The Physics Major

Sonoma State University Department of Physics and Astronomy

Cominsky Is SSU Outstanding Professor for 1992-93

Prof. Lynn Cominsky was selected by the SSU Outstanding Professor Award Committee as their nominee for the state-wide award. This year, for the first time, the SSU nominee was honored at a campus wide event which featured a public lecture and a lunch hosted by President Ruben Armiñana. Cominsky's lecture was entitled "Invisible Astronomy" and described her work with students building the Very Small Array radio interferometer as well as her recent observations with X-ray satellites. In addition to the $1000 award from the CSU, and a fancy dinner in Long Beach, she also received $1000 from the newly created SSU Wayne Rowlands Outstanding Professor Award Endowed Fund.

Next year, Cominsky will be on sabbatical for both fall and spring semesters, concentrating on her research. She will spending half of her time at Stanford's Linear Accelerator Center, where she has been consulting during this past year with Prof. Elliott Bloom's group of particle astrophysicists. During the other half of the time she will be at SSU, supervising the research efforts of interested students.

New Automated Telescope at SSU's Observatory

Holly Jessop

This past summer SSU had the wonderful fortune to receive an automated telescope, on loan from Epoch Instruments Inc. The system is a 10-inch f/5 Newtonian that is completely controlled by a personal computer which instructs motors to move the telescope to any desired object in the night sky. By using this telescope with SSU's CCD camera, students have been able to observe and acquire data on very faint stars and galaxies, even within the light polluted setting of SSU's suburban area. With an initial set-up time requiring only minutes, and the ability to move from object to object within several seconds, this new system has made work at the Observatory extremely efficient and rapid. Previously at SSU, data was acquired at the slow rate of only one or two targets per night, due to the fact that a great deal of time had to be invested in finding target fields and in setting up auxiliary systems to guide the telescope. With this new system, it is no longer necessary for students to spend a lot of valuable observing time performing tasks that have very little in common with modern astrophysical research. Instead, their time is more effectively concentrated on scientific discovery and the imaginative use of available contemporary technology.

The system arrived in June and was immediately put to use with SSU's CCD camera to observe the cataclysmic variable AM Herculis and the variable star CH Cygni. I also began using the system to monitor X-ray binary systems for optical outbursts. In September, I was thrilled to discover that with the better focal ratio of the new system, I could easily obtain time series photometry on the faint cataclysmic variable BY Cam right here at SSU. It had been nearly impossible to observe this star with the old C-14, and I had had to travel all the way to Arizona to use a much larger telescope to observe this system the previous year. For Dr. Spear's Advanced Observational Lab this Spring Semester, the system has been used by many students to acquire data on a wide range of interesting objects. Optical photometry is being acquired on two active galaxies to monitor them for variability, and photometry is being obtained

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Awards and Accomplishments

Amanda Tunison won an SSU Sigma Xi grant of $200 to buy a 200-Mbyte hard disk for the SSU Observatory in support of "Continuing Observations of Cataclysmic Variables at SSU". This disk will allow uninterrupted data collection to occur throughout the night.

At the Annual Sigma Xi meeting (held in San Francisco this year), three SSU students presented astronomy poster papers at a special Undergraduate Poster Session: ***Ben Owen, Holly Jessop*** and ***Greg Sprehn***. Holly's work was supported in part by a Grant-in-Aid from the national organization, and Greg was one of last year's winners of the SSU Sigma Xi Undergraduate Research Award. SSU's contributions to the Poster session represented 33% of the total papers that were presented!

Six physics majors were awarded SSU scholarships for 1992-93: ***Scott Fraser, Sean Fraser, Elizabeth "Libby" Hays, Ben Owen, Mallory Roberts,*** and ***Greg Sprehn***.

Greg Sprehn and ***Dr. Lynn Cominsky*** were awarded $4750 from the National Science Foundation - American Astronomical Society Research Experiences for Undergraduates Program to finance Greg's participation in the Motorization of the Very Small Array, Greg was also selected as the Levy Scholar by the national Society of Physics Students and awarded a $1000 scholarship.

Dr. Joe Tenn presented "Undergraduate Astronomy at Sonoma State University: Radio, Infrared, Optical, and X-ray" at the 104th meeting of the ASP in Madison, June 1992.

Steve Anderson, the Physics & Astronomy Dept. technician, has just had an article published in *LEONARDO, Journal of the International Society for the Arts, Sciences, and Technology*. The article is titled "My Early Holography Education" in the special issue, "The Archives of Holography". The article describes learning holography from some of the earliest practitioners and ways of introducing people to the art of holography. Steve has also just finished two video tapes promoting holography and laser art. Over the summer he will be working for Doug Martin on a series of video tapes of "pedagogical cases". On this year's Putnam Exam, ***Ben Owen*** was the top scorer at SSU, and in the top 25% nationwide with 14 points. ***Scott Fraser*** took second place at SSU, in the top 31% nationwide with 11 points and ***Sean Fraser*** also achieved a non-zero score. Out of a total of 120 possible points, the mode score was zero. This year's test was somewhat tougher than the usual.

Scott and Sean Fraser have been awarded summer research fellowships in Physics at both University of Missouri, and Pennsylvania State University. They intend to spend the summer at Penn State.

The 1991-92 ***SSU Society of Physics Students*** chapter was one of 30 chapters recognized as outstanding out of almost 600 US chapters.

