MOMENTUM

THE UNIVERSITY OF KANSAS DEPARTMENT OF PHYSICS AND ASTRONOMY

Departmental involvement to improve public education

In 1983 the Carnegie Institution published "A Nation at Risk: The Imperative for Educational Reform," in which the problems of public education in the United States were spelled out. Subsequent studies of science education include the 1989 publication by the American Association for the Advancement of Science titled "Science for all Americans," and the National Research Council's "National Science Education Standards." Our department is involved in a number of projects aimed at improving public education and at improving what we offer to our own students.

Professor Tom Armstrong, along with faculty from the Department of Chemistry and the Division of Biological Sciences, has submitted a large proposal to the Eisenhower Program, which is administered by the Kansas Board of Regents. Gerta Dorfmeister (KU Ph.D. in 1992) wrote the proposal for an interdisciplinary high school science teacher workshop covering topics from biology, chemistry, and physics. The proposal aims to serve rural, inner-city, and other minority and underserved populations. The staff will consist of high school teachers and University of Kansas faculty.

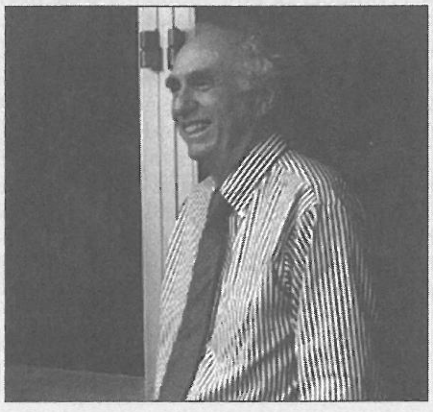
A few of the many specific outcomes of this project include the enhancement of students' problem-solving and communication skills through exemplary scientific projects and exercises, the enhancement of collecting and information processing skills through increased use of software and long-distance facilities, and the enhancement of the integration of science with other disciplines thorough application to real-life problems. Additional outcomes to be addressed include the effective use of low-cost, hands-on science activities to extend student insights and appreciation for science and scientific methods; the development of specific materials that can be used by other teachers in their districts; and familiarity with innovative assessment strategies as well as methods of integrating instruction and assessment. One additional important goal is for the participants to stay in contact with each other and with KU faculty members through an e-mail circle established at the workshop.

Professor Stephen Shawl submitted a proposal titled "An Astronomical Theme Throughout the Junior High Science and Math Curriculum" to the Hubble Space Telescope IDEA (Initiative to Develop Education through Astronomy) program. The proposal, which includes participants from the KU School of Education, the Haskell Indian Nations University education department, the Lawrence school district, and teachers from the Kansas City area, is for a two-week summer workshop aimed at junior high teachers and teachers still in training. During the workshop, participants will be taught astronomical concepts, will work through specific hands-on activities they can use in their classrooms, hear about different methods of teaching astronomy, and hear talks from scientists who have been involved in NASA space science programs. The workshop will be divided into two one-week sessions, with the participants working on materials for use in their classrooms between sessions. Teachers will be paired with those who are still in training so that mentoring will occur. Participants will be instructed in the use of the Internet for finding course materials, and the teaching materials they produce for their projects will be made available over the Internet through the Explorer Database, a project within the KU School of Education funded by the U.S. Department of Education. The good news in January 1996 was that the project has been funded.

Professor Alice Bean's efforts are toward improving the introductory physics labs for Physics 211 and 212. She has obtained funding for computers from the NSF's ILI (Instrumentation and Laboratory Improvement) program. The proposal, which was submitted jointly with Haskell Indian Nations University, is to collaborate on the development of several computer-aided experiments for the introductory physics laboratories. These experiments will bolster the instruction of concepts in mechanics, electrostatics, and thermodynamics by allowing students to relate classroom formalism directly to laboratory observations. In developing the experiments, which will be done by students enrolled in an advanced design laboratory (Physics 601) at KU, an emphasis will be placed on the pedagogy offered by the measurements. The experiments will be used by initially introducing them at Haskell, where the class sizes are small and individualized instruction is possible. After the experimental procedures are optimized, the experiments will be incorporated into our courses. In addition to strengthening the courses at both institutions, this partnership should help Haskell students who wish to transfer to other institutions through a better coordination of their syllabus with that at KU. ■

Nobel winner speaks

Martin Perl, co-recipient of the 1995 Nobel Prize in physics, spoke on "Reflections on Experimental Science" at the University of Kansas March 20. Earlier in the day he met with undergraduate honors students, graduate students and faculty in physics and astronomy. The Royal Swedish Academy of Sciences in December awarded the Nobel Prize in physics to Perl and Frederick Reines of the University of California, Irvine, for their pioneering experimental contributions to lepton physics.



A Letter from the Chairman

The past year has seen major changes at the highest levels of the administration at KU, specifically in the offices of the chancellor and the dean of the College of Liberal Arts and Sciences. This period has also seen budget cuts and a hiring freeze on new faculty and classified staff. However, our department has fared well in spite of this; research productivity is very good, and our external funding continues to hold at a high level, offsetting in part the effects of state budget cuts.

Two faculty members in the department received promotions during the past year: David Braaten (atmospheric science) was promoted from assistant to associate professor, and Stephen Sanders (nuclear physics) was promoted from associate professor to professor. We did not add new faculty during this period, but we are currently searching for a faculty addition to join the cosmology group, which consists of Professors Melott and Shandarin. This new position was funded in part by matching funds provided by a state of Kansas NSF EPSCoR grant. The department also hopes to add positions in experimental condensed matter physics and nuclear physics, but we have not yet received authorization from the College to begin a search.

Professor Barbara Anthony-Twarog was one of three inductees into the Kansas Women's Hall of Fame last spring. In addition, undergraduate physics major Ina Robertson was named the Outstanding Nontraditional Woman Student. In other news relating to our students, Angela Linn (an Abilene senior) received a Barry M. Goldwater Scholarship, which encourages excellence in science and mathematics. A number of other students were also recognized for their recent accomplishments at the department's annual awards banquet in May. These awards are discussed more fully in the section of the newsletter dealing with student news.

Details about the accomplishments of individual research groups are presented elsewhere in this newsletter. I mention here only a few items of recent and general interest. Professor Tom Armstrong and his space physics group have been involved in a project designed to learn more about the planet Jupiter. It has taken the Galileo Orbiter more than six years to reach Jupiter and now that it has finally gotten there it is transmitting data that will reveal details about Jupiter's atmosphere and radiation, and information about its composition and structure.

The high-energy physics group has been exploring possible experiments that would extend beyond their current involvement with the CLEO collaboration at the Cornell Electron Storage Ring. One interesting possibility lies in the field of high-energy neutrino astronomy and involves the detection of coherent radio emission from electromagnetic showers produced by ultra-high-energy neutrino-nucleon interactions in polar ice. The plan is to place the antennas in holes in the ice in Antarctica. Another possibility being explored is to join the D0 collaboration at Fermilab. The recent discovery of the top quark, and the excellent facilities at Fermilab (which has the highest energy accelerator in the world) makes this a promising experiment for many years to come.

