UC DAVIS Physics Newsletter

Number 8 | *A Newsletter for University of California, Davis, Physics Alumni* | *1999*

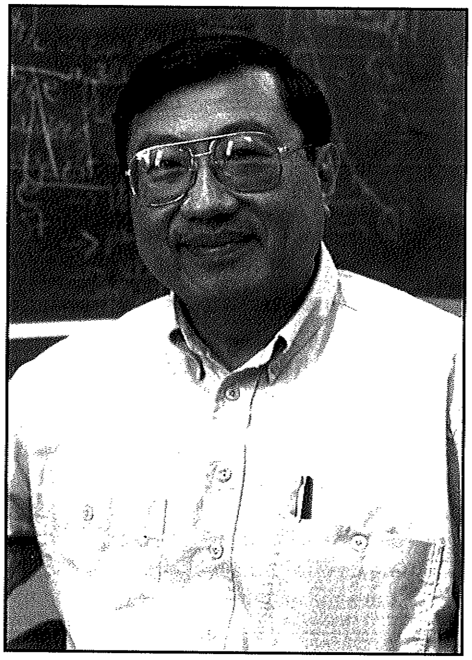
Inside This Issue

From the Chair

The year 1999 started with the unanimous adoption of the "Academic Plan for Physics" by our faculty. It is our collective vision of what the department will be like from now until the year 2005. We have examined the exciting developments in each subdiscipline of physics, as well as opportunities associated with campuswide strategic planning initiatives. The anticipated increase in student enrollment due to our developing cosmology/astrophysics and computational physics programs and the induced workload from growth in other areas of the campus allow us to plan for a physics department with 42 full-time equivalent faculty by 2005. A profile is shown in the "Academic Plan for Physics: Table of FTE Profile" on page 7.

The year also started with the successful recruitment of Professor James Wells, a particle physics theorist from The European Laboratories for Particle Physics (CERN). Dr. Wells' specialty is phenomenology, an area of strength in our department. With him on board, our department can rival any physics department in the world in particle phenomenology.

This year has been a special year for physics–it is the American Physical Society Centennial. This occasion was marked by a special celebration in Atlanta, Georgia, to honor a century of remarkable advances in physics and their impact on the world in which we live. Forty individuals from our department were among the 11,000 (imagine!) physicists attending this event. Professor Warren Pickett was a speaker at the centennial symposium with the topic "Electronic Structure at the Turn of the Century" (an excerpt of his presentation is on page 2). More than 30 alumni and friends attended our grand reunion. All participants in the centennial celebration were energized by the reflection of the past and the outlook for the future. There is no question that the 20th century is the century of physics. Judging from the depth and breadth of the latest developments in physics presented at the meeting, I, for one, would not concede the next century to



Winston Ko

other fields of study. The fundamental developments in all fields of pure and applied sciences will continue to depend upon and benefit from the advances in physics.

Participation of women in physics is disproportionately low for the U.S., at about 15 percent of undergraduate students and 11 percent of Ph.D. students. We are, therefore, quite proud that all three recipients of the Saxon-Patten awards in our department this year are women (see page 6). Professor Ling-Lie Chau, an APS Fellow since 1984, has also been cited in the APS Centennial list of "20th century women who have made original and important contributions to physics." Professor Shirley Chiang is also an APS Fellow (since 1994), and Professor Rena Zieve (our youngest faculty member) received the prestigious NSF Career award last year. In the APS Centennial meeting, a press release was distributed showing that our Physics 7 course significantly helped women students to learn physics, bringing their MCAT performance in par with male students (see page 8). Last year we doubled our number of women graduate students from 5 to 10 (out of 73 total graduate students). This issue of the newsletter profiles five of our recent women graduates (see page 3). This department has a total and continuing commitment to the education and status of women in physics!