At the 181st meeting of the American Astronomical Society in Phoenix, three research papers were presented with SSU authors: "The Cepheid Period-Luminosity Relationship at 12 microns" by ***Dr. Gordon Spear***, B. F. Madore and ***Ben Owen***, "An Automated Telescope: Affordable Astronomy for Undergraduate Institutions", K. Medlock, V. Chin, ***Holly Jessop*** and ***Dr. Gordon Spear***, "CCD Photometry of the Polar BY Cam", ***Holly Jessop***, V. Chin and ***Dr. Gordon Spear***. Vance Chin and Kevin Medlock are the developers of the Epoch Telescope system.

Dr. Lynn Cominsky was awarded $20,000 from the NASA ROSAT Guest Investigator program to acquire and analyze X-ray observations of a Binary Be-star/Radio Pulsar. She also received a $3102 grant from the SSU RSCAP fund to help purchase the Epoch Telescope System.

Dr. Sam Greene was awarded a sabbatical for Spring semester 1994.

THE PHYSICS MAJOR No. 18 May 1993

Published by:
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The Solid State of Hewlett Packard

Saeid Rahimi

The most important question that one faces when pondering about a sabbatical leave is basically "where should I go?". The single most significant feature of a sabbatical leave is that you can go anywhere and do anything within the boundaries of your field.

Like many of my older and wiser colleagues I decided to stay local. I was offered office space and access to the R&D facilities and resources at Hewlett Packard's Fountain Grove site in Santa Rosa. A few years ago I had become interested in the field of optoelectronics and participated in a workshop sponsored by the National Science Foundation at the University of New Mexico. The goal of the workshop was to initiate and encourage a nationally selected small group of university professors to become involved in this relatively new and exciting field. Based on that experience, my background in the field of semiconductors and subsequent studies, I became interested in the further study of semiconductor diode lasers. The HP division in Santa Rosa has a relatively new and dynamic lightwave technology section which appeared to be a suitable place for learning about making and testing these lasers.

The principle of making diode lasers is fairly simple. One has to form a small p-n junction made of a direct bandgap semiconducting material. Passing a current above a certain threshold through the diode will cause the diode to lase. By cleaving the ends of the diode two optically smooth surfaces are formed whose role is similar to the reflecting mirrors in a gas laser. In practice, however, to make the laser suitable for a particular purpose such as lightwave communication through fiber optics, one must have a particular wavelength to minimize the loss in a fiber optics and therefore the band gap of the material must be "adjusted" accordingly. The process of "band gap engineering" requires compound semiconductors of certain stoichiometric ratios. The lasers under study in this case included InGaAsP material.

The region in the diode laser responsible for the emission of light is called the active region. Very thin active regions are called quantum wells. In order to pass current through this region one must connect leads to them. In practice, this is a tedious problem since any type of contacts to semiconductors will produce an undesirable contact resistance which will increase the threshold current, causing more heat dissipation which contributes to a shorter laser life. In order to minimize this problem several layers of other compound semiconductors with varying doping concentrations are added to both sides of the active region. One way to visualize such a device is to think of it as a miniature club sandwich.

The layers directly on top of each other must have a satisfactory degree of lattice matching. Thus one is not totally free in the choice of these materials. Moreover, these layers must be "grown" on top of each other very carefully – a process that is quite time and energy intensive. Frequently Metal Organic Chemical Vapor Deposition (MOCVD) and Molecular Beam Epitaxy (MBE) methods are used.

The final product is hundreds of small lasers (about 0.03 mm^3) on a wafer. These lasers are then tested for Ohmic contact resistance, threshold current density, and emission spectrum. I was more actively involved in this area. One of my assignments was to perform contact resistance measurements on a series of these devices. The method used is called the Transmission Line Method (TLM), which involves deposition of the TLM patterns, basically a number of parallel metallic pads with different spacings, on the test lasers. Measurement of the resistance between several pairs of pads will result in the calculation of the contact resistance and a number of other useful contact parameters. At this time I am preparing to include some of the characterization experiments in the physics of semiconductor course to be offered in the fall and in the lasers and holography course scheduled to be offered in spring, 1994. I am also currently planning to start a research activity in this field.

Unlike the basic principle of diode laser structure, design and manufacturing of such lasers for optical communications is quite involved. This was a great opportunity to observe all this in an industrial environment with an equipment and support budget that usually dwarfs the budget allocated to a university research lab. Moreover, having been in academia for almost all my life, I enjoyed this unique occasion to be involved in an industrial laboratory. Considering their tight schedule, the HP people were friendly, nice and helpful. I became familiar with the process of laser fabrication, learned to use a number of sophisticated pieces of equipment, worked in a clean room environment, participated in meetings and teleconferences, and more importantly, made some good friends and contacts. In short, I had a lot of fun!

X-ray Diffraction Advances

John Dunning, Jr.

We received $4400 from the University for the purchase of complete updated x-ray powder diffraction files and a compact disc reader coupled to the x-ray computer. These files provide chemical and physical property information for 56,000 crystalline compounds as well as the x-ray powder diffraction patterns to be expected. After obtaining the diffraction pattern of an unknown with our machine, the pattern is matched to the file. The match can be restricted as to elements present, chemical composition, density, melting point, color, and other properties, if known. The accuracy of the newer patterns is very high (often better than 0.02 degrees). These high accuracy patterns are replacing the older file patterns. The result is more nearly unique identification of complex unknowns, and some first rate training for our physics majors in Physics 316.

Several of us in Biology, Chemistry, Geology, and Physics have applied for $100,000 in matching funds from the National Science Foundation for a Scanning Electron Microscope with Energy Dispersive X-ray (EDX) analysis of elemental composition. A dual analysis, restricting the elemental composition using the EDX, and then obtaining crystal structure information from the x-ray diffraction pattern, is capable of unambiguous determinations even for complex mixtures. Wish us good fortune in obtaining both the NSF funds and the local matching funds.