As mentioned, there have been changes in key administrative positions at the College and university levels. James Muyskens, who guided the College for the past seven years as its dean, took a position with the Georgia University system at the end of summer 1995. Sally Frost-Mason, previously the College's associate dean for the natural sciences and mathematics, is acting dean. Both Jim Muyskens and Sally Frost-Mason have been very supportive of physics and the sciences in general, and we expect this support to continue. A search committee is looking for a permanent replacement for Jim Muyskens, and Sally Frost-Mason is one of the candidates for the position. Sally's replacement as acting associate dean is Robert Weaver from biochemistry.

Robert E. Hemenway became KU's 16th chancellor in May 1995. He is a professor of English and is the first chancellor in many years to hold a faculty position in the College. He has been vigorous in promoting KU's mission and image throughout the state. The chancellor has made undergraduate recruiting a high priority for his administration. This will help reverse the decline in enrollment experienced during the past year. This relatively small decline is demographic in origin and is expected to be temporary. Nevertheless it has important consequences for state funding of higher education, which is tied to enrollments. The enrollment decline resulted in a reduced appropriation from the Legislature and is responsible, in part, for the current budget cuts and hiring freeze.

The chancellor has also focused on the quality of students and is seeking to attract more merit scholars to the university, a situation that should greatly benefit our department. We are very interested in attracting high quality undergraduates and have been involved in our own recruiting program at high schools and junior colleges throughout the state. Alumni who know of promising students can also be helpful in this regard.

In closing, I would like to thank all of you for your continued interest and support. We devote a part of each annual newsletter to news about our alumni and we are interested in hearing about important events in your careers and personal lives. This is a good way for all of us to stay in touch.

With the advent of the Internet as a staple of American life, there is yet another way for us to stay in touch. The department's home page address is http://www.phsx.ukans.edu/index.html. We think that many of you will enjoy browsing through the material presented there. Our home page provides information on course offerings, research programs, colloquia announcements and much more; we welcome your comments. We also welcome personal visits and have been pleased to renew acquaintances with those alumni who have visited us; if you happen to be in the general vicinity of Lawrence be sure to drop by and visit the department. ■

Ray Ammar
Chairman

STUDENT NEWS

Student Activities

Ina Robertson, a junior and current president of the SPS chapter, was presented with the KU 1995 Outstanding Female Nontraditional Student Award. The award, which comes from the Emily Taylor Women's Resource Center, was made at the spring recognition ceremony.

Atmospheric science students have been involved in a variety of research projects. Undergraduate students Alan Denton and Clinton Rockey presented results of their research at the 75th anniversary meeting of the American Meteorological Society at Dallas in January 1995. Graduate student Paul Castleberry traveled to Crete to present some preliminary results from his master's thesis work. Mickey Delfelder traveled to Antarctica with Professor Braaten to study the dispersal of snow by the wind.

Graduate student Francis Vitt received a NASA graduate fellowship to work on ionization of the middle and upper polar atmosphere as detected by polar ice cap nitrates.

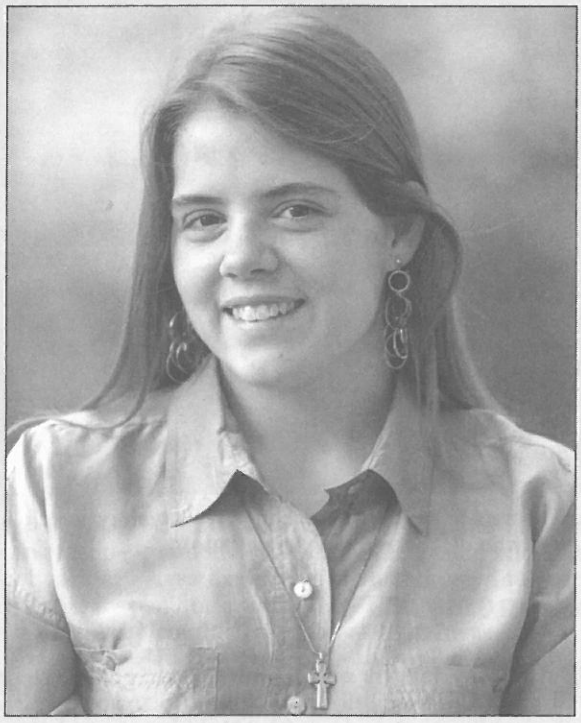
Several students from the space physics group presented research results at national meetings during 1995: Moncef Boufaida, Jay Lindgren, and Ahilleas Maurellis presented papers at the American Geophysical Union Fall Meeting in San Francisco in December 1994; Dennis Haggerty presented a paper at the spring 1995 AGU meeting in Baltimore. Francis Vitt and Naser Alinejad attended the 1995 meeting of the International Union of Geophysics and Geodesy in Boulder, Colo., and presented papers. ■

Ina Robertson

Student wins Goldwater Scholarship

For the second year in a row, a student in the department is a Goldwater Scholarship winner. Angela Linn, a senior from Abilene, has her eyes set on cosmology for her career. Angie has been gaining experience in the nuts and bolts of cosmological research through her programming efforts for Professor Melott. She is studying, through computer simulations, how the ellipticity of galaxy clusters are related to their initial conditions.

When not being a cosmology student, Angie is a brown belt in Tae Kwon Do, and has recently begun fiddlin' around with bluegrass music. She enjoys writing and riding, but since she sold her horse, there has been little of that recently. ■



Angela Linn

SPS

Our SPS chapter had a busy year. Our weekly Friday afternoon coffee/cookie time included short talks on a variety of scientific topics. Furthermore, to help give GTAs experience and feedback on their teaching, they would often give a short presentation similar to what they would give to introduce a lab experiment in the course they are teaching. They were then "subjected" to "stupid" questions one might expect in the lab and provided with a critique. This was a learning experience for everyone.

SPS again joined the department for a presentation of Natural Magic to the Lawrence community.