Sincerely,

Winston Ko
ko@physics.ucdavis.edu

Designer Materials

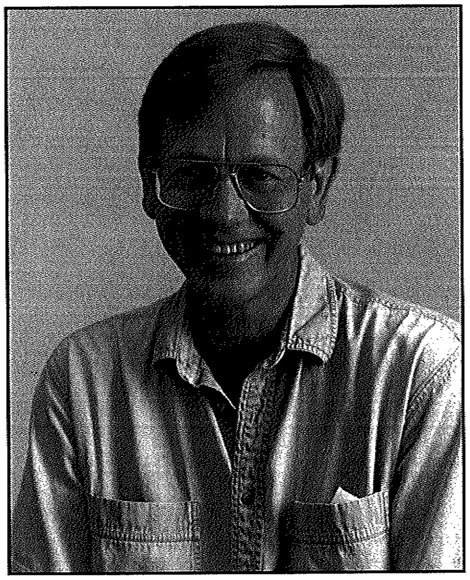
by Warren Pickett, professor

Designer jeans is an old, but not yet tired, concept. Designer nose rings and designer cologne are probably the current rave. So designer materials no doubt will bring to mind Tommy Hilfiger spinel ferrites and Versace hybrid ruthenocuprate perovskites, right?

Wrong. "Designer materials" may be a slight misnomer, with a more accurate term being "materials by design." The point is that computational implementation of our quantum mechanical theory of the behavior of electrons in solids is so advanced that we are justified in designing materials by computation. Although very demanding of resources, computing properties of materials can often be much quicker than making samples in the lab. The lab approach, which requires some trial and error and then putting samples through the various methods of characterization, is still being riddled by doubts about impurity content or stoichiometry. The computational approach is not perfect, of course. But the calculations are often very, very good; we know exactly what (perhaps idealized) system we are working on, and we can delve into the intermediate results to learn the microscopic origin of the behavior. Quite apart from being a research tool, these calculations are being used on a large scale by dozens, perhaps hundreds, of companies to speed up their materials development and reduce costs.

So, if it is a bit of a misnomer, why "designer materials?" The American Physical Society has formed a Centennial Speakers Program in celebration of the 100th anniversary of the APS, in which chosen speakers volunteer to give colloquia at universities and colleges on topics within their expertise. I was asked to be in the program. The suggested title was "Designer Materials," which I accepted. The topic loses a bit of scientific precision at the gain of a catchy title; a small price to pay, we hope.

My presentation is geared more to the research side, whereas much of the "materials by design" emphasis is specifically directed toward applications. I introduce the theoretical basis, density functional theory, in a gentle way, mainly pointing out that it redirects the focus from the wave function, which has unmanageable complexity in a real material, to the electron density only, which is a remarkably simple quantity in comparison. The theory was formulated by Walter Kohn (1998 Nobel laureate) and collaborators in the 1960's and has been developed, implemented and extended by scores of physicists since that time.



Warren Pickett

I focus on three examples (perhaps skimping on one of them due to time constraints–the main rule is that we are to try not to put the audience to sleep) where density functional theory has led to useful or novel properties. The first is a negative electron affinity material. The affinity of a solid is the binding energy with which an extra electron is bound to an otherwise neutral solid; this is virtually always positive. In fact, if the electron affinity is negative, an extra electron will simply pop out of the surface. This ability to form electron beams with low energy cost is what could make such a material useful for example, for large flat panel displays. In certain doped semiconductors covered by gunk, one can obtain materials with an effective negative affinity, but not with a true negative affinity. I reasoned that using "extreme" components might lead to an extreme result. Choosing diamond (due to its wide bandgap rather than its extreme hardness) with its surface covered with oxygen (known to be stable surface), I decided to cover that surface (computationally) with cesium. Cesium is the largest alkali atom with the smallest affinity, so when it donates its loosely bound electron to the surface a large dipole (voltage shift) occurs. The calculations indicated a -0.85 eV affinity, a healthy negative value. This negative electron affinity seems to have been verified by laboratories on both the east and west coasts, although quantitative verification and close comparison with my predictions have been slowed by the filing of patent applications.