Record Number of Physics Graduates Forecast for Class of '93

Mallory Roberts

This year SSU will produce more physics graduates than ever before. There are 20 students planning to graduate in 1993, 19 of them in June. The department will award 12 Bachelor of Arts degrees and 8 Bachelor of Sciences. Of these, 10 are planning to enter graduate school, three are getting teaching credentials, and the rest are going directly into the work force. There is a nearly equal split between prospective engineering graduate students and prospective Physics and Astronomy grad students. Alon Katz is planning on attending the Mechanical Engineering program at Colorado State University at Ft. Collins, and Nicko Melville has been accepted to two U.C.s in the same field. Geoffrey Syphers is going to U Mass, Lowell to study Energy Engineering. Greg Sprehn, who has been working at Lawrence Livermore Labs for the last year, has been accepted to the U.C. Davis School of Engineering and Applied Science, also known as "Teller Tech", where he will continue building astronomical instruments to send into space. All of the above are earning B.S.-Applied degrees this year. The exception is Eric T. Mueller, who is going on to study Civil Engineering at the Univ. of New México, proving you can be an engineer with a B.A..

Among those planning to continue studying physics in graduate school, Ben Owen, SPS president, may have set an SSU record for number of prestigious schools turned down. Although accepted into Stanford, U.C. Berkeley, U.C. Santa Cruz, and M.I.T., he has decided to take his $40,000 NSF Fellowship and follow in the footsteps of his hero, Nobel Laureate Physicist Richard Feynman. Caltech is his school of choice for theoretical physics. There are three women graduating in Physics this year. Holly Jessop, the premier optical astronomer at SSU, will continue in her research at San Francisco State, along with Monika Ivancic who hopes to join her in the physics program there. Both of them are graduating with a B.S.. Libby Hays, B.A., has been accepted into four medical schools so far, and is still waiting to hear from more.

Alan Duquette is hoping to find work as an Optical Engineer working with lasers. Paul Somerville is applying for work at OCLI, and continuing to play saxophone at night, until he decides to go to graduate school in engineering in a couple of years. John Allen, who graduated in January, has already started substitute teaching. Michael Fink and Matthew Davis are both entering the SSU credential program, so they will still be around next year. Art Onwan is moving to Florida, where he plans to study interdisciplinary subjects at U.C.F. in a year or so. Jeffrey Strach, Suryadi Wijono, Matthew Gurish, and Robert Linstadt will also be graduating. The surprise graduate of the year is Mark Robinson who has decided to retire from student life to work on a semi-autobiographical romance novel.

GARY ZUPAN ('69) is a software engineer in Santa Rosa. He was formerly technical manager at Applied Computer Techniques in Crown Point, Indiana. He earned an M.Ed. at Anderson College in 1983.

STEPHEN D. JILKA ('71) is an area manager for Xerox's XSoft division in San Diego, where he develops document-related applications for UNIX systems. He earned master's degrees in physics at San Francisco State in 1972 and in systems management at the University of Southern California in 1979.

Experimental Astrophysics at Livermore

Greg Sprehn

Last summer, I accepted an offer of student employment at the Lawrence Livermore National Laboratory. I was assigned to a room in the Laboratory for Experimental Astrophysics that was chock full of broken vacuum pumps, pieces of X-ray sources, vacuum chambers and valves, and an assortment of everything people had discarded in what had become the "storage closet." My assignment was to make something of the pile and clean the place up.

What I did was get rid of most of the stuff, find all the pieces to a Manson X-Ray source that could produce a decent flux at the 8 KeV copper line, and put together an automatically controlled valved vacuum chamber X-Ray calibration facility. In the process, I learned how to buy stuff at the Lab (scrounge), how to work with the people there (lab rats), and how to stay out of trouble (wear your dosimeter).

I enjoyed working with a lot of bright, degreed people, especially the physicists. The Tuesday journal seminars are inspirational. So many lectures and presentations take place throughout the lab that I missed a lot of good stuff for lack of time.

I actually stayed beyond the summer program and have been working on astrophysical instrumentation development since then, working part-time during the school year. Of all the jobs I have held in my life, none has been this exciting.

SPS Keeps it Humming

Ben Owen

For a bunch of people who never seem to do much, SPS accomplished quite a lot this year. Under the direction of El Presidente Ben Owen, Vice President in absentia Greg Sprehn, and Secretary-Treasurer Mallory Roberts, the Very Small Array T-shirt design was finally implemented. SPS managed to sell enough shirts to actually make a profit, and used the ill-gotten gains to buy food and drinks for the Christmas party.

As usual, the SPS managed to sponsor two field trips. The fall 1992 trip, to the San Francisco Exploratorium, was relaxing and entertaining but quite poorly attended. The spring 1993 trip, however, more than made up for the previous semester. Due to the efforts of VP Greg Sprehn, we were able to arrange a tour of the Lawrence Livermore National Laboratory. This was then followed by the traditional wild student party at Lynn Cominsky's new dwelling in Novato. Unfortunately, due to the strict security requirements of LLNL we were only able to bring twenty people.

SPS also sponsored a number of talks this year. In the fall, Holly Jessop spoke to the SPS about her work on optical observations of the variable star system BY Cam, Nicko Melville spoke about his summer work in plasma physics, Mallory Roberts spoke about multi-wavelength astronomy at SSU, and Dr. Joe Tenn gave his ever-popular lecture on how to get into graduate school. In the spring, Nicko Melville explained his senior design project on regenerative braking, and Saeid Rahimi gave a lecture on his work on sabbatical with Hewlett-Packard in the areas of diode lasers, fiber optics, and optical communications. Also, in an unusual crossover, SPS and the radio station's Klub KSUN co-sponsored a talk by Leonard Thomasen of Microscan Laboratories about his incredibly simple new devices for curing stereo speaker distortion.