The SPS officers for the coming year are Ina Robertson, president; Angie Linn, vice president; and Daniel Nunes, secretary/treasurer. This board of officers demonstrates something important about our department: two are women, one is a nontraditional student, and one is a foreign student from Brazil. These outstanding students, who are mentioned in various other places within this newsletter, show that our department continues to attract high-quality students. ■

Student Awards

Each year the department presents a number of Slosson Awards for graduate teaching assistants. The Slosson Award for teaching assistants in physics and astronomy was given to Jenny Hand, Yoshihiko Nagai, and Surujhdeo Seunarine. The outstanding teaching assistant award in atmospheric science was given to Paul Castleberry. Outstanding Senior Awards were given to Tony Michael in physics, Robyn Brooks in atmospheric science, and Jose Pires in engineering physics. The Storer Award for outstanding contributions to the astronomy program went to Jenny Hand. The Stranathan Award, a senior-year scholarship based on an outstanding record as a physics undergraduate (selected in summer 1994), went to Ina Robertson. ■

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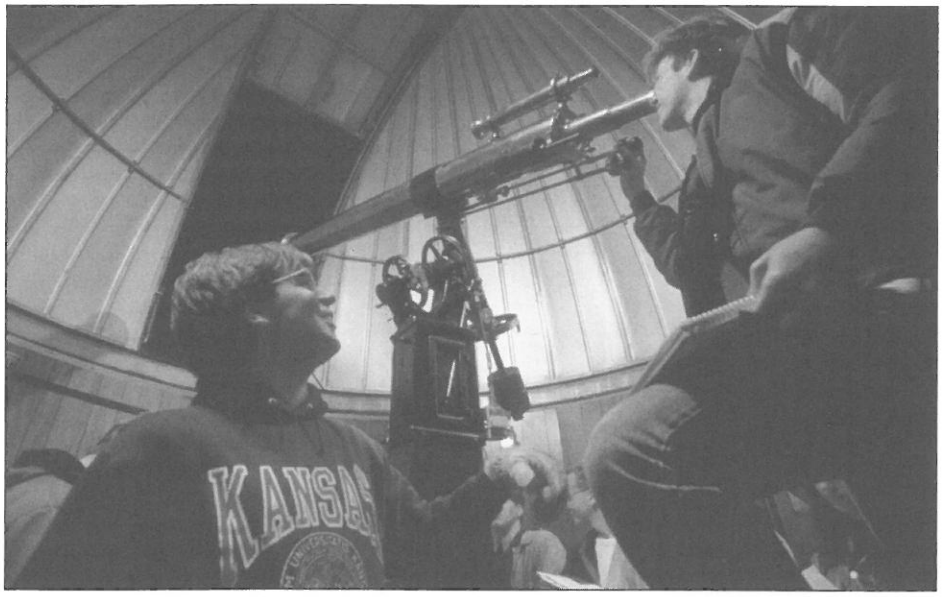

Astronomers at the Clyde Tombaugh Observatory, which is named after a former KU student who discovered the planet Pluto.

Astronomy

Astronomy faculty and visitors continue to use facilities both south (to Chile and Tucson) and up (the Hubble Space Telescope and the International Ultraviolet Explorer) to obtain data for a variety of exciting projects. Professors Bruce A. Twarog and Barbara Anthony-Twarog have continued their research initiatives in the areas of stellar populations and galactic structure. They have completed an analysis of UBVRI photometry in the very old thick disk cluster, Melotte 66. Melotte 66 is deficient in metals (a term used by astronomers for everything other than hydrogen and helium!) by a factor of three compared to the sun and typifies the old thick disk population more than most other well-studied clusters aged five gigayears or more. It becomes even more interesting when you appreciate that this disk cluster betrays some of the composition inhomogeneities of globular clusters, and may include some of the coolest and brightest red giants in the open cluster population.

The Twarogs have also continued their critique of metallicity calibrations used to study the field star representatives of the thick disk and halo populations. A suggested revision in the calibration of metallicity indices based on photometry in the system developed at the David Dunlap Observatory in the 1960s has far-reaching consequences for analyses of the galaxy's oldest stellar populations. In particular, it appears that evidence for a significant population of stars with motions similar to the sun's but chemical composition more typical of the oldest and most metal-poor stars of the halo has faded as a result of these reanalyses.

In another collaborative effort, the dynamic Twarog duo (and collaborators) have embarked on an observational project granted long-term status at Kitt Peak National Observatory through 1997. This "key project" is to examine a sample of 15,000 stars to find the dozens of stars expected to have metal abundances lower than the sun's by 10,000 times or more. These low metallicity stars are the ones formed very near the beginning of the Milky Way's initial collapse.

The Twarogs and Steve Shawl have continued to make observations with the International Ultraviolet Explorer Satellite. Observations were made during the summer from an observing site established in Malott Hall. The observations were of CS 22995-96, a star having an extremely low abundance of metals compared with the sun. They were looking particularly at nitrogen, which appears to have an abnormally high abundance relative to the other (low abundance) elements.

With the textbook writing temporarily behind him, Steve Shawl has returned to analyzing the cool star polarization data that have been collecting dust in his office. The extensive data set contains 166 stars. Because polarization results when asymmetries are present, each object is unique and requires individual analysis. Thus, one question to be answered is whether the publication should be done in one large paper or 166 smaller ones!

Visiting Assistant Professor Keith Ashman has been carrying out research on the formation, evolution, and dynamics of elliptical galaxies, the formation of globular cluster systems, and the cosmological distance scale.

With numerous collaborators, Ashman has obtained Hubble Space Telescope (HST) images of two nearby merging galaxies. This is part of a long-term effort to study the importance of galaxy mergers in the formation of ellipticals. If elliptical galaxies form through the mergers of spirals, young globular clusters are expected to be found in recent galaxy mergers. This is required to explain the larger numbers of globular clusters found around ellipticals relative to spirals. Analysis of these data has revealed a large number of young globular clusters in the target galaxies. Ashman is also involved in ground-based work in this area. As well as studying galaxy mergers, this includes obtaining velocities and metallicities of globular clusters around normal ellipticals to probe the dynamics and chemical evolution history of these galaxies.

Ashman and collaborators have been awarded HST time to search for disk globular clusters in edge-on spiral galaxies. The presence of such objects is predicted by models that explain the stellar thick disk in spirals as arising through a minor merger event.

With KU Visiting Scholar A. Conti, Ashman has also been studying the use of the globular cluster luminosity function as a standard candle to determine extragalactic distances. Such "secondary" distance indicators are required to probe the regime of pure Hubble flow, where the expansion of the universe is not disturbed by internal motions. Obtaining distances in this regime allows a measurement of the Hubble constant, which is a measure of the scale of the universe and which provides constraints on the universe's age. They have shown that a previous discrepancy between the globular cluster luminosity function method and other techniques is removed when proper account of stellar population differences between globular cluster systems is taken into account. ■

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Atmospheric Science

A new atmospheric science student lab, funded by NSF with a KU match, is in full swing. A Sparc 20 workstation receives National Weather Service Family of Services data, satellite data through the University of Wisconsin McIdas data stream, lightning data, and NEXRAD data. A color printer outputs selected maps for posting. The Sparc 20 and the five Sparc 5s get heavy use from the students for map discussions and other class work. A successful open house was held in the spring for the university and meteorological communities. Another Sparc 5 has been set up in a small student study room in the basement of Malott. The department has obtained a high quality color projection panel so that the displays generated by these computers can be shown to large classes.

David Braaten recently received additional support from the National Science Foundation to carry out field research in Antarctica during the next three years. This support includes three four- to six-week trips to the continent to expand his current investigations of snow accumulation and snow transport dynamics. One of the new instrument locations is on the polar plateau 300 miles from the south pole. For the 1995-96 field season, graduate student Mickey Delfelder will accompany him to Antarctica to help with snow sampling and analysis.

Atmospheric science graduate student Melvin Martin is involved in a master's research project with Braaten to investigate decadal trends of polar tropopause height and stratospheric temperature and winds. Of particular interest in studying these trends is the role of El Niño, an equatorial phenomenon.