My second topic is thermoelectric materials, unusual solids that convert heat to electricity, or vice versa, with reasonable efficiency. To work well in applications it is necessary not only that their electrons convert heat to voltage (and vice versa), but also that the materials have very low thermal conductivity, so the heat stays where it is put rather than leaking back. The best thermoelectric materials are certain members of a class of compounds with the skutterudite structure. This structure is a cubic network of bonded atoms containing holes large enough to accept additional atoms, and the theoretical conjecture is that filling these holes with "rattling" atoms would increase scattering of the atomic vibrations that carry heat, thereby reducing the thermal conductivity and increase the efficiency. This effect has been studied with density functional methods and verified in the lab, at least to some extent.

The third topic, one that I am still intensely involved in, is a peculiar type of magnetic compound whose electrons with spin up (for instance) are metallic, while those with spin down are insulating. This is strange enough. In addition, however, theoretical work indicates that with an appropriate pairing interaction between electrons, this "half-metallic antiferromagnet" would become a superconductor. Not only would this be a superconducting magnet, which is stranger still, but due to the time reversal symmetry that is already destroyed before superconductivity sets in, the superconducting state ("single spin superconductivity") would be very weird–it would have a preferred axis even if the crystal is cubic. The problem here is that no such materials are yet known. Our calculations have suggested two possibilities, but until these compounds are grown, half-metallic antiferromagnetism and single spin superconductivity will remain predictions of the theory.

A large number of other choices could have been made to illustrate the designer materials concept. Each of the examples I have chosen relates to applications, but each has a novel aspect to it, and each has a certain level of complexity that enables the complex behavior; simple (e.g., elemental) materials could never show these phenomena, and simple theories could never provide realistic descriptions or predictions. Unanticipated properties will continue to be discovered, both by innovative computational theory and by the conventional experimental route. ❖

Where Are They Now?

by Richard Scalettar, professor

One of the primary functions of this newsletter is to help build a sense of community among alumni of the UC Davis physics department. This is important, since one of the characteristics of the few years after receiving a degree in physics is the wide geographic dispersal that takes place upon graduation! In this issue, we will update you on the careers of five women who received their Ph.D. degrees in the last decade.

Jessica Kintner (thesis adviser: Dan Cebra)

Immediately after graduation, I took a visiting assistant professor position at Lawrence University in Wisconsin. I grew up in the midwest and knew that Lawrence was a liberal arts college with a strong reputation in the sciences. I stayed for one year (I couldn't take the cold; it was 50 degrees below zero for one solid week while I was there!) and then returned to the San Francisco Bay area to a tenure-track position at Saint Mary's College of California (SMC).

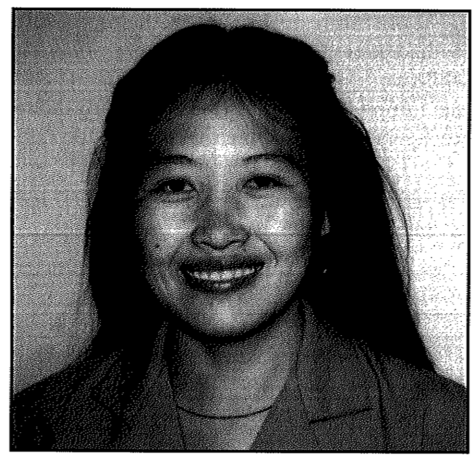
SMC is a four-year, co-educational, Catholic liberal arts college in Moraga (a sleepy little town about 20 miles east of San Francisco). This is my third year at Saint Mary's, and things are going very smoothly. My primary responsibility during the semester is teaching. This semester I am teaching the introductory sequence for physics majors, which has about 30 students per year. Since I've been here I've also taught Electronics, Electricity and Magnetism, and both Introduction to Physics sequences.

