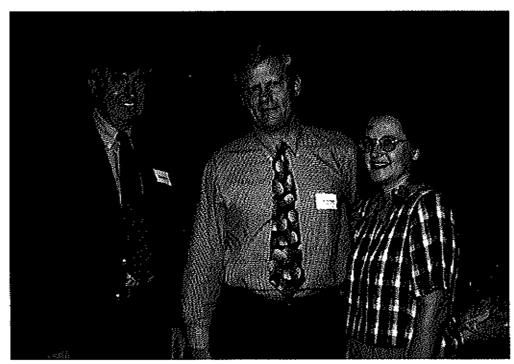
Standing: Larry Coleman, Veronica Benet, Greg Spooner, Lisa Couper
Sitting: Claude Garrod, Grace Wheeler, Don Wheeler, Chris Couper

I was saddened to learn that Dr. Greider, who I remember for his enthusiasm and energy as a teacher, has passed away. Dr. Peek, who did attend, was recovering from a setback in his health and I hope his recovery is speedy. In general, however, I was struck by how little people had changed and how fit and in good spirits everyone was.



Jeffrey Heffernon

Dr. Peter Rock, the Dean of the Division of Mathematical and Physical Sciences, greeted Ursula and me at the cocktail reception and we had a delightful chat with him. We also mixed with the faculty, alumni, and their spouses. Dinner was delicious. We sat with Dr. Knox and he shared his many experiences over a long career at UC Davis with those of us at the table. It was particularly interesting to hear the history behind the Crocker Lab. Dr. Klein gave us an update about UC Davis and the physics department. Some of the former graduates shared their experiences with the group. Each guest received a commemorative UCD Physics Mug.



Rod Reid, John Rominger, Carol Rominger

I think everyone had a delightful time, and we all owe Barry and his staff a big thanks for making all of this happen. Best wishes to former teachers, colleagues and friends! ❖

'62

Sheldon M. Smith (M.A.) now retired, spends time volunteering with the Tech Museum of Innovation in San Jose as well as being chair of the Trails and Bikeways Committee for the town of Los Gatos.

'67

John C. Baker (Ph.D.) is currently principal physicist with ANSER in Arlington, Virginia. He is a part-time professor of electrical engineering and professional lecturer of telecommunications at George Washington University. He is also a consultant on such matters as federal acquisition and space legislation.

'68

Carl Kukkonen (B.S.) went on to receive his Ph.D from Cornell in 1975. He is presently director of the JPL Center for Space Microelectronics Technology and manager of supercomputing at NASA's Jet Propulsion Laboratory in Pasadena. Before his current position he worked at the Ford Motor Company assessing the prospects for "Hydrogen as an Alternative Automotive Fuel" as well as designing a direct injection diesel engine.

'70

Clifford M. Krowne (B.S.) holds the title of research scientist at the Naval Research Laboratory's Microwave Technology Branch, Electronics Science and Technology Division, in Washington, D.C. He received his Ph.D. in electrical engineering at UCLA in 1975. He is author of 135 journals, conference papers, patents, and book contributions and has authored two-thirds of Academic Press' *Advances in Imaging and Electron Physics* series, Vol. 92. A new contribution of his will soon be published in the series. In spring of 1996 he participated in the Scientists at Sea Program aboard the USS Halyburton.

Frank Kozusko (M.A.) joined the Navy in 1971 as an officer aboard a nuclear-powered submarine. He spent 21 years operating and driving nuclear submarines, cruisers, and aircraft carriers. Before retiring from the Navy in 1992, he earned an M.S. degree in math and a Ph.D. in applied computational math from Old Dominion University in 1995. He is currently assistant professor of mathematics at Hampton University, Hampton, Virginia.

'71

Dan Koenigshofer (B.S.) received his master's degree in public health–air and industrial hygiene. He began his career by working briefly for the EPA until he started his consulting engineering firm. He is senior partner with IES Engineers, in Chapel Hill, North Carolina. He still actively plays doubles volleyball, has two children, and is "enjoying life."

'72

Richard Fobes (B.S.) currently resides in Corvallis, Oregon. He has written a book titled *"The Creative Problem Solver's Toolbox: A Complete Course in the Art of Creating Solutions to Problems of Any Kind."* He has worked as an electronics technician, inventor, computer programmer, technical writer, designer of educational multimedia software, and currently teaches seminars and workshops in creative problem solving.

Scott K. Perry (M.A.) is presently a physics teacher at American River College in Sacramento. He has taught physics and astronomy for the Los Rios Community College since 1974, and has participated in teaching exchanges which sent him and his family to Montreal.

'79

Dan Parker (Ph.D.) is currently senior physicist with StorMedia, Inc., in Santa Clara. His work involves the research and development of disk drive media.

'80

Brian Haughton (B.S.) went on to receive his Juris Doctor from UC Berkeley in 1983. He is a partner with the firm of Landels, Ripley, and Diamond, LLP, practicing environmental law. He also teaches environmental law at Hastings College of the Law in San Francisco.

Joel W. Parke (B.S.) is currently a consulting engineer/engineering manager with Dragon Systems, Inc., in Newton, Massachusetts.

'82

John Harton (B.S.) completed his education at MIT where he received his Ph.D. in elementary particle physics. He holds the position of assistant professor at Colorado State University.

'84

Jordan Bajor (B.S.) is presently director of operations at LocalMed, Palo Alto. He married his wife, Janis, in 1989 and has a son, Aaron Walter Bajor, born January 26, 1994. At the moment, his work involves developing catheters for delivering medication directly into the coronary arteries, along with designing and building the company itself.

'85

Stephen Bradford Gospe (B.S.) obtained his Ph.D. from Stanford, then went to work as senior process engineer with Intel in Santa Clara, where he works with flip chip bonding development.

Calvin W. Johnson (B.S.) is currently assistant professor in the physics department of Louisiana State University. He received his Ph.D. degree from the University of Washington in 1989.

Greg Showman (B.S.) is pursuing his Ph.D. in electrical engineering at the Georgia Institute of Technology. His research centers on radar digital signal processing.

'87

Daniel L. Codiga (B.S.) is a Chateaubriand Postdoctoral Fellow at the Laboratoire Des Ecoulements Geophysiques et Industriels, Grenoble, France. He completed a Ph.D. in oceanography at the University of Washington School of Oceanography, Seattle, in 1996.

Jim Alves-Foss (B.S.) received his Ph.D. in computer science from UC Davis in 1991. He is currently assistant professor of computer science at the University of Idaho.

'88

Timothy D. Solberg (M.S.) is currently assistant professor at the UCLA Department of Radiation Oncology.

Frederik Ter Veer (B.A.S.) went on to receive his M.B.A with an emphasis in project and venture management. He works with Kyocera America, Inc., in San Diego, managing metal ink fabrication and print screen groups, as well as being the technical liaison between Mexican Maquiladora and American plants. He has one daughter, Sierra Herranen Ter Veer, born January 26, 1996. He adds, "Having a blast in San Diego; the weather is as usual--great."

'89

Susan (Holtsman) Highnote (B.S.) earned her M.S. in physics at San Diego State in 1992. She has been working at Laser Power Research in San Diego since 1993 as a staff scientist. Her work centers on sub diffraction limited optical systems, human vision, and color perception. She will begin the graduate program in psychology this fall at UCSD.

James Vesenka (Ph.D.) is an assistant professor in the physics department at California State University, Fresno. He began his tenure track position at CSU Fresno last August. His research interests consist of the continuation of interdisciplinary collaborations to use the scanning probe microscope both in biosciences and in developing educational based resources.

'90

Cathy Cahill (B.S.) went on to earn her masters and then her Ph.D. in atmospheric science at the University of Nevada, Reno. She was recently awarded a Fulbright Scholarship to study for one year in the physics department at the University of Galway, Ireland.

Robert Gallup (Ph.D.) is currently an assistant professor of physics and mathematics at Southwestern College, Kansas.

'91

Fernando Erismann (B.S.) presently lives in Elk Grove, and is employed by C&K Systems as senior optical designer. His area of work includes diffractive and IR optics for use in IR motion sensors, the company's major product.

Steven W. Finch (B.S.) has worked at Fidelity Investments in Boston, Massachusetts for the past three years. As the senior software technical support analyst he provides production and planning support for PC and web based trading products.

Jim Jadrich (Ph.D.) is presently associate professor of science education and physics at Calvin College in Grand Rapids, Michigan.

Kurt Kanzler (B.S.) holds the title of manufacturing engineer with Coherent Optics Division in Auburn. He presently works in the field of defractive optics, using microfabrication techniques to produce structures onto the surfaces of optical materials, thereby controlling the phase of incoming radiation.

David E. Krull (B.S.) is currently technical trainer with Applied Materials in Santa Clara. He recently completed four years as a Navy lieutenant in Orlando, Florida, teaching nuclear physics at the Naval Nuclear Power School.

David Perdue (B.S.) is presently conversion analyst with XP Systems in Ontario, California. His work involves client-server data processing solutions for credit unions.

'92

Jacob A. Blickenstaff (A.B.) began teaching at Galt High School in Galt, after receiving his teaching credential from UC Davis in 1993. He was nominated for the Sallie Mae First Class Teaching Award in 1994, and is vice president of the teachers union at GHS.

Paul Lee (B.S.) is currently a science data analyst with the Space Telescope Science Institute at Baltimore, Maryland.

John V. Sandusky (B.S.) worked as an undergraduate developing a fourier transform spectrometer for William Jackson, professor at UC Davis' chemistry department. This work led to a job involving optical pulse compression at the Stanford Research Institute. He began pursuing his Ph.D. in optical science at the University of New Mexico and is currently a research assistant at the Center for High Technology Materials at the university. He hopes to be finished by May 1997. In 1993, he married his college sweetheart.

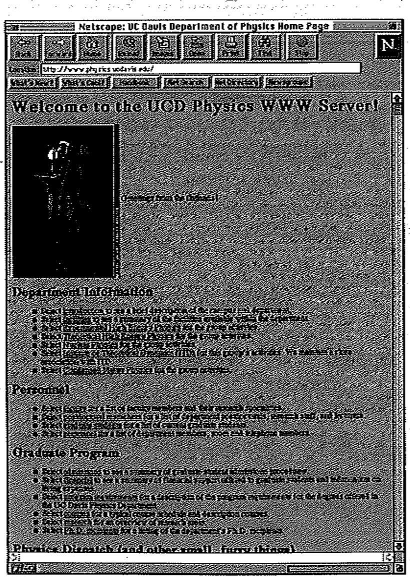
'93

Stephen Underwood (B.S.) presently works as a process development scientist for the Bayer Corporation's Biotechnology Unit in Berkeley.

'95

David Scott Gardner (B.S.) is currently a graduate student researcher at UC San Diego's electrical and computer engineering department, working with the Optical Computing Group under the advising of Dr. Sadik Esner. His project involves the implementation of a photorefractive beam splitter to be used with reflective mode modulators in a free space optical interconnection system. He hopes to earn his master's degree by 1997 and then pursue a Ph.D. in photonic engineering. ❖

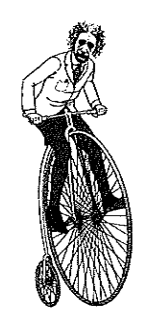
Physics Home Page



For more information about the UC Davis physics department, browse through our World Wide Web home page at: <http://www.physics.ucdavis.edu>

What are you doing now?

If you are interested in sharing your current activities in future issues of *The Physics Newsletter*, please complete and return the information form on page 11. You may also send your information via e-mail to: simoes@physics.ucdavis.edu. Please include the word "Newsletter" in the "Subject/Regarding" line of your message.



Teaching Opportunities for Graduate Students

by Jason Dunn and David Feldman, graduate students

This past academic year Jason Dunn and David Feldman each participated in special university programs designed to give graduate students a chance to teach a large introductory course. As a student in theoretical statistical mechanics, David was awarded a Chancellor's Teaching Fellowship, which allows prospective future faculty members to co-teach a course with a current faculty member.

In spring quarter 1996, David co-taught Physics 9A, a calculus-based introductory physics course for engineering and physical science majors. Through the Chancellor's Teaching Fellowship, he was paired with Professor Richard Scalettar as a faculty mentor. Richard and David equally shared all aspects of the course: lecture preparation, office hours, test writing -- even the lecturing itself, switching places halfway through each lecture. Besides providing a nice change of pace, this approach also let students know that both had input into every lecture. Each of the half-lectures were then about the same length as the average television show. This surely helped students stay focused.

Before coming to UC Davis, David taught high school physics and math, so this was not his first teaching experience. However, David discovered that a lecture hall of 200 relative strangers is quite different from a room full of 20 students that he had gotten to know well over the course of a year. Richard, however, was a veteran of several such large classes, and together they made a good team. David had a lot of experience in designing lessons and interacting with students. Richard was familiar with the course and the intricacies of orchestrating a 200-person lecture.

Before the quarter began, Richard and David spent a lot of time discussing how to teach the course. They both felt that typically too much material is covered in introductory courses. They sought a deeper level of understanding and de-emphasized problem-solving calculus stunts. What good is being able to do a volume integral if you don't know what moment of inertia is? Thus, they left out some of the more advanced material (that they believe students quickly forget anyway). Most students appreciated this approach -- several commented that Richard and David took the time to teach and explain, rather than just present material.

Jason Dunn, who studies particle identification in relativistic heavy ion collisions, participated in the Program in College Teaching. This one-year program coordinated by Graduate Studies and the Teaching Resource Center emphasizes a mentored teaching experience and addresses issues and practices in higher education.

In winter quarter 1996, Jason taught one section of Physics 5A, an introductory algebra-based mechanics course. Jason was able to gain experience in all aspects of a large introductory course: large hall lectures, demonstrations, problem-solving sessions, selecting homework, exam writing, and grading. He also gained valuable insight on how to deal with the most formidable obstacle of large introductory courses: the administrative part. Learning to simultaneously enroll, test, and process excuses from hundreds of students Jason feels is an art in and of itself. He observed some strange statistical fluctuations in his course, where the death rate of students' relatives seemed to spike on and around midterm and final dates.

Because one has to make decisions on every aspect of the course, teaching a course for the first time is well known to be both time-intensive and challenging. Luckily, Jason was mentored by several department members before and throughout the course, which helped ease the learning curve. Jason believes that one of his most useful learning experiences was sitting in on Randy Harris' lectures the quarter before he began teaching his course. Randy is an experienced and well-respected teacher; observing him gave Jason one good model and many practical ideas for teaching his own course.

Throughout the quarter, Jason tried to emphasize an inquiry-style method of lecturing. He introduced conceptual ideas by posing fundamental physical questions. Over the last 20 years, research in physics education has shown us that one of the most important things in learning the subject lies in what you already know, think you know, or know incorrectly. Introducing a question about a specific physical concept forces the students to take a mental inventory and confront their initial conceptions or misconceptions. After a demonstration or discussion of the concept, the students can then evaluate whether their initial understanding was correct or in need of modification. If the students' initial models of a physical idea are never confronted or challenged, they often just memorize a few algorithms to solve the problems, forget those algorithms, and return to their previous faulty conceptions.

New Graduate Students

Fall of 1996 will bring 15 new graduate students to the UC Davis Department of Physics to begin their studies:

Christopher Algieri from Central Connecticut State University

Joonhee An from California State University, Fresno

Richard Garavuso from San Francisco State University

Christopher Hill from Dartmouth College

Jennifer Klay from University of California, Los Angeles

Albert Loui from University of California, Davis

Brandon Murakami from California State University, Long Beach

Thomas Nielsen from California State University, Chico

Peter Salzman from San Francisco State University

Alexander Slepoy from San Francisco State University

Ayoub Tartir from University of Jordan

Gayle Thayer from University of California, Santa Barbara

Marcus Watson from California State University, Chico

Huoping Xin from Wuhan University, People's Republic of China

Chengang Zhou from Anhui Institute of Optics and Fine Mechanics (Academia Sinica), People's Republic of China

One innovation that both Jason and David tried was incorporating advances in computer technology into the courses. Technologies such as e-mail and the World Wide Web can be useful educational tools, allowing greater accessibility to class information by more students. Homework assignments, due dates, and miscellaneous announcements were posted regularly on web pages. The 9A students used the web more than the 5A students; this may be due to the engineers in 9A being more familiar with computers and having more convenient access to them. Those students who did utilize the web pages found them very helpful. While the Internet will never replace person to person contact (we hope!), it does provide another useful mode of communication. This is especially important when teaching such large classes.

Both Jason and David have expressed that they feel grateful for the opportunity to have accumulated college-level teaching experience so early in their careers. Through the Program in College Teaching, other physics graduate students will also have such opportunities. Like David, Jason has received the Chancellor's Teaching Fellowship for the upcoming academic year. These opportunities are valuable and will shape one's future in numerous ways. Not only has this opportunity helped to make Jason and David more marketable in future job pursuits, they have also had the chance to formulate and modify their teaching philosophies and techniques with direct experience. Many new faculty members who enter their first teaching assignments have no experience teaching introductory physics in front of 200 demanding students. With the confidence of having already met this challenge as graduate students, Jason and David will be more seasoned educators when (if?) they become faculty members at an institution of higher education. ❖

Degrees Awarded

Ph.D. Degrees Awarded

March 1996

Alan Wong
"Optical Studies of Adsorbate Dynamics on Metals and Nonlinear Optical Responses at Interfaces"
*Senior Process Engineer, Intel Corporation, Santa Clara, CA.

June 1996

John Bacigalupi
"Strange Particle Production In Awayside Jets In High P_t p^0 And Direct Photon Triggered Events In p^- + Be/Cu Interactions At 515 GeV"
*System Engineer at VIASAT, Carlsbad, CA.

Chih "Johnny" Kuei
"Ferromagnetism in Itinerant Electron Systems"
*Senior Manufacturing Engineer at Advanced Micro Devices, Sunnyvale, CA.

Iad Mirshad
"Direct Production of Technetium-99m and Molybdenum-99 with Accelerated Protons"
"Techniques for the Synthesis of Superconducting Single Crystals of A_3C_{60} (A = K, Rb) and Measurement of Their Magnetic Properties"
* Postdoctoral Researcher, Laboratory for Novel Carbon Materials, Physics Department, Washington University, St. Louis, Missouri.

September 1996

In-Chu Chang
"Superconducting Properities of Polycrystaline $HgBa_2CuO_{4+\delta}$, $Hg_xTl_{1-x}Ba_2Ca_2Cu_3O_{8+\delta}$ Compounds, and Single Crystal $LuBa_2Cu_3O_{7+\delta}$."
*Process Engineer, IBM Almaden Research Center, San Jose, CA.

Stephen H. Irons

James G. Kelly
"Searching for MSSM Higgs Bosons at e^+e^-, $\mu^+\mu^-$ and $\gamma\gamma$ Colliders"
*Postdoctoral Researcher, Department of Physics, University of Wisconsin.

Roger King
"Hydrogen Depth Profiling Using Coincidence - Protein Elastic Scattering"
* Lecturer, Department of Physics, University of California, Davis.

M.S. Degree

December 1995

Leif Terry
*Junior Programmer at Acclaim Coin-Operated Entertainment, Mountain View, CA.

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 recongition 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.

March 1996

Geoffrey J. Balleisen . . . . B S
Dana Le . . . . B S

June 1996

Rafael M. Reveles . . . . B S
(Degree in Applied Physics)
Jeremy F. Thorsness . . . . B S
(Degree in Applied Physics)
Nga-Ching A. Wong . . . . B S
(Degree in Applied Physics)
Tara L. Ingram . . . . AB
Julian N. Basler . . . . B S
Honors
Departmental Citation
Lockheed Undergraduate Scholarship
Saxon-Patten Prize in Physics
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September 1996

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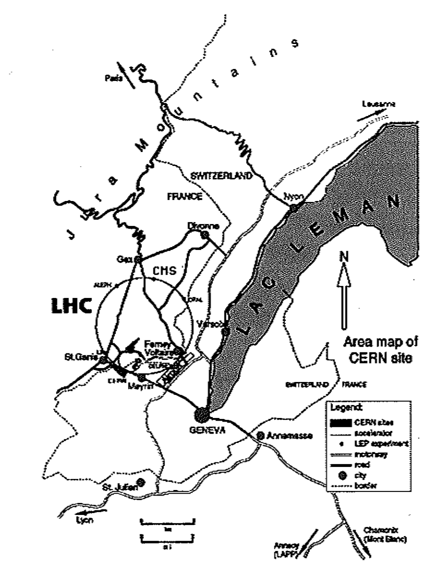
Physics at the Frontier: The CMS Experiment

by Richard Breedon,
associate research physicist

The Large Hadron Collider (LHC) will open up new physics horizons at the energy frontier, probing interactions between proton constituents at the 1 TeV level, where new behavior is expected to reveal key insights into the underlying mechanisms of nature. To be built at CERN, the European Laboratory for Particle Physics in Geneva, the LHC is a superconducting ring to provide proton-proton collisions around 14 TeV. The machine truly represents the long term future of high energy physics.

One of the two initial experiments at the LHC is the Compact Muon Solenoid (CMS) experiment to be built around a very high field (4 Tesla) solenoidal magnet. As the name suggests, excellent muon detection is its primary design consideration. Several members of the UC Davis faculty are involved in CMS, including Professors Ko, Lander, Mani, Pellett and Wuest, as well as theory Professors Gunion, Han and Vogt. Other participants besides myself include researchers Yuri Fisyak, Gary Grim and John Smith, and graduate students Jeff Rowe and Patrick Hession.

The UC Davis high energy physics group has a history of involvement with the principle of a compact detector with a high field solenoidal magnet emphasizing lepton detection. The group recently completed the AMY experiment at the KEK laboratory in Japan, a 3 Tesla solenoid detector that proved to be highly successful and cost-effective. UC Davis has been a member institution of CMS since 1992; some of us are original signatories of the CMS Letter of Intent. Participation in the CMS experiment expanded to include about 10 percent of the U.S. high energy physics community following the demise of the SSC in 1993, yet UC Davis has retained its leadership role.



The site of the LHC, straddling the border of France and Switzerland near Geneva

We are heavily involved with one of the two major U.S. responsibilities, the endcap muon system, specifically with simulation software and electronics development. Professor Ko is the overall muon software coordinator for CMS. In addition, a unique specialty of UC Davis is in the development of pixel technology for the CMS tracking system involving Professors Pellett, Mani and Lander. Professors Ko and Pellett both serve on the ten-person U.S. CMS management board as software and tracking coordinators, respectively.

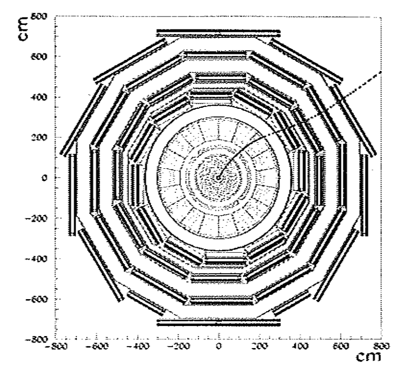
With the importance of the LHC for the future of high energy physics and UC Davis' strong leadership role in one of the only two experiments there, our students, as physicists of the future, will have good access to the frontier of experimental particle physics as well as to the frontier of technology.

Higgs, top and SUSY

The physics program of CMS includes the study of electroweak symmetry breaking, investigating the top quark, searching for new heavy gauge bosons, probing quark and lepton substructure, and looking for supersymmetry and other new phenomena. Typically a model of electroweak symmetry breaking includes a scalar field whose interactions give mass to the W and Z bosons, as well as to the charged fermions. The dynamic component of this scalar field, the Higgs boson, is expected to decay in WW and ZZ pairs if its mass exceeds 180 GeV. Other theories predict new particle states that decay into ZZ, WW, WZ or gZ pairs. Thus, the study of boson pairs is important for the understanding of electroweak symmetry breaking. CMS provides efficient detection of their decay muons and electrons over a large solid angle.

Millions of events containing top quarks will be produced in every year of LHC operation. We will be able to make precision measurements of t-quark properties that will shed light on the Standard Model and the fermion mass spectrum. CMS will identify top quarks by searching for one or two isolated leptons from semileptonic t-quark decays. To reduce backgrounds from W-multijet production, the CMS tracking system, especially the pixel detector, will be used to identify the b-quark jets (jets with a secondary vertex) in the t-quark events.

New forces may appear at LHC energies in the form of massive gauge bosons similar to the W and Z. The signature of heavy charged bosons are events with high-p_t, isolated leptons and large total missing E_t. If quarks consist of other particles bound by some new force, this would manifest as scattering of quarks at high energy different from the predictions of QCD: an excess of hadronic jet events at high transverse momenta.



A cross section view of the CMS detector illustrating a 5 GeV muon track bending in the 4 Tesla magnetic field

Supersymmetry (SUSY) proposes a relationship between fermions and bosons that forecasts a host of new particles. For example, the gluino, the supersymmetric partner of the gluon, could decay to at least one stable neutral particle, which is not observed. Gluino events would therefore be characterized by a large imbalance in the total transverse momentum observed in CMS.

Muon detection and Software

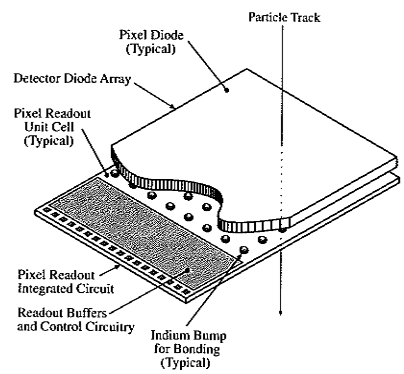
To explore the TeV mass scale, the LHC is designed to operate at a luminosity of 10^{34} $cm^{-2} s^{-1}$, two orders of magnitude higher than any previous hadron collider. This presents a challenge not only to the machine builders, but also to the designers of the CMS experiment who must contend with vast numbers of background particles in the detectors. Since they are highly penetrating, muons will provide the cleanest signatures for a wide range of the sought-after new physics process, some of which are expected to be quite rare. Electrons and most secondary hadrons will be absorbed in the calorimeters and flux-return iron before reaching the muon detectors.

Detection of muons is thus of central importance in the CMS experiment. The muon system needs to fulfill three basic tasks: muon identification, trigger, and momentum measurement. Good momentum resolution and trigger capability are facilitated by the high field solenoid magnet and its flux-return iron. The latter also serves as the absorber for muon identification. The muon detector is designed to have the capability of reconstructing the momentum and charge of muons over the entire kinematics range of the LHC. The system is extraordinarily robust with the muon momentum measured three times independently:

- sagitta measurement in the inner tracker;

- bending angle measurement right after the coil;

- sagitta measurement in the return yoke.



Hybrid pixel detector

The UC Davis group made major contributions to the muon system performance study for the CMS Technical Proposal, the document submitted to the CERN Council on which it based its eventual approval of the experiment. We have also contributed substantial development of a software system that will allow the vast amount of simulation and reconstruction code required for all subsystems of the experiment to be developed harmoniously. Muon and inner tracking reconstruction algorithms for CMS are complicated by the extremely high multiplicity and by the presence of muon radiation and other backgrounds. We are working on an ambitious global reconstruction program based on the Kalman filter, a technique that will greatly reduce the amount of computing time required to re-create a particle track.

Our work in software and simulation takes advantage of the massive amount of state-of-the-art computing power the high energy group has assembled. Our students have access to these workstations and gain valuable experience working with the huge and intricate software packages used for physics and detector simulation.

Homemade chips: Switched Capacitor Array ASIC Development

The endcap muon system of CMS consists of four stations of cathode strip chambers (CSC), each separated by part of the iron flux return yoke. A CSC is basically a drift chamber with one of the cathode planes replaced by conducting strips that provide a precise position measurement in the bending plane of the magnet by charge interpolation. There are six layers of CSCs per muon station. The large number of channels (more than a half million cathode and anode channels) requires that data reduction electronics be mounted directly on the detectors. The trigger decision whether or not to record data collected at the detector will be available to the detector-mounted electronics after about 3.2 ms following a pp collision (which occur every 25 ns). During this time, the signals must be held in temporary storage before being transferred to the data acquisition system or thrown away.

Analog storage of the cathode signal is required because the charges on the cathode strips must be accurately recorded for later cluster reconstruction. For this temporary waveform storage, the switched capacitor array (SCA) was chosen as a low-cost, low-power, and high density solution. The SCA samples a waveform at 20 MHz and stores each sampling in one of an array of 96 capacitor cells per channel. It is read out based on the result of the trigger decision. For the precise cathode signal to be reconstructed to better than 1 percent accuracy as required for track fitting, the SCA must be designed to meet challenging specifications.

The SCA is being developed as an Application Specific Integrated Circuit (ASIC) at UC Davis. With the help of the physics department's senior electronic engineer, Britt Holbrook, we have designed and prototyped the 16-channel chip at low cost using public-domain MAGIC software and the university consortium MOSIS service for fabrication. Design work is performed on a dedicated workstation optimized for ASIC development. Physics students, as well as student assistants from the electrical engineering department, have been involved; in fact, the physics Ph.D. student who first worked with us on our ASIC design, Feng Cheng Lin, became a senior design engineer for Philips Semiconductors in Silicon Valley within a year of his graduation from UC Davis. The prototype chips are tested by physics undergraduate assistants using a computer-controlled Tektronix Data Analysis System. Test results so far have been encouraging as we narrow down on the performance specifications for linearity and cell-to-cell pedestal variation.

Tracking particles with microchips: The Pixel Vertex Detector

UC Davis is leading the U.S. program to build a pixel vertex detector for CMS.

The CMS central tracking system will play a major role in all physics searches. The system includes a pixel vertex detector consisting of two barrel layers plus three pixel disks at each end. The U.S. has taken responsibility for the disks. Pixels are crucial for finding tracks from decays of short-lived particles, such as those containing B quarks. Such events are interesting for what they might reveal about B physics, as well as being part of the expected signature for new particles.

The figure shows the two parts of a hybrid pixel detector: a thin array of reverse-biased silicon pixel diodes and a readout chip with the associated electronics. Each pixel diode is connected to a separate input on the readout chip by a pair of indium bumps. The pixels are 125 mm on a side and 150 m thick. They will be read out by a chip with 4096 inputs arranged in 64 rows and 64 columns. Several readout chips can be butted against one another to read out larger diode arrays, forming detector "tiles." Overlapping tiles are used to make the disks.

When a charged particle passes through a pixel, electron-hole pairs are generated, generating an electronic signal. The pixel readout unit cell contains a charge amplifier, discriminator, and control circuitry so that the amplitude and LHC beam bunch crossing time will be stored for pulses above a predetermined threshold. The readout chip will send out data when it receives a trigger signal from the rest of the experiment with the crossing time of a stored event. Data from events with no trigger are cleared.

Pixel detectors allow measurements close to the LHC beam; other types of detectors would be rendered useless by the high track density and resulting radiation damage.

Besides the overall coordination of the project, members of the UC Davis group are working on the design and testing of the readout chip, studying chip hybridization and participation in the computer simulation of the detector array. Laboratories in the Physics Building have been equipped for integrated circuit design and testing, for detector bonding (a unique facility among university groups), and for detector testing using an infrared laser. Radiation damage studies are carried out in a test beam at the UC Davis cyclotron in the Crocker Nuclear Lab.

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Faculty Highlights...

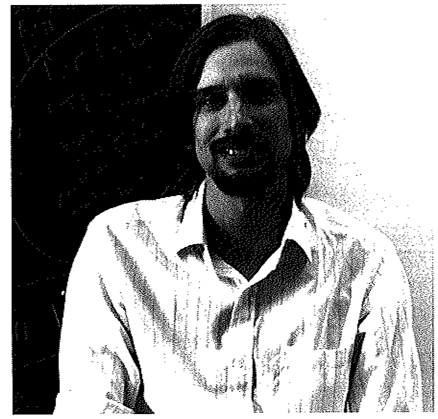
Daniel Cebra
Assistant Professor
Ph.D., Michigan State University, East Lansing, 1990
Experimental nuclear physics

The study of relativistic heavy-ion collisions is the newest and fastest growing sub-field of nuclear physics. By using the powerful accelerators of high energy physics to bring beams of BIG nuclei (up to masses of about 200 amu) up to almost the speed of light, we are able to create reactions with target nuclei that are so violent that nothing comparable has existed in the universe since the big bang. In essence we are deliberately creating 'small bangs' in the laboratory.

In the course of a high energy collision between two large nuclei, the matter in the region of the impact experiences extremes in pressure and temperature. Normally, a nucleus can be understood as a 'cold liquid drop' of nuclear matter. But during the course of an interaction with another nucleus, one can observe the effects of heating and compression. This allows us to study the 'equation of state' of nuclear matter. As we raise the energy of the projectile, the first interesting effect is that nuclear matter exhibits a 'phase transition' from a cold-liquid state to a hot-gaseous state. In experiments at the Bevalac accelerator at Berkeley, our group has been studying the nature of this phase transition.

At the Brookhaven Alternating Gradient Synchrotron the collisions between nucleons become sufficiently violent to shatter nucleons (neutrons and protons) into their constituent quarks and to create quark-antiquark pairs from the vacuum. At these energies, we are studying the effect that the hot dense nuclear matter has on the production of strange and exotic particles and learning about the nature of the hadronic gas.

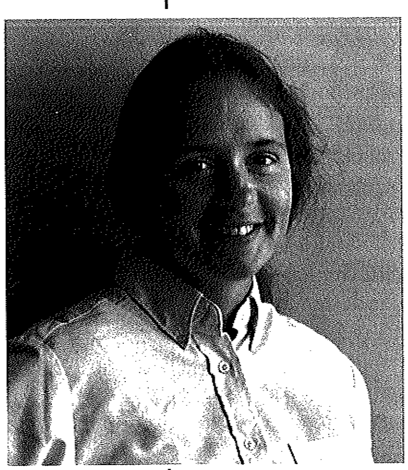
As one continues to raise the energy of the projectile, the pressures and temperatures become high enough to 'melt' nucleons and to enter yet another 'phase' of nuclear matter, the quark-gluon plasma, a phase of matter that has not existed since the big bang. At experiments at the Super Proton Synchrotron at CERN, we are searching for evidence of ignition of such a plasma. This has not been conclusively demonstrated in the experiments which have been completed with oxygen or sulfur beams, but we are hopeful that the new experiments at CERN using lead beams will finally combine sufficient quantities of nuclear matter with sufficient energy density to enter this new state of matter. The lead beams program will be producing its first results in late 1994.



The final experiment in our series takes us back to the Brookhaven Laboratory where they are constructing the Relativistic Heavy Ion Collider which will collide two gold beams, each with 100 GeV/n; this is equivalent to a fixed target experiment at 400 GeV/n. This machine will be ready for operation in early 1999, and with it we expect to produce quark-gluon plasma in sufficient quantities to study its characteristics. ❖

Rena Zieve
Assistant Professor
Ph.D., University of California, Berkeley, 1992
Experimental condensed matter physics; low temperature physics

As a manifestation of quantum mechanics on a macroscopic scale, superconductivity is a fascinating and often counterintuitive phenomenon. Forty years after the Bardeen-Cooper-Schrieffer (BCS) theory explained the basis of superconductivity, many open questions remain. Several recently discovered classes of superconductors, such as high-T_c oxides, heavy fermion compounds, and organic superconductors, are poorly described by the standard theory. In addition, some of the more complicated behavior of BCS superconductors has never been adequately explained. As experiments achieve lower temperatures, cleaner samples, and new geometries, they highlight the gaps in understanding.



One problem I am particularly interested in is the behavior of superconductors in a magnetic field. A field penetrates a superconductor only in the form of quantized packets of flux, known as vortices. The behavior of these vortices depends on vortex-vortex interactions, randomness, crystal impurities and grain size, temperature, and dimensionality. Vortex motion is of practical as well as academic interest, since it governs the maximum current a superconducting magnet can carry with zero resistance, and the amount of dissipation at higher current. I plan to use nanofabrication techniques to make simplified systems in which the many influences on vortices can be disentangled.

I am also working on heavy fermion superconductors. These display unprecedented behavior including magnetism coexisting with superconductivity, phase transitions within the superconducting regime, and superconducting electrons with extremely large effective mass. My goals are to determine the nature of the phase transitions, to identify the superconducting order parameter(s), and to explore any new vortex structures which could result from non-s-wave order parameters.

My work involves specific heat, transport, magnetization, susceptibility, and magnetic resonance measurements. Cryogenic temperatures are reached with a ^{3}He refrigerator or a dilution refrigerator. Certain projects also require photolithography, thermal evaporation, and other fabrication techniques. ❖

Spring Picnic

by Tao Han, assistant professor

Once again, a warm Davis afternoon welcomed the annual physics department Spring Picnic held this year at the Recreation Pool Lodge. This picnic is traditionally held to recognize outstanding undergraduate students majoring in physics. The event, held on Monday, June 3, was attended by a considerable number of department members. Approximately 80 faculty, students, postdocs, staff, and their families turned out to join the festivities.

Dinner began with the department Social Committee providing soft drinks, a variety of chips and salsa, and a hot bed of charcoal for the grill. Participants exchanged various salads and desserts with each other and grilled their favorite barbecue items.

After the dinner was well under way, Dr. Barry Klein announced the recipients of this year's undergraduate awards. Winners of the Departmental Citation, which recognizes academic excellence, included: **Julian N. Basler, David L. Griffith, Chad Leidy, Al Loui,** and **Sarah E. Zedler**. This year's Saxon-Patten Prize in Physics, was awarded to **Julian N. Basler**. This award recognizes both an excellent academic record and promise in continued work with physics and/or the related physical sciences.

Throughout the evening, people took advantage of the relaxed atmosphere by brushing up their volleyball skills, playing various other games, or simply spending time talking with each other. Everyone had a great time. The Spring Picnic is a nice department tradition and a pleasant way to end the academic year. ❖

We'd Like to Hear About You!

Please return this form with news about yourself to be included in future newsletters. We are very interested in how you are doing and where your career has taken you. Please mail your information to: University of California, Davis, Physics Department, Davis, CA, 95616, Attention: Joey Simoes. You may also e-mail your information to: simoes@physics.ucdavis.edu . We would especially like to receive alumni e-mail addresses, so please be sure to include yours!

Name: ______________________________

UC Degree: ______________________________

Class of: ______________________________

Current Employment

Title: ______________________________

Company/School: ______________________________

Address: ______________________________

Other News

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Co-President — Ian Johnson

Secretary — Hollie Cooper

Treasurer — Chad Hyatt

Sergeant-at-Arms - Steve Hershman

Social Director — Dave Stark

From the Chair

(Continued from page 1)

have them see the "big picture" at an early stage and remove some of the frustration and uncertainty that may be inhibiting students from pursuing careers in science. Of course, we will also try to enhance our students' abilities to compete in the work force and/or make better choices for graduate and postgraduate studies. We've already instituted a "Career Skills" graduate course this year, taught by Professor Steven Carlip and myself.

I've touched on a few of the relevant curriculum issues we are grappling with. It would be very helpful if our alumni and other friends would contact me with their views on how our curriculum served them and, using their life experiences, letting me know what changes they would suggest. I will pass your comments on to the rest of the faculty.

It would be great to have a dialogue with you on these issues. Please get in touch with me.

I hope you all had a great summer. This fall I will begin planning another alumni activity for the spring of 1997.

Sincerely,

Barry M. Klein

klein@bethe.ucdavis.edu

UCDAVIS
Physics Newsletter

is a publication of the UC Davis Department of Physics. It is published twice a year to provide information about the teaching, research, and service activities of the department. For subscription information contact: Joey Simoes, Physics Department, University of California, Davis, CA 95616; telephone: (916) 752-1500; fax: (916) 752-4717; email: simoes@physics.ucdavis.edu

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