Donna Tucker has started a project investigating the initiation of Mesoscale Convective Systems (MCS) that form in the lee of the central Rocky Mountains. She is using the Penn State/NCAR Mesoscale Model and has been interacting with scientists at the National Center for Atmospheric Research. MCS are responsible for over half of the summertime precipitation in the central United States. Although much is known about the general conditions in which they form, forecasting the beginning of a specific storm system remains elusive. Professor Tucker will be comparing model simulations of cases where MCS formed with other cases where no MCS formed. She hopes that the differences in the two types of cases will shed light on the mechanisms that cause MCS to form. ■

Chaos

The chaos group, which involves Professor Ying-Cheng Lai, other interested faculty members, and several physics and mathematics graduate students, has continued its work on forefront research projects. Current research focuses on significant applications as well as certain fundamental aspects of the chaos theory.

One significant application is chaotic time series analysis, which involves extracting useful information from a measured time series. In many scientific experiments, the measured signals are random. The traditional viewpoint is that these random signals are simply unimportant noise that should be eliminated as much as possible. It has now been realized, thanks to the chaos theory, that most of these random signals are actually chaotic signals that may contain vital information. It is thus important to be able to detect the useful information in real applications where the system's equations are not known and the only available information about the system is one or a few measured time series. The KU chaos group has been exploring methods to detect and compute quantities important to the characterization, short-term prediction, and control of chaotic systems.

In the realm of chaos fundamentals is the topic of spatiotemporal chaos. The research aim is to explore and understand complexity and unpredictable behavior in spatially extended physical and biological systems. In particular, super-long transient chaotic behaviors and the origin of the spatiotemporal complexity are the main directions of investigation. This study is highly relevant to natural phenomena such as turbulence in fluid motion, and evolution of spatially extended ecological systems.

An additional fundamental field is the transition to chaos, which investigates new routes to chaos and how qualitative changes of chaotic attractors occur as a system parameter changes. The main research is to explore new bifurcations in certain physical and biological systems. One recent result concerns the transition to chaotic attractors in systems driven by two incommensurate frequencies. A novel type of bifurcation has been identified that is conjectured to be quite general. Another result concerns the scaling behavior for catastrophic events such as crisis in chaotic systems. ■

Condensed matter

Thin films

The KU superconducting thin film group, headed by Professor Judy Wu, has focused on two research projects during the past year: the study of Hg-based superconductors, and the development of metal-organic chemical vapor deposition (MOCVD) system for coating high-temperature superconducting films. Significant progress has been made on both of the projects, as detailed in the following.

A novel technique, based on a study of the phase equilibrium of the Hg-vapor annealing process, has been developed for fabrication of the new superconducting Hg-based cuprate thin films. This so-called fast temperature ramping Hg-vapor annealing technique (FTRA) has overcome the difficulties caused by the highly volatile nature of the Hg-compounds; FTRA is safer, easier, and much less expensive than the previous techniques. Using the FTRA technique, superconductivity above 130 K was achieved, for the first time to our knowledge, on high-quality c-axis-oriented-epitaxial Hg-based cuprate thin films. Moreover, record high critical current density, especially at either high temperatures (0.1 MA/cm^2 at zero field and 115 K) or strong magnetic fields (~ 2 MA/cm^2 at 5 Tesla and 5 K) was also obtained. Through collaboration with many other institutions, several experiments are underway to investigate the physical properties of these films, including studies of the growth mechanism, the effects of chemical doping, and the effects of ion beam irradiation on electronic structure and microwave characteristics.

A computer-controlled single-source photo-assisted MOCVD system has been designed and assembled for the growth of large-area high temperature superconducting (HTS) thin films. Several unique features have been incorporated to cope with the common problems of nonuniformity in large-area growth and the decomposition of precursors. With this MOCVD system, good-quality c-axis oriented YBCO thin films of 1-inch diameter have been reproducibly obtained with Tc up to 88 K and the superconducting critical current Jc up to 10^6A/cm^2 at 77 K and zero field. Good uniformity in large-size deposition (up to 2 inches) has also been achieved. A Rutherford backscattering spectroscopy (RBS) analysis of 1- or 2-inch samples showed a nonuniformity of less

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than 10 percent across the whole sample area. It has also been found that for the single-source MOCVD system, a nonstoichiometric precursor mixture is necessary for the fabrication of high-quality HTS thin films. To determine the stoichiometric ratio of the precursor mixture, its correlation with the superconducting properties, the crystalline structure, and the composition of the YBCO films were systematically studied with the transport measurement, X-ray analysis, and SEM/EDX analysis. An optimal ratio of precursor mixture has been for YBCO thin films.

Bulk materials

The study of bulk materials is being done by a group headed by Professor Ken Wong. The group's area of recent study has been high-temperature superconducting cuprates. They are concentrating on improving the physical properties such as critical current densities and critical temperatures of such materials through elemental dopings and novel sintering methods. For example, they have successfully fabricated the current world record Tc = 140K mercury cuprate by doping with thallium, and they have also achieved the highest packing density reported, 95 percent of the theoretical density, for polycrystalline thallium 2223 cuprates by using a HIP (hot-isostatic-pressure) sintering method. Such a bulk material can be made into high current leads and ultrahigh electromagnetic shields.

Giant magnetoresistor materials are the subject of a second research area. There is a lot of recent interest in these giant magnetoresistors, because of their potential applications in magnetic memory discs. Like the cuprate superconductors, these novel ceramics are perovskites and possess similar properties. New facilities allow Wong's group to compete in this field. The key is optimizing the antiferromagnetic to ferromagnetic transition, which they have found to be extremely sensitive to elemental dopings. They recently reported that when cooled in the absence of a magnetic field, $La_{0.67}Ca_{0.33}MnO_x$ exhibits a reentrant magnetic behavior near 50K, which coincides with an increase in the peak magnetoresistivity of 1300 percent. This result is of practical interest in the making of superdense magnetic memory discs and reading heads. ■

Cosmology

The "Kansas Alliance for Cosmology — Interdisciplinary Astrophysics" (KACIA) has been funded by the National Science Foundation EPSCoR program. It was proposed by Professors Adrian Melott and Sergei Shandarin, with Barbara Anthony-Twarog (astronomy) and David Besson (particle physics), and in collaboration with the department of physics at Kansas State University. This research grant will bring in more than $1.1 million over a three-year period, with nearly half going to KU. In addition to providing computer upgrades for cosmology research and to sponsoring a major workshop in large-scale structure, the funding will provide equipment for a new faculty member in cosmology. The search for a person to fill this position has begun.

Melott was allocated 2,000 hours of supercomputer time at the National Center for Supercomputing Applications, keeping the KU group in the forefront of using large-scale computing to follow the evolution of matter in the universe. He has also recently begun working with a Chicago-led team attempting to use quasar absorption spectra from the Hubble Space Telescope to shed light on the spatial clustering relationship between galaxies and pregalactic clouds. ■

High-energy experimental physics

The experimental high-energy physics group continued its focus on CLEO, while keeping an eye out for new directions.