The physics department here consists of four faculty members, and two of us are Davis grads! (Chris Ray is the other.) It's kind of nice to play a major role in the department even as junior faculty members.

During the summer and winter months I am able to continue some research. I still have close ties to the nuclear group at UC Davis and Lawrence Berkeley National Lab. Last year I received an NSF grant which allows students to work with me. So far, two undergraduates at SMC have learned first-hand what research in heavy-ion physics is all about.

This summer SMC is starting construction on a brand new science center. I'm looking forward to all the new office and lab space we'll have in a couple of years!

Nancy Jia (thesis adviser: Robert Shelton)

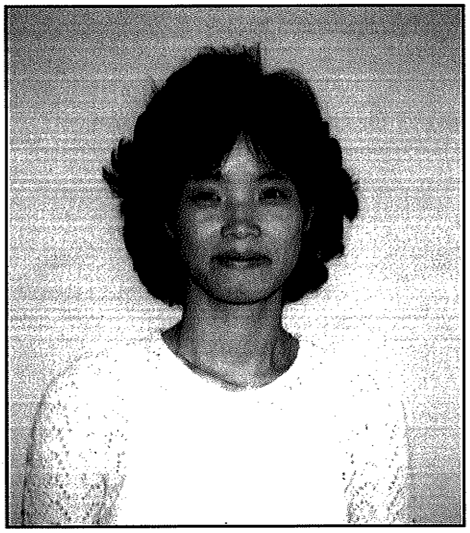


I am Nancy Jia and was a graduate student at the UC Davis physics department between 1989-1992. I am now a research scientist at the Wilson Center for Research and Technology, Xerox Corp. Some of the physics students might be wondering, how do physicists in industry feel? If we had an opportunity to re-select majors, would we choose something different? I would like to share some of my limited experience with everyone.

At Xerox R&D Centers, physicists are well respected. Physics is the major driver for future product concepts. Materials, chemistry and electrical designs and controls, etc., have to work around it. When I was looking for a job after the postdoctoral program, I had to over-emphasize my material/chemistry backgrounds regardless of whether the potential job was in academia or industry. Here at Xerox, you want everyone to know that you are a physicist. In fact, even in the material/chemistry division, many of the leading scientists/technologists have their advanced degrees in physics. I consistently hear complaints from our materials colleagues that Xerox was traditionally led by physicists, and it is not fair that it is still led by physicists. Fair or not, it is certainly much easier for someone with a physics background to walk into any other field than vice-versa. I did not plan to have a career in industry, but I am pleasantly surprised at how much I am enjoying the experience.

There is the stereotype in academia that the less successful students should go to industry. I have to say that this idea is incorrect. The work can be fascinating and challenging, and you are well paid to do what you enjoy doing. Being the inventor, you have the opportunity to witness your work making a difference in people's lives. Female researchers, being in the minority, bring new opportunities and challenges to the work. Women must be self-confident in order to survive. It takes more time for a female to earn the respect and trust of her coworkers than a male who is as competent. Xerox is one of the companies trying very hard to hire women and minorities, not because they have to, but because diversity is needed for the growth of the company.

It always brings back pleasant memories whenever I think or talk about the UC Davis physics department. I remember fondly the professors and friends, the hard work in the first year and the pleasant times in Professor Shelton's lab. My adviser, Robert Shelton, continues to have a tremendous influence in my life. If there is any regret at all in my graduate education, I wish I had spent more time learning about electronics, chemistry and computer programming. A broad background is always advantageous.



Insook Lee (thesis adviser: Ching Fong)

Insook graduated with her degree in late 1990 and then took a position as research associate at Oregon State University in the Department of Electrical and Computer Engineering, where she studied the influence of optical lattice vibrations in alloy semiconductor quantum well systems on electron transport in two-dimensional systems.