Other SPS activities included a picnic/rocket launch co-sponsored by the local model rocketry club AEROPAC, participation in the fun and games of Science Night, and participation by Holly Jessop and Amanda Tunison in the Expanding Your Horizons conference for eighth grade girls. A few die hards also took advantage of a rare opportunity to sit in on a Stephen Hawking lecture in Berkeley last December.

Congratulations to next year's officers: President Jeff Kavanaugh, Vice President Mallory Roberts, Secretary Lisa Christensen, and Treasurer Rebecca Freeman. Onward and upward!

DAVID NIELSEN ('74) is a system manager in the comprehensive emergency management division of the Utah Department of Public Safety. Formerly a computer specialist with the Environmental Protection Agency in Las Vegas, he has published several papers on the use of lasers for water quality assessment.

ROY W. HARTHORN ('78) is a student in the master's degree program in public administration at California State University, Northridge. Formerly chief of building and zoning for the city of Santa Barbara, he is past president of the central coast chapter of the International Conference of Building Officials.

KENNETH ALINE ('81) is a senior material and process engineer with Lockheed in Sunnyvale, where he has worked on such projects as the Hubble Space Telescope. He also does consulting.

JOHN LACOMBE ('83) is a manager with Pacific Lists, Inc. in Mill Valley.

Our Neutron Flux is Up

John Dunning, Jr.

The reactor at Los Alamos, New Mexico was used for the "Hot Hair Laboratory" during the Fall 1992 semester. Students successfully measured the concentration of 12 longer half life trace elements in 0.2 gram samples of their hair which had been sent to Los Alamos for neutron irradiation and then shipped back to Sonoma State for analysis. Los Alamos's neutron flux is more than eight orders of magnitude higher than our local neutron flux. The results are impressive.

Our local neutron flux has increased over a factor of two due to the arrival of a new larger neutron source donated by Kalamazoo College in Michigan. This source came with a superior stainless steel and paraffin shield tank which has the capability of exposing larger samples without getting them wet. The water tank shield tank is no longer needed.

The local neutron source is used mainly for neutron activation and subsequent trace element detection. An immediate benefit to the second semester physics laboratory is our ability to use Iodine-128 with its 25 minute half life. This replaces Mn-56 with its longer 54 minute half life. The replacement results in a shorter measurement time, a more dramatic decrease in activity during the laboratory period, and a much more exciting experiment .

When applied nuclear (Physics 482) is next offered, exposure times can be reduced by a factor of two or a signal to noise ratios which is currently at the limits imposed by room background will give more satisfying results. Smaller concentrations of trace elements can be detected.

Very Small Array on the Move

Greg Sprehn

This year the VSA has been undergoing a complete mechanical rebuild to control it with stepper motors connected to a computer. Not only will this allow the automatic selection and pointing of the dishes to a particular location in the sky to do the drift scans like we have done so far, it will also mean we can track an object across the sky and collect data for much longer periods of time. The latter capability requires the development of a variable delay line to compensate for the changing effective baseline as the position of the object changes. But since the year is over and budgets exhausted, that upgrade will be left to the next generation of Sonoma State radio astronomers.

The money to accomplish the motorization came from two sources, with very little financial support required from the school. The SPS grant for $2000 that we won last year paid for the parts, and this year we won a NSF - AAS REU grant. As part of the terms of the grant, I will be presenting the results of our upgrade and our best observations to date at the June meeting of the AAS in Berkeley.

One windy exciting night in January, just 4 days after the Hat Creek 85-footer blew over, our dishes blew off the roof! They were sitting on the top of Darwin Hall, like two cereal bowls, while we worked on the mounts in the machine shop. The two inches of standing water up there kept them in place for weeks until the rain stopped, and then the wind was able to launch them. They made a terrific crash, but were only minimally damaged. They fell to the intermediate roof, into a lower potential well, and we left them there until we were ready to bolt the whole thing back together.

Work parties have been taking place on Wednesdays, with drop-in help from a number of students. Amanda Tunison has done a lot of the lathe work. Mark Robinson built the new counterweights. Ben Owen, his sister Sarah and her friend Jesse came the day we had to put the dishes back on the upper roof, and returned the following week to help with the dish-drive reassembly.

Jorge Polanco helped manufacture aluminum support pieces. Robin Adams wired the inside of the motor controller boxes. Mallory Roberts took our picture the day we reassembled the dishes. My thanks to all these students, the terrific support staff at the school, and all the people I forgot to mention.

At science night I gave two presentations about the principles of interferometry, the first one scheduled and the second one by demand! It's surprising what a slide projector and a couple of blinking red lights brings out in people.

KITTY CHELTON ('81, physics and biology) is a Marriage, Family, and Child Counseling intern in Santa Rosa. She earned an M.S. in biophysics at the University of California, Davis in 1985 and an M.A. in psychology from Sierra University. She has conducted research and was a radiation safety technologist at the UC Davis Medical Center.

STEPHAN R. CRANDALL ('82) is a principal engineer with Xerox Engineering Systems. Formerly a senior software engineer with Versatec, Inc., he has also worked at Atari and Mattel.

WILLIAM TOMLINSON ('83) is a student in the M.B.A. program at the University of Arizona. He earned a second B.A., in management, at SSU in 1992.