Professor Phil Baringer spent the past year on sabbatical at the University of Michigan, participating in the D0 experiment. D0 was one of two experiments at the Fermilab proton-antiproton collider that announced last year the observation of the top quark and measured its mass. The top quark discovery was easily the most newsworthy item in particle physics during 1995. Baringer performed extensive Monte Carlo studies on top quark production mechanisms, which should lead to further interesting measurements in collider runs. Based on his successful work with D0, the Kansas high-energy physics group has been invited to join that experiment. Clearly this is an option that they will weigh very carefully, especially since planned upgrades to the D0 detector and the Fermilab collider will lead to even more exciting physics opportunities. The upgrades are planned to be completed by 1999. Baringer's contribution to the D0 detector upgrade has been his work on the design and construction of the central preshower detector with a team of physicists from the University of Michigan. Meanwhile, Baringer continues his extensive work on CLEO, along with graduate student Yuyi Guo. Together they are working on data analysis projects and assisting Professor Alice Bean and postdoc Chris Darling in their CLEO III efforts (more on this below).

Professors Nowhan Kwak and Robin Davis and graduate student Nader Copty added another particle discovery to their impressive list of past accomplishments. Having discovered the neutral orbitally excited charmed meson (the D**0) last year, Kwak, Davis, and Copty turned their attention to its charged isospin partner, the D**+. Their efforts paid off as, within the last year, report of the discovery of this particle was published. Kwak and Davis also spent part of their summers at the CESR particle accelerator in Ithaca, N.Y. In addition, Kwak was invited to attend the 1995 Lepton-Photon Symposium in Beijing, China.

Professor Ray Ammar spent most of last summer at CESR. He initiated a project that seeks to determine separately the properties of charged and neutral B-mesons. Previous inclusive studies of B-mesons were unable to distinguish between the two types of B-mesons, and only reported on the gross properties of the two. Ammar and postdoctoral researcher Don Coppage plan to attack this problem using the technique of "tagging," or using the subset of data where CLEO is able to identify charged and neutral B-mesons separately. This work should help take B-decay studies to a significantly improved level of understanding.

Professor Alice Bean, postdoctoral research associates Don Coppage and Chris Darling, and graduate students Ilya Kravchenko and Daniel Smith have been spearheading the effort to provide the monitoring system for the upgraded CLEO-III detector. This work, being done in conjunction with Baringer and Guo, as well as undergraduates John Howard, Arjun Krishnamoorthi, and Kyros Hadjikyrou, involves the essential task of providing the failsafe mechanisms for the $100 million CLEO-III detector so that, in the event of failure of one of the CLEO-III

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subsystems, alarms are sent out before damage can be done. This responsibility was entrusted to Bean by the CLEO-III collaboration in recognition of her long and accomplished record of hardware success.

Professor Bean has also been working with the Allied Signal Corporation of Kansas City to produce the precision electronic devices known as flex circuits, which will connect the innermost segment of the CLEO-III detector (a silicon-based detection system) with the electronics that will perform the signal characterization and amplification coming out of the silicon. Construction of the low-capacitance, low-resistance flex circuit requires use of modern technology that must accommodate extremely demanding specifications.

Bean, in conjunction with Dave Besson and graduate student Suruj Saruhedo, is also leading in the design and construction of an experiment that seeks to verify the high-energy neutrino particles that may be arriving at Earth from distant black holes. This experimental project will be the realization of a suggestion put forth by KU theorists Ralston and McKay that these neutrinos may leave distinctive traces in the Antarctic ice cap. The KU group has taken on the task of overseeing the assembly of the radio transmitters, as well as the data acquisition system to be used in this project. As part of this effort, Saruhedo, along with graduate student Sergei Kotov, has been writing software to simulate the response of a planned polar detector system to the neutrinos incident on Earth (using money provided to Bean et al. under the auspices of the university's General Research Fund). McKay and Ralston are stunned that the project that they have theorized about for almost 10 years seems to be on the verge of realization! (More on the theory of this work under the high-energy theory section.)

The high-energy physics group has been fortunate to have highly capable undergraduates performing research with them. Undergraduate majors Ina Robertson and Hillary Bull have been working to understand the discrepancies in the experimental data on the inclusive production rate of Λs resulting from Λc decay. This work has recently been bolstered by the addition of undergraduate major James Holliday to this research group. ■

High-energy theory

Herman, Doug, and John make up KU's tachyonic particle theory group. They continue to tell us that physics is a moving target, but like Mom, apple pie, and tofu, "theory is good for you."

Professor Doug McKay and collaborators are focusing on the recently discovered top quark. The "top" is the culminating piece of the generation puzzle, that pattern in particles and symmetry by which the universe reveals three copies of itself, all alike save in particle masses. But even before top was found, McKay and colleagues had decided that "top is not enough." They claim there might be a fourth generation of quarks lurking in the Fermilab data. This would be significant, if confirmed, because it would provide a hint of physics beyond the Standard Model. The new mechanism involves supersymmetry (SUSY), which is generally considered beautiful and "politically correct" in theory circles. At the same time, however, SUSY enthusiasts are upset that the masses of SUSY particles in McKay's theory get pushed up even higher. In May, McKay gave a talk on this at the (appropriately named) "Top and Beyond" meeting at the International Center for Theoretical and Applied Physics at Iowa State University.

Former student Lesley Smith and McKay also published a paper on dynamical quark masses and Higgs particle effects. "We're pushing into new dynamical, technicolor schemes for producing single top quarks (without a partner anti-top) at Fermilab and the CERN LHC collider," says McKay. After dynamical technicolor, will there be wide-screen quadraphonic technicolor with Surround Sound? "If the data warrants it," muses McKay.

Professor Herman Munczek works on relativistic bound states, the atom-like particles made of quarks moving at close to the speed of light. Along with graduate student Zhi Hua Dong and collaborators, Munczek recently published a snazzy idea to conquer problems of gauge invariance that plague these calculations. This is the "easy case" of quantum electrodynamics, considered plenty hard enough to be unsolved for a long time. They are preparing the way for solving some problems in quantum chromodynamics, which is the "real" theory of quarks and gluons.

Munczek and Doug McKay also work together on confinement, which is the big question of why a quark, once born, never can leave its hadron home and wander freely in the universe. The answer is not simple: nobody knows why, nor how. Physics is still full of mysteries!

John Ralston visited Cambridge University during the summer to give a talk on the interface of particle physics-type QCD and nuclear physics at the ELFE Summer School. An ELFE is a cute nonexistent creature, costing several billion French francs, which the high-energy experimentalists in Europe want to build. For now the experiment may be even more hypothetical than the theory, but just wait.

Ralston also did historical research in Dublin, Ireland, on an obscure, entirely unknown early physicist whom he claims made the first Gauge Theory — the correct theory of light long before Maxwell. Nobody has yet figured out why Ralston was reading papers from the 1830s!