In 1995, Insook became a research scientist at the L.G. Electronics Research Center and is now a senior research scientist with the Thin Film Application Team at the L.G. Institute of Technology in Seoul, Korea. She works on deep-submicron MOSFET device physics and modeling and on the physics and modeling ofplasma display panel cells.

Brenda Weiss (thesis adviser: Chuck Fadley)

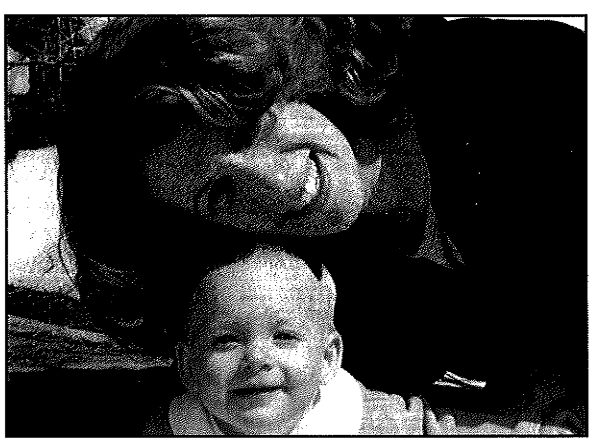
While finishing my dissertation, I thought carefully about what I would like to be doing 10 years from now. I enjoy teaching college students; however, my experience with them has underscored the need for better science education pre-college. Unsure of where it would lead, I chose to forego the usual experimental post-doc in favor of a do-it-yourself course designed to uncover possibilities in science education.

After looking around, I realized that some of the most interesting progress in physics education is taking place right here at UC Davis and that Wendell Potter would let me on the playing field. About the same time, I decided that I could gain insights into how kids learn science by having a child of my own sooner rather than later. What an education! Adrienne has just turned a year old and loves investigating things, particularly lab apparatus in the Physics 7 Discussion/Labs to which she accompanies me. Students in D/L laugh at Adrienne's antics and comment on her growth. They are also surprised and pleased to learn that a Ph.D. in physics has a background in inorganic biochemistry as well as math and physics.

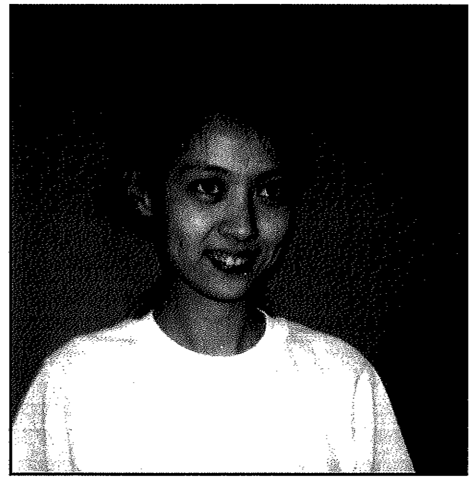
In my graduate work I worked with the Cramer Group in Berkeley to explore areas where physics, chemistry and biology overlap in the complex systems of life. Now I blur the line between work and family in an effort to enrich both. This school year, in addition to teaching part-time at UC Davis, I have worked at home on experiment revisions for PASCO Scientific, a Roseville company whose byline is "Better Ways to Teach Science."

My future goals include cataloging, recording and, where necessary, developing a pedagogy for physics. Before coming to UC Davis, I studied piano for 16 years; 11 years with a Ph.D. in piano pedagogy. In college I took her class in pedagogy and taught private piano lessons while working as a TA in an undergraduate physics lab. If it is possible to make piano fun and rewarding for children, as my instructor did for me, I think it should be feasible to turn their innate curiosity into a tool for understanding the physical world before they become bored teenagers and determine that math is too difficult to make learning physics worth the trouble.

I've found it easier to make a living with physics than with music, but I think that musicians are far ahead of us in developing a legitimate pedagogy. If we want a science-conscious public, we need to pay more attention to how and what they learn. Off my soap-box and back to the recital ... oops... lecture hall.



Rose Zhang (thesis adviser: Robert Shelton)



Five years ago, I accepted a tenure-track position at California State University, Stanislaus. I wanted a teaching job because of the three-month summer vacation. Shortly after I started to work, I learned that besides teaching, I was also expected to do research and university services. I wondered if I would survive!

During the past five years, I have maintained a teaching load of 24 units/year, written research publications and attended numerous committee meetings. Teaching has been a great learning experience for me, research has become my summer hobby, and I have learned to speak in a brief and effective way at committee meetings.

Today, I still love my job, not only because I earned tenure in my fourth year but also because I truly love teaching. I always feel very happy and excited when I return to UC Davis to work in Dr. Shelton's lab, meet with my former teachers and share my experiences with current graduate students.

In five years I may try to get an early retirement. ❖

Physics Professor Elected Vice-Chair of Academic Senate

by Larry Coleman, professor

This past spring, I was elected by the systemwide Academic Senate Assembly to the position of vice chair. In this role, I am vice chair of both the University of California Academic Council and the Assembly and will rise to the position of chair in September 1999.

Within the university's system of shared governance, the responsibility for courses, curricula, admissions and graduation has been delegated by the regents to the Senate. The Senate is also charged with advising the administration (the president, chancellors, provosts and deans) on issues of the budget and the faculty merit and promotion system. The systemwide Senate functions through committees, and the Academic Council acts as the executive body. The Academic Council is made up of the chairs of each campus Senate (I served as Davis chair 1995-97) and the chairs of the university committees on admissions, planning and budget, academic personnel, educational policy, graduate affairs and faculty welfare. The Assembly is the representative legislative body of the Senate.

In addition to leading the Council and Assembly, the vice chair and chair serve as the faculty representatives to the Board of Regents and as the main point of contact between the Office of the President and the faculty.

The position has been an exciting one. It is a very interesting learning experience to see the operation of the university at the super-macro level. The big issues I have been working on are new undergraduate eligibility criteria, articulation of coursework for transfer students, planning for the new campus at Merced, copyright in the era of the Internet, the digital library, planning for future enrollments of undergraduate and graduate students, the effects of healthcare funding on medical education, oversight of the DOE laboratories, and, always, the university's budget.

The big downside is that I attend lots and lots of meetings, travel extensively (to nine campuses, three laboratories and the Office of the President in Oakland) and must spend considerable time at the Academic Council office in Oakland. As a result I am averaging only two days a week in Davis. I am told that when I become chair the schedule will be even more hectic. So if you visit the department in the next year and don't see me, never fear; I will be back as just Professor Coleman in September 2000. ❖

Ph.D. Degrees Awarded

Fall 1998

David Alves
"The Nine Million Star Color-Magnitude Diagram of the Large Magellanic Cloud"
Postdoctoral Research Fellow at Space Telescope Science Institute, Baltimore, MD

Winter 1999

Efrain Lopez

"Magnetization of Superconducting PbBi Thin Films Patterned with Magnetic Arrays"
Applications department manager with Luxtron Corporation, Santa Clara, CA

Bachelor's Degrees Awarded

December 1998

William E. Mickelson .... BAS
Saxon-Patten Award
Department Citation
Brett A. Sackett .... BS

March 1999

Robert O. Messiah .... AB
Selina Z. Li .... BS

June 1999

Shasha S. Baroiant .... BS
Christopher M. Clark .... BS
Department Citation
David L. Corman. .... AB
Christopher DeStefano .... BS
Alan Farrell .... BS
Alfonso Garcia .... BS
Miguel Garcia .... BS
(Degree in Applied Physics)
Jess D. Lawton .... BS
(Degree in Applied Physics)
Lai Lain Lee.. BS
(Degree in Applied Physics)
Janelle M. Leger .... BS
Department Citation
Saxon-Patten Award
Christopher A. Lehman .... AB
Joseph F. Rakow .... BS
Department Citation
Tynisha N. Shabazz .... BS
Andrew G. Tenn .... BS
Department Citation
Tiffany D. Wilkes .... BS
Department Citation
Saxon-Patten Award

❖

Three UC Davis Students Receive Top Awards for Undergraduate Physics Work

by David Beavers, news writer,
The California Aggie

In a lively ceremony in April, three students received the Saxon-Patten Award, the top honor presented annually to the top undergraduate physics majors at UC Davis.

Receiving the award this year were graduating seniors Kassandra Kisler, Janelle Leger and Tiffany Wilkes. The prestigious award, normally given to just one or two students, was presented this year to three female undergraduates – the maximum number of recipients the award allows – an impressive feat in a traditionally male-dominated field.

The award includes a certificate of recognition and a check for $900, an amount that varies from year to year. The winners' names are also added to a special plaque housed in the Physics/Geology building.

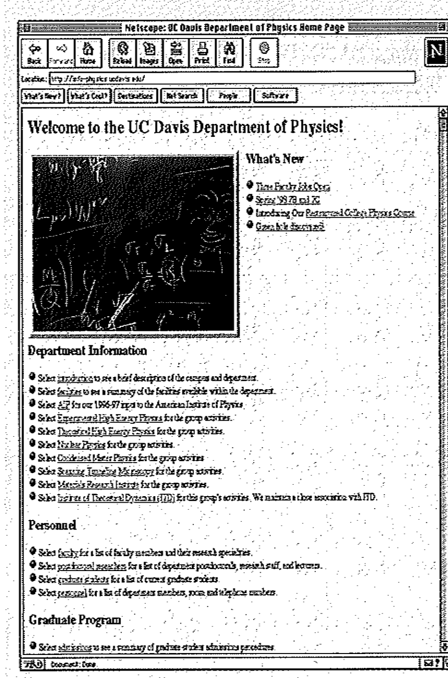
According to UC Davis physics department chairperson Winston Ko, the award is given based on academic standing, as well as the potential for future achievement in the field. Additional criteria include maintaining a 3.5 grade point average in physics and an overall GPA of 3.2.

"It was a lot of work, but it was also a lot of fun," said Kisler, summarizing her labors.

After the students received the awards, professors who had taught them attested to their prowess in the field, commenting both on their year-to-year improvement as well as their potential for future work in physics. According to Ko, all three students are going on to graduate school and will continue to work in the field.

The Saxon-Patten Award was created in 1985 with a contribution from former UC President David Saxon. Since then, the physics department has received an annual grant that is used to fund the award. ❖

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>***

ACADEMIC PLAN for PHYSICS

Table of FTE Profile
1999-2005

Sub-discipline	07/01/99	07/01/01	half-GFTE included		07/01/05	half-GFTE included	
			ECIS	NEAT		ECIS	NEAT
C M Theory	7.0	7.0			7.5		0.5
C M Experiment*	7.5	8.0		0.5	9.5		1.0
H E Theory	5.0	5.0			6.5	0.5	
H E Experiment	5.0	6.5	0.5		7.5	0.5	
Nuclear Physics	3.0	3.0			3.5	0.5	
Astro/Cosmology	3.0	5.5	0.5		5.5	0.5	
Opportunity					1.0		
Senior Lecturers	2.0	2.0			1.0		
TOTAL	**32.5**	**37.0**	**1.0**	**0.5**	**42.0**	**2.0**	**1.5**

*Note: Each half-GFTE** listed has an associated FTE committed to the Initiative by Physics.*
** In the departmental planning tradition, CM includes Atomic-Molecular-Optics physics.*
*** Growth Full Time Equivalent*

The planned FTE Profile shows a physics department composed of two pillars of strength, condensed matter physics (theory and experiment) and high energy physics (theory and experiment), as well as a nuclear physics program at critical mass emphasizing relativistic heavy ion collisions and an aggressive build-up of the cosmology program in the next two years. Two of the campus-wide initiatives, Nanophases in Environment, Agriculture and Technology (NEAT) and Engineering, Computational, and Information Sciences (ECIS, now called Computational Science and Engineering) fit our departmental programs and aspirations. We will leverage these initiatives for growth positions (GFTE). Overall, we have made careful strategic plans in order to maintain and build upon existing strengths, to foster new opportunities and, overall, to bring the department to the next level of excellence. ❖

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 take a few minutes to respond.