Portraying Astronomers for Fun, Not Profit

Joe Tenn

This semester, spring 1993, I am on sabbatical leave. It is true that I am on campus a lot, but I am not teaching.

The main purpose of my leave is to get ahead on a series of articles I am writing on astronomers awarded the Catherine Wolfe Bruce gold medal of the Astronomical Society of the Pacific. Awarded most years since 1898 to the world's leading astronomers, this medal is one of the most prestigious awards an astronomer can receive.

At the A.S.P. centennial meeting, in 1989, I presented (with assistance from Miriam Tobin, '90) the world's largest poster paper: mounted photographs of the then 82 medalists. The photo exhibit was so popular that I was asked to publish the photos with longer biographical articles in the Society's bimonthly magazine, *Mercury*. These articles have appeared in all but three issues since Jan/Feb 1990. If all goes well and no more issues are skipped, I will be caught up, writing about the then current (99th) medalist, in the issue of Nov/Dec 2006.

My goal is to present modern astronomical discoveries through the stories of the men and women who made them. I try to get to know each medalist by reading as much as possible, including correspondence which is usually held in the archives of the institution where the medalist worked. After attending the American Astronomical Society meeting in Phoenix, I spent most of January in Pasadena, making use of the superb library of the Observatories of the Carnegie Institution of Washington and the archives of the California Institute of Technology. In February I was in England, reading astronomers' letters and papers in the archives of the Universities of Cambridge and Oxford and of the Royal Astronomical Society and Imperial College in London. I also used the libraries of these institutions for works not easily available here.

I am now reading a lot of French (slowly), as I research the next article on Paris Observatory director Benjamin Baillaud. As chair of the history committee of the A.S.P. I am organizing the history session for the Society's 1993 annual meeting, to be held in San Diego in July. I have also agreed to organize a symposium on the history of astronomy in California for the February 1994 meeting of the American Association for the Advancement of Science, to be held in San Francisco.

Sabbatical leaves are a wonderful thing. They give faculty an opportunity to become involved in projects which complement their teaching. I look forward to returning to the classroom in August with renewed enthusiasm.

A Summer at U.C. Irvine

Nicko Melville

Last summer I was awarded a research internship at the University of California Irvine. The internship was under Dr. William Heidbrink and Dr. Frank Wessel. Their research entailed understanding the nature of plasmas under various conditions. I was assigned to head the design, construction, and testing of a particular type of plasma generator called a plasma deflagration gun. The purpose of the gun was to produce a high density plasma that would be shot through a background plasma, while a variable magnetic field was present. This system was to model the activities of the sun's cosmic rays interacting with the Earth's magnetic field.

With the help from an engineering student and Dr. Wessel, I customly tailored the plasma deflagration gun to function in the desired environment. The construction entailed 80% of my time with the remaining 20% used in understanding the gun's characteristics.

During my internship I learned a great deal about plasmas, and short time data acquisition, as well as a bittersweet respect for mechanical engineering. I would like to thank the staff at U.C. Irvine for making my summer both interesting and exciting. I would recommend the experience to any aspiring physicist who would like to taste the true nature of research.

DANIEL O'DONNELL ('83) is graduate student in environmental chemistry at California State University, Northridge. Formerly an independent photographer and writer, he has published in the *Los Angeles Times*.

STEPHEN BECK ('86) earned his master's degree in physics at San Francisco State University in 1992 with a thesis on trapping in solar cells. He is currently a substitute teacher in Marin County.

JAMES AROYAN ('87) is a graduate student and teaching assistant in physics at UC, Santa Cruz, where he earned his M.S. in physics in 1990. A specialist in bioacoustics and musical acoustics, he is also a consultant on elastic wave propagation.

PHILIPPE ARGOUARCH ('88), an accelerator system operator at the Stanford Linear Accelerator Center, recently completed a computer simulation of Stanford Linear Collider beams for a BBC program on high energy physics.

"What Physicists Do" Highlights

Mark of the Robinsons and Holly Jessop

This has been a wet year at Sonoma State. The ample rain has nurtured nature into a splendid green view. Similary, the *What Physicists Do* lecture series has provided a rich collection of seeds for the growth of physics majors and community visitors.

One of the most engaging lectures of the year was given by Dr. Thomas Hofler of the Naval Postgraduate School. He told us about his efforts to build a thermoacoustic refrigerator. This refrigerator is a resonant cavity driven by a speaker. A compression wave heats up the air in one region and when that same air is struck by a rarefaction wave and cools, it has moved allowing for the transport of thermal energy. Just in case there were any skeptics in the audience, he also brought a thermoacoustic engine which made quite a loud sound after one end of it was cooled by liquid nitrogen.

Sonoma State's nineteen year old senior, Ben Owen, gave a talk about the work he has been doing with data from the Infrared Astronomy Satellite. Working with Dr. Spear, Ben has discovered large numbers of new variables.

SSU graduate Francis Moraes came down from the Oregon Graduate Institute to talk about his research on climate modelling. Francis has been writing computer programs that model the earth's climate.

Another alumnus, James Aroyan, came up from UC Santa Cruz to talk about his study of dolphin echolocation. He has also been using the computer to make models. His models are of the formation of the sound beam dolphins use for echolocation.

Physics doesn't occur in a vacuum. Much of the research done in physics is driven by government dollars. One of the directions that governments have always pushed science is the development and production of weapons. Scott Saleska of UC Berkeley told us about some of the problems left behind by the nuclear arms race. The biggest problem is radioactive contamination of the environment. We learned that the U.S. has been dumping radioactive slurries into trenches dug in the desert and has problems with leaking tanks in Hanford, Washington. Scott also showed us pictures of a Russian village that had been abandoned because of contamination of an adjacent lake. This talk brought home how much easier it is to make a mess than to clean one up.