McKay and Ralston worked with Kansas Institute postdoc George Frichter during the year on detecting neutrinos with microwaves. The neutrinos make 0.5 Ghz microwaves via showers of particles traveling near the speed of light. These thought-experiments assume a neutrino with really high energy, 10^{16} eV and above, found in cosmic rays. Surprisingly, the neutrinos get a lot "bigger" at extremely high energies because they see more quarks! The theorists have convinced experimenters to work on this at the south pole. Why there? The ice is a good transparent medium for radio waves, and there's lots of ice!

Ralston and grad student Borge Nodland have challenged the good old Maxwell equations for electromagnetism on the largest cosmological scale. It seems that even the speed of light is not the speed of light! ■

Editor's note: Yeah, but is it testable? Ralston replies: "Yes, otherwise it would just be theory. Furthermore, we work only on testable ideas."

Kansas Institute for Theoretical and Computational Science

With 20 outside seminar speakers and a distinguished physicist visiting for several days, the Kansas Institute for Theoretical and Computational Science (KITCS) added a lot of action to our de-

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Kansas Institute

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partment in the past year. The seminar series was particularly heavy in the area of numerical analysis and computational physics and chemistry. Time series analysis was a favorite subject, with Bell Labs physicist David Thompson presenting an analysis of global warming, among other things, and University of Missouri condensed matter/bio-physicist Frank Moss reporting on his study of possible chaotic behavior in the crayfish's sixth ganglion. These are two examples from a wildly diverse group of fascinating visitors.

The KITCS distinguished lecturer this year was Leo Kadanoff from the University of Chicago. In his public lecture he struck the theme of computer simulation and visualization in physics with a talk titled "Little Worlds," in which he described investigations of reality in computer models. He used a number of intriguing examples ranging from "dancing patterns" in liquid flow to similarities among pulled taffy, splashing milk, and dripping faucets. Kadanoff spent several days on campus talking with faculty, graduate students, and undergraduate students.

Physics graduate and undergraduate students worked with faculty members Braaten, Lai, McKay, and Ralston on a variety of interdisciplinary subjects that drew participation from faculty and students in other departments. Research in turbulence, controlling chaos, time series analysis, and neutrino astrophysics was reported in conferences and refereed publications. Proposals to funding agencies on all of these topics have been spun off from the KITCS collaborations, and details of the work appears in the accounts of the individual research groups. ■

Nuclear physics

The experimental heavy-ion nuclear physics program, whose faculty consists of Professors Frank Prosser and Stephen Sanders, continues to be active. Their three-year grants from the Department of Energy and the National Science Foundation cooperative grant with the Center for Nuclear Research in Strasbourg, France, will end in 1996. A renewal proposal to the DOE will be made, and their proposal to the NSF in collaboration with the Nuclear Physics Laboratory of the University of Sao Paulo, Brazil, is under review.

Graduate student Kelly Farrar's dissertation involved the analysis of fusion-fission data obtained in the interaction of ^{36}Ar and ^{12}C. For this experiment, which made use of particle-particle and particle-γ-ray coincidence measurements, he developed a large Bragg-curve spectrometer. Since his defense, Kelly has remained with us in a postdoctoral position and has been exploring new counter gas mixtures for use with the Bragg spectrometer. He has also written a draft of his thesis work for publication.

The group, along with graduate student Andrew Dummer, returned to Argonne National Laboratory in February 1995 to do another experiment with this same target-projectile combination, but with a quite different objective. Theorists have speculated that the compound nucleus ^{48}Cr formed in this interaction may occasionally fission into three ^{16}O nuclei, and they wished to investigate for the presence of this ternary fission channel. The predictions indicate that the use of this very asymmetric entrance channel offers the most favorable combination of excitation energy and angular momentum for this process to occur. Analysis of these data is still in process. This experiment gave them the opportunity to use the hybrid detector consisting of a multiwire proportional counter followed by a silicon-strip detector mentioned in last year's newsletter, and it performed quite well. The MWPC portion is position sensitive to provide angular information and timing for time-of-flight determination, while the Si(SB) detector provides them with total particle energy and additional timing. The combination of time-of-flight and energy allows the determination of the mass of the detected particle. Development of the hybrid detector is continuing by exploring the use of alternative gasses for the MWPC with the possibility of using the energy loss in it with the particle energy to identify the charge of the particle and, thus, full isotopic identification of the detected particles.

Working in a different mass region, Sanders has been analyzing data obtained in an earlier Argonne measurement of single and few nucleon transfer channels for the $^{136}Xe + {}^{64}Ni$ reaction. The goal is to determine whether mass flow occurs by sequential transfer of nucleons or by cluster transfer. Preliminary indications are for a cluster transfer mechanism, although the analysis is not yet completed. Cluster transfer would involve interesting correlations among the transferred nucleons. ■

Space physics

The space physics group has had a busy year. Several students in the group received Ph.D.s in the past year, including Jay Lindgren in November 1994 ("Magnetohydrodynamic Models of Comet Halley"); Moncef Boufaida in April 1995 ("Gradients of 0.3 to 5 MeV Protons in the 1-5 AU In-Ecliptic Plane: Propagation, Modulation and Acceleration"); and Naser Alinejad in July 1995 ("Analysis of Galileo Energetic Particle Detector Observations of Earth's Geomagnetically Trapped Protons").

Professor T.E. Cravens spent the spring semester on sabbatical at the Laboratory for Space and Atmospheric Physics at the University of Colorado in Boulder. He worked on the evolution of the Jovian ring system, and on the Jovian magnetosphere and aurora. Additional research involved work with grad student A. Maurellis on the ionospheric effects of the impact of the fragments of comet Shoemaker-Levy-9 with Jupiter.

Professor T.P. Armstrong continues his work as a co-investigator on the Galileo, Ulysses, Voyager, Geotail, and Cassini spacecraft missions. He and graduate student Dennis Haggerty continue to receive the Ulysses HISCALE investigation data from NASA's Jet Propulsion Laboratory and to process it for distribution and scientific analysis at scientific laboratories around the world. In addition to maintaining and improving the software for this task, Armstrong and Rajat Sahi have published the authoritative Handbook for HISCALE Data Analysis. Armstrong has also developed computer codes to describe the design of the charged particle counting instrument on the CASSINI MIMI investigation. Graduate student Chris Brull has prepared Galileo Earth I and II encounter data for archiving and is writing code for the energetic particle detector experiment that will analyze the downlink data stream as revised to accommodate the malfunctioning antenna. Alexei Nikitin, Ruslan Davidchak, and Armstrong have developed and tested a new technique for evaluating the responses of silicon-charged particle detectors in space to solar X-rays. This work will enable an extension to two full solar cycles of observations of the largest solar flare X-ray events. ■

FACULTY NEWS

Faculty awards and news

David Besson received the Undergraduate Teaching Award. Nominations come from students and the Faculty Evaluations Committee, which makes the final decision.

Barbara Anthony-Twarog was elected to membership in the Kansas Woman's Hall of Fame.