Name: ______________________ Class of: __________ Degree(s): ______________
Address: ____
E-mail address: ____

Current employment

Company/School: ______________________ Position Title: ______________________
Address: ____

Other news

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Items you'd like to see in future newsletters

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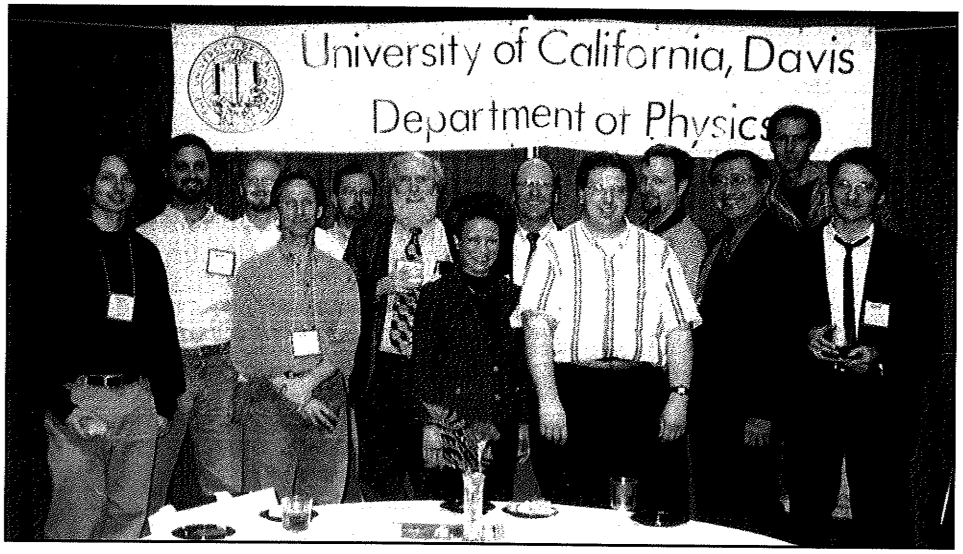
Please mail to: University of California, Davis, Physics Department, One Shields Avenue, Davis, CA 95616.



Some of the UC Davis American Physical Society Centennial Meeting attendees at the UC Davis reception - From left to right: Dave Rackowski, Ed Nabhigian, Philip Rogers, Matt Enjalran, Alessio Filipetti, Wendell Potter, Ling-Lie Chau, Carey Huscroft, Ronald Sobey, Tom Nielsen, Winston Ko, David Everitt, Ferenc Pazmandi.

UCDAVIS
PhysicsNewsletter

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 the Physics Department, University of California, Davis, CA 95616; telephone: (530) 752-4088; fax: (530) 752-4717

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

Women Excel in Redesigned Physics Course

In traditionally taught, large-enrollment introductory physics courses, it is common for women to be less successful than men. To counter this trend, professors Larry Coleman and Wendell Potter and instructor Charles De Leone redesigned the format of Physics 7, General Physics, which is taken by more than 1,200 biological science students each year. They then used the MCAT (the Medical College Admissions Test) to examine the outcomes of students completing the traditional course compared with students who took the redesigned course. They found that while men continued to perform well, the women students showed a 30 percent increase in the physical science portion of the test, bringing them to the same level as the men.

Coleman, Potter and De Leone attribute the women's improved performance to the active-learning format and teaching approach used in the redesigned course. They described their success at the American Physical Society's 1999 Centennial Meeting. ❖

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