Well, some physics occurs in near vacuum. That is the case with accelerators. Drs. Robert and Marianne Hamm of AccSys Technology talked to us about making money doing physics by manufacturing linear accelerators. They have come up with a system for quickly manufacturing an accelerator that generates a beam of ions with a specific energy. Although they have made efforts to sell to the commercial sector, the major project of their fledgling company seems to be work on the SSC.

There were several excellent lectures this year about current and exciting new research in astronomy and astrophysics. Dr. Jane Luu from UC Berkeley gave a fascinating talk on the similarities between asteroids and comets, and on the new theories about how they may be related phenomenon. A description of the Extreme Ultra-Violet Explorer Satellite and its on-going progress was presented, that included many beautiful illustrations, by Dr. Isabel Hawkins of UC Berkeley. Dr. John Huchra from the Harvard-Smithsonian Center for Astrophysics began the Spring 1993 Series with an awe-inspiring presentation of his work with maps of the nearby universe. With his slides and video, he captivatingly showed and described the nearby universe of galaxies in three dimensions. Dr. Geoff Marcy gave an excellent review of many of the projects underway to detect other solar systems, including some of his own research work. He discussed how his work adds to other suggestive evidence of planetary formation around young stars. And, Dr. Chris Mauche from the Laboratory for Experimental Astrophysics at LLNL, described interacting stellar binary systems that contain a red dwarf which loses matter to a white dwarf. He described his research into the structure and properties of the accretion disk that forms around the white dwarf.

One of the best attended lectures this year was by Professor Steven Koonin of Caltech. He describes a method for measuring "Earth-shine", the ghostly glow of the dark of moon, which could then be used to calculate changes in the Earth's albedo. Since more reflected light from the Earth means that less sunlight is absorbed, these measurements could have major implications for global warming.

Once again, each semester was rounded off by dinner at Ruth Clary's home. Ruth is a long time Sonoma County resident that, much to the delight of the department, has taken to inviting us over for dinner. Thanks to Ruth and all the other contributors to our Public Programs.

TIMOTHY KIMBALL ('92) is a science data analyst at the Space Telescope Science Institute in Baltimore.

A Summer in Virginia

Scott and Sean Fraser

We spent last summer at the College of William and Mary in Williamsburg, Virginia. (It was an especially interesting summer for us not only for the historical locale, but because it was also our first trip out of California.)

This REU program let the participants choose their research projects after they arrived -- which meant that everyone ended up scrambling for projects during the first few days. We chose to work on two projects dealing with two very different kinds of waves.

One project was at the Virginia Institute of Marine Science, which is located just across the river. We went out on Chesapeake Bay with the team to deploy pressure sensors underwater, and again to retrieve them days later. Our project was to work with some earlier data taken during a storm that actually destroyed the frame holding the sensors underwater. (It was pure luck that one of the datalogs washed ashore!) We read up on some fluid mechanics and wrote a computer program to Fourier analyze the data to look for second-order (nonlinear) effects in the surface waves. These become significant when wave heights become large, as in storms.

The other project was at NASA Langley Research Center, where we learned about what useful X-ray spectra look like and wrote a program to simulate X-ray tomographic imaging. This is the same process used in CAT scans, but it can also be used to identify density variations in stressed metals or fatigued plates. As it turns out, the algorithms rely on Fourier transforms, so by the end of the summer we were quite used to Fourier jargon.

Other activities included weekly talks by members of the faculty (a sort of "What Physicists do" away from home) and a tour of CEBAF (a superconducting accelerator currently under construction). But the ongoing attraction was right next to the campus: Colonial Williamsburg, a large tourist area reconstructed to its original 18th century appearance, complete with costumed folk and and an authentic Fourth of July.

The REU program really broadens your perspective on what kind of physics is out there in the real world. We not only learned something, but had a good time, too.

GREGORY M. CRAWFORD ('88) is a regional sales representative for Baker/Norton Pharmaceuticals in the Bay Area. He recently completed a term in the U.S. Marine Corps, where he was an air defense controller at Camp Pendleton with the rank of Captain.

My Summer at Notre Dame

Monika Ivancic

I spent last summer doing research with one of the high energy groups at Notre Dame. The group I joined was building a scintillating fiber detector, which was tested in a muon beam at Brookhaven National Lab. Once perfected it will be used at Fermilab and possibly the SSC in Texas. The material in a scintillation detector emits light when struck by á particle. These scintillations are detected and counted by a photomultiplier and recorded by a data acquisition system. Our detected used 4m scintillating fibers connected to 6m clear waveguide fibers which lead into He dewars with VLPCs (visible light photon counters). A collaboration of physicists were working on this detector and our group at Notre Dame was in charge of preparing the clear waveguide fibers. This consisted of shining light down each one of the 6m fibers and looking for bright spots where light was escaping. The bad fibers were replaced. The fibers were then carefully threaded into connectors and the precise location of each was recorded, to help determine where the particle passes through. We spent a lot of time polishing these connectors, since the connection with the scintillating fibers must be very clear and we wanted more than 95% of the light to be transmitted.

The test run at Brookhaven National Lab began in mid-June and we had a tight squeeze to get everything done in time. Unfortunately the grad students and I didn't get to go! Some problems ocurred at the test run; there were 25% dead channels and a lot of background noise while taking the data. Another test run was scheduled for late July and we had to work on improvements by then. One of my projects was to design copper screen cages for the He dewars in order to block radio frequency waves, a big source of background noise. The second test run was a success and tracks of particles were observed in the fibers.

Another one of my projects was to use a photospectrometer to perform emission scans on different types of scintillating fibers. All in all it was a great learning experience. It felt good to be able to participate in real life physics experiments in the frontiers of science and I learned a lot about high energy - particle physics. I also learned this field is quite political; much time was spent arguing about things such as whether to use wire or fiber detectors.

MARIE-CHRISTINE RAUDE ('91) is manufacturing quality supervisor at Precision Lamp, Inc., Cotati.

Covering the Spectrum: Astronomy Research at SSU

Holly Jessop, Ben Owen and Mallory Roberts

Opportunities for undergraduates to do publishable research is rare at most Universities. Most physics majors have to wait until graduate school to be involved in serious research programs. Our department has been an exception for several years. Astronomical research across the electromagnetic spectrum has been an integral part of many students' lives at SSU. During the last year, there were active research programs in infrared, optical, and X-ray astronomy.

Ben Owen, working under the direction of Prof. Gordon Spear, has continued analyzing data from IRAS (Infrared Astronomical Satellite). They have been preparing the IRAS Catalog of Variable Sources in order to facilitate time variability analysis of infrared sources detected by IRAS. Due to last year's discovery in the old IRAS data of over 10,000 previously unknown variables, the ICVS more than doubled to 19,000 objects. A major result of their work is to determine an accurate infrared period-luminosity relationship for Cepheids. This infrared relationship is superior to the more conventional optical studies which suffer from 1) the Earth's atmosphere, which IRAS was above; 2) the interstellar medium, which is transparent in the far infrared; and 3) variations in optical emission from Cepheids which make it hard to determine an average luminosity. The final version of the ICVS should be ready for publication soon.

Holly Jessop worked last summer with Prof. Lynn Cominsky on two proposals for guest observer time on the Extreme Ultraviolet Explorer satellite and analyzing data from the HEAO satellite. Throughout the year she has been reducing and analyzing time series photometric data on the cataclysmic variable BY Cam. One data set, spanning six nights of photometry, was acquired with the SSU CCD camera at the 40-inch telescope on Mt. Lemmon, Arizona in November 1991. The other data set spans two nights of photometry and was acquired with the new Epoch telescope at the SSU observatory. Holly has also developed and implemented a monitoring program for Dr. Cominsky's Compton Gamma Ray Observatory project. Using the new Epoch telescope, she has kept track of selected X-ray binary stars, hoping to see signs of an optical outburst.

Further along the Electromagnetic spectrum, Mallory Roberts worked with Prof. Cominsky on several X-ray astronomy projects. During the summer, he continued work on the data from HEAO A-1 (High Energy Astronomical Observatory), begun last year by Greg Sprehn. With Dr. Cominsky, he developed a system to analyze over a year's worth of data from 1978 that has never been properly examined before. Jeffrey Kavanaugh and Amanda Tunison are now using this system to search for pulses from X-ray binary systems. Starting in the fall, Mallory and Dr. Cominsky started analyzing X-ray data obtained from the German Roentgen satellite (ROSAT) from a newly discovered radio pulsar binary, PSR1259-63. This pulsar is in orbit around a Be-star, and is similar to many X-ray emitting systems that Dr. Cominsky has long studied, but was not expected to emit X-rays due to the extreme eccentricity of the orbit and wide separation between the stars. However, Dr. Cominsky and Mallory have found that the system does indeed emit X-rays, They have data from two observations, made six months apart, which contain the arrival times of ~1400 photons. They will be presenting this work in June at the upcoming meeting of the American Astronomical Society which is being held in Berkeley. They also plan to attend a special conference on Interacting Binary Stars sponsored by the Astronomical Society of the Pacific in July, where the unusual properties of this system should attract interest.

Mallory has also been working on data from the GRO (Gamma Ray Observatory) BATSE experiment of 4U0115+63, the x-ray pulsar that Prof. Cominsky discovered while a graduate student at M.I.T. (and which is being optically observed by Holly Jessop). They plan to have a new set of orbital elements that they will present, at the Berkeley AAS meeting.

The future of Astronomical research at SSU looks bright. With the new Epoch Automated telescope, optical research has become practical, even in Rohnert Park. Dr. Spear plans to continue work on the IRAS data for at least another year and has submitted a new proposal to study other types of infrared variables. Dr. Cominsky has written new proposals for more ROSAT and CGRO data, as well as data from a new Japanese satellite. These will provide further opportunities for student research in coming years.

KEITH WAXMAN ('90) is teaching astronomy at Santa Rosa Jr. College and working on a master's degree with a special major in astronomy and philosophy at San Francisco State University.

JASON ALEXANDER ('92) is a graduate student and teaching assistant in physics at Indiana University – Purdue University at Indianapolis.

Contributions are Appreciated

Duncan Poland, Chair

Both direct and endowed accounts have been set up to receive charitable contributions from interested sponsors. Funds are drawn from the direct accounts by the Department of Physics and Astronomy as needed. Donations to endowed accounts are invested by the SSU Academic Foundation; only the earnings from these are used to support programs and scholarships. All contributions made to either type of account are under our direct control.

Endowed accounts that support scholarships for physics majors are the Physics and Astronomy Department Scholarship Fund and the Joseph S. Tenn Scholarship Fund. An endowment account, the Science at Work Fund, was established in 1990 by John Max, president of Max Machinery Company in Healdsburg, to support the "What Physicists Do" lecture series.

The Department also has four direct fund accounts for the Radio Telescope Project, the Public Programs, the Astronomy Observatory, and the Department Equipment account. The Radio Telescope account is used for improvements to the student-built interferometer on the roof of Darwin Hall. The Public Programs account provides direct funds to support the "What Physicists Do" lecture series and Public Viewing Nights at the SSU Observatory. The Astronomy Observatory account funds equipment and research at the observatory. The Department Equipment account supports the purchase of new materials for use in the laboratories. (This year there were no equipment funds from the state; next year will apparently be the same.) Contributions from Fred Aves were used to purchase a a neutron source with twice the flux of our old one. Contributions from many helped us to purchase the Epoch Instruments telescope.

Contributions to any of these accounts may be sent to Prof. Duncan Poland, with a note explaining which account you wish to support. Checks should be made out to the SSU Academic Foundation. All contributions are tax deductible.

Thank You!

The Department of Physics and Astronomy wishes to express its gratitude to the following 1992-93 donors to the funds described above:

SCIENCE AT WORK : Mr. John Max.

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PHYSICS & ASTRONOMY SUPPLIES: Mr. Fred Aves; Mr. Charles Carpenter; Mr. Robert Steele; Mr. & Mrs. James L. R. Wilder.

PHYSICS & ASTRONOMY SCHOLARSHIP: Mr. & Mrs. Phillipe Argouarch; Drs. Lynn R. Cominsky and Garrett Jernigan; and Dr. & Mrs. Duncan E. Poland; Dr. & Mrs. Joseph Tenn.

ASTRONOMY OBSERVATORY: Mary Jensen; Mr. & Mrs. Charles McKinney; Dr. & Mrs. Morton Klein.

JOSEPH S. TENN SCHOLARSHIP: Mrs. Edith Tenn; Mr. & Mrs. Daniel Tenn; Mr. & Mrs. William Kolitz; Prudential Foundation.

DONATIONS IN KIND: Hewlett-Packard; Craig Paul.

Another View of an Irvine Summer

Paul Somerville

For ten weeks last Summer I was a resident of southern California, working in the plasma laboratory at U.C. Irvine, as a participant in the NSF REU program. The area of experimentation assigned to me was the study of Langmuir probes, which are used to characterize plasmas. My duties, at first, were very similar to those I had performed as the "new guy" in past research jobs: sweeping the lab, hauling heavy cables, and fiddling with anything interesting in the lab that didn't work. Over the course of ten weeks, however, I eventually did develop a feel for the basics of plasma physics.

After building and using about ten probes to measure the temperature and density of the plasma, certain questions began to arise about the actual measurement process such as, "do the ions and electrons really interact with the probe in the way we assume that they do?" The experiment I designed to test these assumptions was very simple, it involved taking measurements with different probe (B-field) orientations than are usually used. The resulting temperature and density measurements agreed with my predictions but a third measurement, the floating potential, reacted exactly opposite to its predicted behavior. Neither the graduate students nor my advising professor could think of a reason for the discrepancy, although it didn't seem to concern them much either.

Beyond what I learned about plasma and probes, and more important, was what I learned about graduate students and their lives (or lack of). They were not mental gods who had held 4.0 GPAs all of their lives. They were mostly just people who loved physics, and who were willing to work very hard and very long to gain even the smallest amount of ground on the unknown.

Epoch Telescope

continued from p. 1

on the possible Cepheid-type star V651 Herculis. And, several comets are being observed in order to accurately determine their positions and orbital elements.

With all these successes and the wonderful new ease with which data can be quickly acquired, it became clear that the Epoch System should become a permanent instrument at the SSU Observatory. So, we launched a fundraising campaign to purchase the system, and so far have raised nearly all of the necessary funds. Upcoming plans for the Epoch System at SSU include an expanded monitoring program of several x-ray binary stars for optical outburst in coordination with Dr. Cominsky's CGRO research. Additional links with faculty research projects are anticipated with expanded student involvement in Dr. Spear's anti-galactic center survey for the discovery of variable stars. Overall, the new system is expected to improve 'hands-on' education, student research opportunities, and student-faculty interactions at SSU.

DAVID MUNTON ('82) is teaching mathematics at Ohio State University-Newark in Newark, Ohio. He earned his Ph.D. in theoretical physics at the University of Texas, Austin in 1991.

Alumnotes

BRETT MORGAN ('82) is proprietor of a bagel business in Jamestown, CA. Formerly a system operator on CompuServe for Symantec Corp., he has invented devices for both computers and bagel-making.

KEYVAN FARAHANI ('85) is a visiting assistant professor of biomedical physics at UCLA, where he earned his Ph.D. in 1993. His dissertation was on magnetic resonance imaging of interstitial laser thermo-coagulative therapy. He received the American Association of Physicists in Medicine Student Research Award and the J.T. Case Certificate of Merit for outstanding research in radiological sciences in 1989

DARITH PHAT ('87) is a student in the M.B.A. program at the International Institute for Management Development in Lausanne, Switzerland. Formerly an assistant professor at École Centrale, Paris, and a research consultant for Rhône Poulenc Rorer in Antony, France, he is now specializing in technology management. He earned his Ph.D. in bioengineering and spectrochemistry at the University of California, San Diego and École Centrale in 1991.

MARC AFIFI ('89, physics and communication studies) is teaching physics, chemistry, and algebra at Central High School in Fresno. He coached the Odyssey of the Mind team which placed second at the 1993 state championships. He earned his secondary credential in physical science at SSU in 1990.

JEFFREY LEE ('92) is working on a second bachelor's degree, in mechanical engineering, at California State University, Sacramento