Tom Cravens attended an International Astronomical Union symposium at the Space Telescope Institute in May of this year. The topic was the Shoemaker-Levy Comet collision with Jupiter.

Adrian Melott organized a special session at the June meeting of the American Astronomical Society in Pittsburgh, Pa., on "Dynamics of Large-Scale Structure in the Universe." Invited speakers included **Professor Shandarin** of KU. One result of this session was an article in Science News that highlighted the KU cosmology group's role in constructing a new approach to the theory of structure formation in the Universe. The KU group was also featured in the spring issue of Access, the publication of the National Center for Supercomputing Applications.

Sergei Shandarin spent two weeks in July 1995 at the Inter-University Center for Astronomy and Astrophysics in Pune, India. He was an invited speaker at the XV Moriond Astrophysics Meeting on "Clustering in the Universe" in Les Arcs, France. He also was on the bill at the meeting on "Measuring, Mapping, and Modelling the Universe" in Valencia, Spain.

Adrian Melott spoke this year in scientific colloquia at the University of Illinois, Ohio State, Carnegie-Mellon, the University of Michigan, the University of Nevada, the University of Florida, and Columbia. He also reviewed proposals for NSF, NASA, sat on a NASA advisory committee, commented on research proposals for the governments of India and Germany, and advised an endowed professorship search in Germany.

Adrian Melott has become interested in the emerging "anti-science" movement in academia. He attended the New York Academy of Sciences meeting, "The Flight from Science and Reason," in June. He recently lectured on "Is America Becoming More Superstitious" at a number of off-campus sites and had letters to the editor on this topic published in The Sciences, Academe, and The Scientist. He has also recently begun work on developing a curriculum to introduce ideas about cosmology to young children.

Jack Davidson was elected chairman of the Senate Executive Committee for the next academic year.

Alice Bean plays in the Topeka Symphony and was thrilled to experience playing with Itzak Perlman in November 1995.

Steve Shawl was an invited participant in a symposium titled "Astronomy Education: Recent Developments, Future Directions" at the annual meeting of the Astronomical Society of the Pacific at the University of Maryland in June. He continued as a Harlow Shapley Lecturer for the American Astronomical Society, for which he spent two days giving talks at Hameline University in St. Paul. On the weekend after the talks, he was on the stage during the live broadcast of Garrison Keillor's "Prairie Home Companion," which he reports to be great fun in person. ■

What does the faculty do?

What do faculty members do with their time? According to many voices coming from Topeka, faculty do little. The reaction heard is something like "What can a teacher who spends merely three to six hours per week in the classroom be doing to earn an all-too-high salary?" While hearing such sounds during the last spring, one member of the department spent a few minutes making up the following partial list of typical faculty work:

- Prepare course lectures.
- Grade course assignments and exams.
- Prepare syllabi for courses.
- Advise undergraduates.
- Tutor and answer questions from enrolled students outside of class.
- Do research and scholarly work.
- Advise graduate students.
- Attend departmental and university committee meetings and do the required out-of-meeting work (examples: curriculum, admissions and assistantships, laboratories, computers, evaluations).
- Read (and criticize) master's theses and attend the exams of other peoples' students.
- Read (and criticize) Ph.D. theses and attend the exams of other peoples' students.
- Read the scholarly literature and stay abreast of the most important recent knowledge in one's specialty and of science generally.
- Assist Ph.D. students in the development of a research problem and guide progress through it. Closely monitor and criticize the dissertation work to be certain that it is correct, complete, and adequate for the Ph.D. degree. Offer detailed editorial comment on the dissertation draft.
- Respond to telephone inquiries from the public.
- Respond to and interact with scholarly colleagues world-wide to cultivate contacts.
- Write proposals for external support of one's research.
- Write manuscripts and books on one's research.
- Review proposals for external funding agencies
- Review manuscripts for professional journals.
- Write textbooks.
- Review textbook manuscripts for publishers.
- Respond to administrative requests for program review and self-study materials.
- Attend professional meetings.
- Prepare and present papers at professional meetings.
- Prepare and carry out on- and off-campus speaking requests.
- Assist in or conduct public relations activities for the department and the university.
- Contribute to the improvement of K-12 education — especially in science and mathematics.
- Attend seminars, colloquia, and lectures, and contribute to the intellectual life of the university.
- Write letters of recommendation for students (majors and non-majors alike).
- Write letters of recommendation for colleagues around the world. ■

DEPARTMENT NEWS

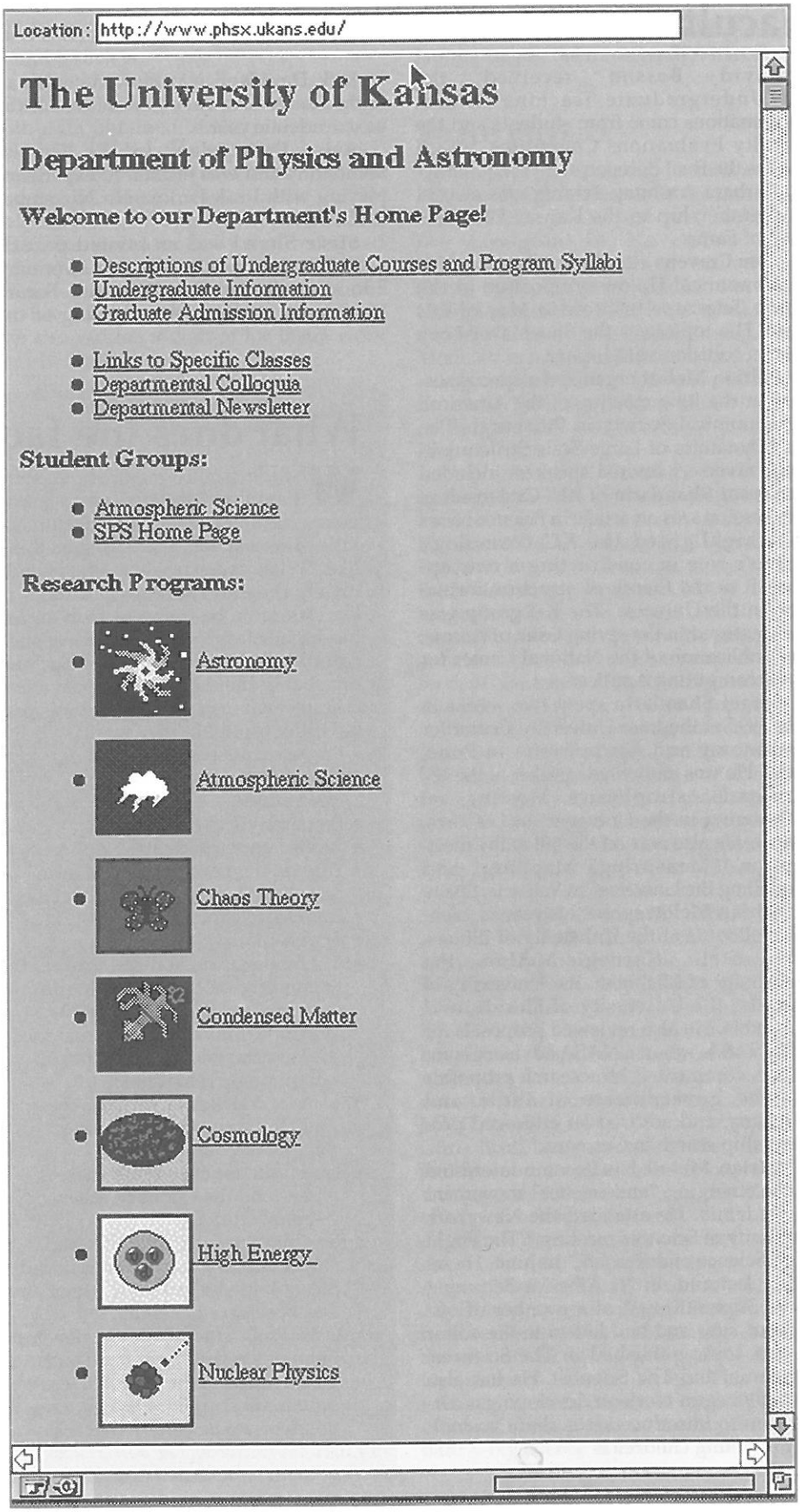
Our place in cyberspace

Since scientists have been communicating with each other via computer for more than 20 years, the usefulness of an Information Super Highway is not particularly new to us. However, the present-day high-speed communications, along with the dramatically expanded availability of information, has provided increased usage not only by faculty but also by students. To help and encourage students to utilize the resource, a computer specifically for their use of the Internet has been set up in the department reading room.

Departments across the country have established home pages to present their programs to the outside world. We are no different. These pages are accessed by people throughout the world and provide an important recruiting tool. Our home page, located at http://www.phsx.ukans.edu/, contains information on our undergraduate and graduate programs, our weekly colloquia, SPS and the Atmospheric Science Club, each of our research programs, and connections to physics, astronomy, and meteorology sites around the world. Our in-house monthly newsletter is also available there, so those of you connected to the Internet can stay up with the department more easily. The page was begun last year by Professor Stephen Sanders and brought to its present state over the summer by undergraduate physics major Ina Robertson.

The World Wide Web provides a tremendous opportunity for educators. Professors Besson, Sanders, and Shawl are making use of this resource in their classes. For example, Besson uses it to post the course syllabus, attendance records, and homework scores for Physics 115. Sanders has specific links to PSPICE available for his Physics 536 class on electronic circuits and measurements. Shawl uses it to provide advanced students with data necessary for problem sets that require analysis of large amounts of data. A page for his introductory astronomy course includes his syllabus, study guides, course schedules, and other materials pertinent to the course as well as links to astronomical sites around the world.

Finally, there are links to other parts of the University and Lawrence communities. The Lawrence Cybervillage is the official Web site for the city. The link to the Lawrence Journal-World allows you to keep up on local events from the comfort of your home or office. We hope that readers of this newsletter will visit us via the World Wide Web and stay in touch with us more often since it is now so easy! Of course, a visit to Lawrence is better yet! ■



ALUMNI NEWS

Recent Graduates

Randall Splinter received his Ph.D. (Melott was adviser). He accepted a postdoctoral offer at the Center for Computational Science at the University of Kentucky. He will continue his cosmology research there, and is extending his techniques to include computational fluid dynamics.

Kelly Farrar successfully defended his Ph.D. dissertation in December 1994 (Sanders was adviser). He remained with us as a postdoctoral student during the spring and summer of 1995.

Homa Roshanaei completed her M.S. degree and wrote a thesis entitled "An investigation of the sources and impacts of airborne particulate matter to works of art inside the Spencer Museum of Art (Lawrence, KS)."

Jenny Hand (BS, astronomy and physics), whose astronomical studies were always of distant objects, is focusing on more nearby problems as a graduate student in atmospheric science at Colorado State. Her change to atmospheric studies resulted both from the poor prospects in astronomy and her desire to do something that would have direct social and environmental impact. She'll be able to apply the research experience she gained during summers at Haystack Radio Observatory, the National Radio Astronomy Observatory, and NASA AMES to good use.

Jason Craig (BS, astronomy and physics) is using his scientific training at the law school of Lewis & Clark University.

B.J. Custard (BS, astronomy and physics) is working for Software Synergy in Kansas.

Tony Michael (BS, astronomy and physics) is a graduate student in physics at the University of Illinois.

1960s

Bill Daeschner (BA61, physics/math) retired from his work in operations research with the federal Senior Executive Service at the end of 1994. He is currently being treated for non-Hodgkins lymphoma.

Bruce Barrett (BS61, physics), a physics professor at the University of Arizona in Tucson, traveled with his wife for two weeks in Namibia. Traveling on their own in a rental car allowed them to see quite a bit. His wife Joan, a free-lance writer, wrote a story about the trip that was published in the Tucson paper.

Monti Wilson (BSEP68, PhD72 physics) is now free to pursue science on his own terms because of corporate downsizing. When not playing pool at the local pub, he is director of research for TensorTech Corp. His latest (sixth) invention is the first high-quality time compression/expansion algorithm for digital audio broadcast time slot fitting. He thanks KU for teaching him the practical side of physics!

1980s

Robert Bunch (PhD81) is a full professor at Rose-Hulman Institute of Technology in Terre Haute, Ind. His research interests are broadly in the areas of fiber optic components and systems, optical fiber measurements and characterization, optical instruments and measurements, and image processing. He is also the assistant director of the institute's Technical Assistance & Services Center, which directs industrial projects to faculty experts who then consult with the industry.

Rebecca Chaky (PhD81, physics) is the lead engineer for integration of the plasma contactor on International Space Station. She works for Boeing at the Johnson Space Center in Houston.

Brad Roth (BS82) has accepted a position as the Robert T. Lagemann Assistant Professor in Living State Physics at Vanderbilt University in Nashville, Tenn. He will teach physics, continue his research in theoretical cardiac electrophysiology, and help develop a computational physics program. From 1988 to 1995, Brad worked at the National Institutes of Health in Bethesda, Md. He is married and has two daughters, ages 4 and 6.

Keith Propp (PhD84), who is still working for Kaman Sciences Corporation in Colorado Springs, Colo., was honored recently by Casper College in Wyoming as an "exemplary alumnus."

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Alumni response

An important message to our alumni

The department receives assistance from the KU Alumni Association and the Office of University Relations to produce and distribute this newsletter. But you help us in this and many other ventures through your contributions to the department's Development Fund. Please take a moment to send some news of yourself and, if possible, a contribution to the fund.

_____ **Contribution to the Department of Physics and Astronomy Development Fund enclosed.**

_____ **Contribution to the Clyde W. Tombaugh Observatory Fund enclosed.**

Name _____

Address _____

City _____ State _____ ZIP _____

Country _____ Year(s) of graduation, degree(s), and program(s) _____

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Alumni information for this newsletter _____

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Suggestions for improvements or additions to the newsletter: