MICHIGAN STATE UNIVERSITY
Department of Physics & Astronomy
East Lansing, MI 48824-1116

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New Building Nearly Complete

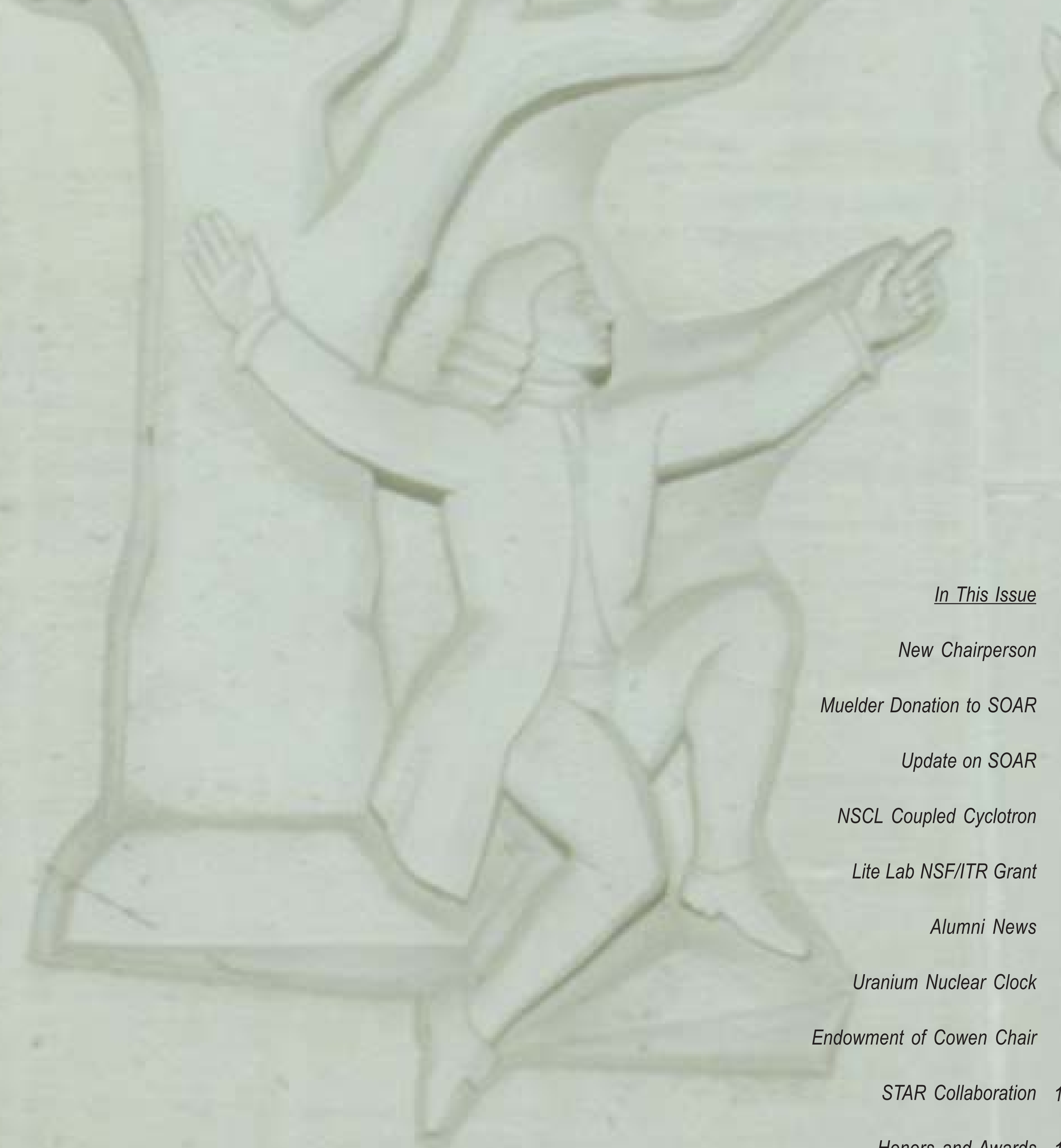
Wayne Repko

When seen from the outside, the new Biomedical and Physical Sciences (BPS) building looks ready for occupancy. The condition of the building's interior, however, ranges from very nearly completed office and laboratory space on the upper floors to a noisy, dusty construction site on the main floor. Much of the main floor is devoted to physics teaching and research space, and at this stage of construction the walls for the various rooms are in place, large air handling ducts have been installed and the installation of the electrical service is progressing. The scheduled completion date of January, 2002 looks firm.

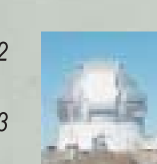
With the building completion only six months away, plans for the move are becoming serious. This will be a rather elaborate process since three departments, Microbiology, Physiology, and Physics-Astronomy, and the Chemistry and Physics libraries are moving into BPS. With luck, the move will be completed in the first half of 2002, and the first classes will be taught in BPS in the fall of 2002.

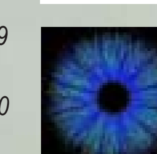
Physics and Astronomy

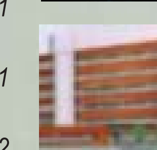
Michigan State University Summer 2001



In This Issue







Volume 3
Summer 2001

Newsletter
MSU Physics and Astronomy Department

Wolfgang W. Bauer. . . . Chair, Department of Physics and Astronomy
Daniel R. Stump . . .Associate Chair for Undergraduate Instruction
Phillip M. Duxbury . . . . Associate Chair for Graduate Instruction
Eugene J. Kales . . . . Newsletter Production Editor

A Letter from the Chair

Dear Friends of the Department of Physics and Astronomy,

After seven years of dedicated and very successful service to the Department in the role of chairperson, Prof. Brock has decided to return full-time to the life of a researcher and teacher. His tenure as chairperson has seen marked improvements in our national rankings - we are currently number #10 in citation impact and #8 in federal funding of all physics departments in the country - and witnessed the start of very important construction projects, the coupled cyclotron upgrade, the SOAR telescope, and our new biomedical and physical science building. I am very fortunate to be able to take over the duties of chairperson from Prof. Brock. He will be a tough act to follow, but I am willing to try.

On July 27, we celebrated the inauguration of the new coupled cyclotron facility of the NSCL. This $20 Million upgrade will ensure that our nuclear physics group, currently ranked #2 in the country only behind MIT, will continue to be a leader in the international nuclear physics community. Among the speakers at the inauguration was Michigan Governor John Engler who pointed out that our research in the physical sciences was crucial for the future of the state of Michigan.

Our new science building will become our home starting in January and is making very rapid progress. In particular the research facilities for condensed matter physics, housed in the basement, will be competitive at the highest level. Many private donations, some of them very large, continue to ensure that we will be able to afford state-of-the-art research equipment, as well as to provide the highest quality teaching facilities for our students.

Raymond Brock and Wolfgang Bauer

The construction of the SOAR telescope is making great progress, the undergraduate physics and astronomy major enrollments are rising, our teaching programs continue to earn national awards and large research grants, and the Department has just received its first privately endowed chair, the Jerry Cowen Chair of Experimental Physics. It sure is a great time to work and study in our department, and we hope that the content, as well as the new format, of this newsletter conveys this message to you and lets you share in the excitement.

Best wishes

Wolfgang Bauer
bauer@pa.msu.edu

url: www.pa.msu.edu/alumni.htm
email: newsletter@pa.msu.edu

Chronology of Department Chairpersons

(no separate Department)	1857 to 1889
Philip B Woodworth*	1890 to 1899
Martin D. Atkins*	1899 to 1902
Arthur Rodney Sawyer*	1902 to 1918
Charles Willis Chapman	1918 to 6/30/41
Thomas Harris Osgood	9/01/1941 to 3/15/1950
Egon Alfred Hiedemann	9/01/1950 to 6/30/1954
Thomas Harris Osgood	9/15/1954 to 8/31/1955
Richard Schlegel	9/01/1955 to 8/31/1956
Robert Dean Spence	9/01/1956 to 8/31/1957
Sherwood Kimball Haynes	9/01/1957 to 8/31/1969
Frank Joachim Blatt	9/01/1969 to 12/31/1972
Truman Owen Woodruff	1/01/1973 to 12/31/1975
William Harold Kelly	1/01/1976 to 9/10/1979
Julius Stephen Kovacs	9/01/1979 to 8/31/1980
Sam M Austin	9/01/1980 to 8/31/1983
Jack Bass	9/01/1983 to 8/31/1989
Gerard Marcus Crawley	9/01/1989 to 1/15/1994
Raymond Brock	8/16/1994 to 2/15/2001
Wolfgang Bauer	2/16/2001 to present

*Head

Honors Mentionable

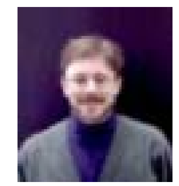
Congratulations to Faculty, Staff, and Students in the Department who have received the following Awards and Honors recently:

Wolfgang Bauer receiving the Alexander-von-Humboldt Distinguished Scientist Award

Chip Brock, Fellow, American Physical Society

William Hartmann, Distinguished Faculty Award

Hendrik Schatz, Alfred P. Sloan Research Fellow



Stuart Tessmer, Alfred P. Sloan Research Fellow

Gary Westfall, Fellow, American Physical Society

Department of Physics and Astronomy Awards for 2000/2001: Bruce Ver West Outstanding Junior Award to **Jeris Stueland**; Thomas H. Osgood Outstanding Senior Award to **Stelios Tsangarides**; Best Teaching Assistant Award to **Paul Kotas**; Sherwood K. Haynes Outstanding Graduate Student Award to be shared by **Barry Davids** and **Tatiana Sharpee**; Best Graduate Teacher Award to **Wayne Repko**; Outreach Award to **Edwin Kashy** for Dimensions, CHAMP, and CAPA; Distinguished Staff Award to **Deborah Simmons**; Thomas H. Osgood Teaching Award (Non-Tenured) to **Scott Pratt**; Thomas H. Osgood Teaching Award (Tenured) to **William Pratt**; Thomas Kaplan Award to be shared by **Ming Lei** and **Viktoria Greanya**.

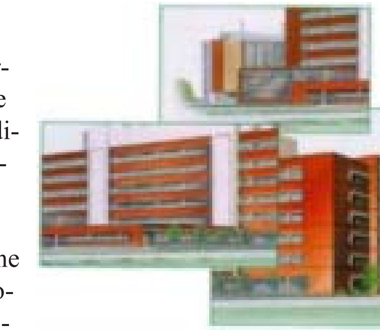
heavier than helium. Hydrogen and helium are products of the initial "Big Bang" expansion of the universe, but all heavier elements were built up by nuclear reactions in, or having to do with, stars. The understanding first of this general process and now of its details has been a major theme in astronomy over the past 50 years.

The study of emission lines from quasars also tells us about the evolution of the central black holes, in particular the rate at which mass falls onto them. This again carries information about the early evolution of the stars in these primeval galaxies. The overall aim of Baldwin's research is to use quasar emission lines to learn about the early evolution of galaxies.

Baldwin is currently working with graduate student Aaron LaCluyze and a nation-wide group of collaborators on a survey for new quasars, combining optical-passband images from ground-based telescopes with x-ray images from NASA'a Chandra X-Ray Observatory. This will identify an optimum sample of quasars for follow-up spectroscopic studies using the SOAR telescope after it comes on-line next year.

Strosacker Foundation Helps Fund New Science Facility

Rick Seguin



The Charles J. Strosacker Foundation of Midland has given Michigan State University a grant of $250,000 to be used toward the new Biomedical and Physical Sciences Facility currently under construction on campus. The grant will specifically fund the Collaborative Teaching Laboratory in that part of the facility that will be utilized by the Department of Physics and Astronomy. Such a laboratory gives the department an opportunity to teach in a setting that best allows students to interact and develop their science skills.

"In addition to being the first lab of its kind on MSU's campus, it will also be one of the first of its kind in the nation designed for one-on-one, active learning opportunities in physics," said Eugene C. Yehle, Chairman of the Charles J. Strosacker Foundation. "The trustees of the foundation support this effort and innovation and are happy to be able to ensure its existence in the facility."

Recent experiments with collaborative learning have proven to MSU faculty that a more personalized approach greatly benefits students. Gathering students in large spaces with grouped tables, computers, and blackboards promotes collaborative learning which, after several years of experimentation in the department, clearly reinforces the mathematical and physical reasoning needed to firmly grasp the concepts of physics.

"Physics faculty at MSU have been learning over a long period of time the benefits of teaching in a collaborative atmosphere," said Wolfgang Bauer, Chair of the Physics and Astronomy Department. "The new facility will enable us to build on our strength and enhance our national leadership position in this field as well as enable us to teach our students more effectively."

"The Strosacker Foundation has been a generous supporter of Michigan State University in the past, and this gift is further evidence of their commitment to supporting important educational opportunities," said MSU President Peter McPherson. "We're glad to count the Foundation among our most significant supporters of the new science facility."

The new Biomedical and Physical Sciences facility is a seven story, 350,000 square foot building located at the corner of Wilson Road and Farm Lane on MSU's campus. It will connect with the biochemistry and chemistry buildings to create the largest research complex on campus and will provide much needed space for several colleges and departments across campus. Of the total $93 million cost for the facility, MSU is responsible for raising $13.3 million from private sources. The Strosacker Foundation gift brings MSU's efforts to over $11 million to date.

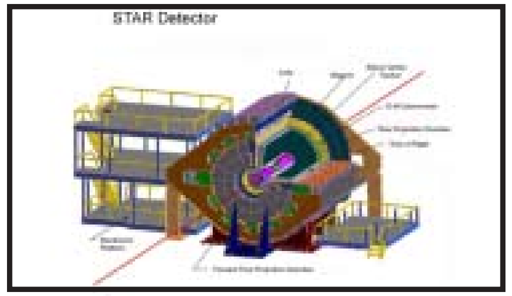
The Foundation was established in 1957 by the late Charles J. Strosacker, one of the pioneers of Dow Chemical Company, to assist and benefit political subdivisions of the State of Michigan, and religious, charitable, benevolent, scientific and educational organizations.

STAR

A few microseconds after the big bang, the universe existed as a soup of quarks and gluons. These quarks and gluons were not confined in nucleons as we find them today but instead formed a plasma of nearly massless quarks and gluons. Using the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory on Long Island, New York, nuclear physicists are attempting to recreate this state of matter (on a small scale, of course!) by colliding two beams of gold nuclei each with kinetic energies of 100 GeV/nucleon. This energy is thought to be high enough to create an extended system of deconfined quarks and gluons. To detect the quark gluon plasma, nuclear physicists have created four specialized detection systems to measure the expected 10,000 particles per collision; STAR and PHENIX, PHOBOS and BRAHMS. The STAR (Solenoidal Tracker at RHIC) detector consists of a large room temperature solenoidal magnet, the world's largest time projection chamber (TPC), a silicon vertex tracker (SVT), two forward TPCs (FTPCs), a central trigger barrel/time-of-flight array, a ring-imaging cerenkov hodoscope (RICH), and an electromagnetic calorimeter (EMC).

Aerial View of Brookhaven National Lab showing the MP tandem Van de Graff injector, Alternating Gradient Synchrotron (AGS), and RHIC ring.

Last summer RHIC began it first physics run with the first event being recorded by STAR June 12, 2000. The main part of the run was carried out with two gold beams of 65 GeV/nucleon giving a center of mass energy = 130 GeV. A typical event observed by STAR is shown below as registered by the TPC. This view is looking down the beam axis at the TPC. This event is a central collision with about 1,500 tracks registered. RHIC and STAR finished the first physics September, 2000 and will resume running early this summer and run through April, 2002.

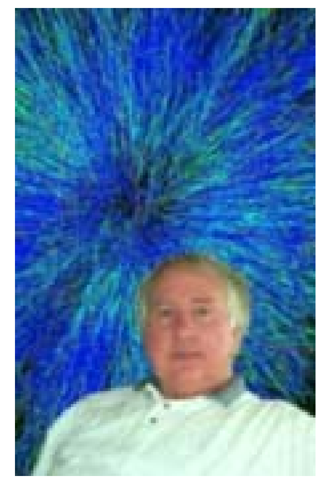


Drawing of the Solenoidal Tracker at RHIC(STAR)

MSU nuclear physicist Gary Westfall and his group are collaborating in the STAR experiment. MSU is responsible for the construction of the optical fibers for the barrel EMC and the endcap EMC. The barrel EMC consists of 120 modules each containing 40 towers each with 21 layers of scintillator and lead. The endcap EMC consists of an annular detector with 720 towers each with 24 layers of scintillator and lead. Both the barrel and endcap EMCs have shower maximum detectors embedded at a depth of five radiation lengths to provide high spatial resolution and hadronic/electromagnetic separation. Completion date for the calorimeters is early 2004.

STAR has published its first physics result in Physical Review Letters (Phys. Rev. Lett. 86, 402 (2001)) and has several more in preparation. MSU is carrying out an analysis project to clock the time of hadronization in RHIC collisions using the recently proposed balance function.

Gary Westfall is a member of the STAR Council and is the Convener for the Event-by-Event Physics Working Group in STAR. During the last run Gary Westfall served as Period Coordinator for the last two weeks of the run.



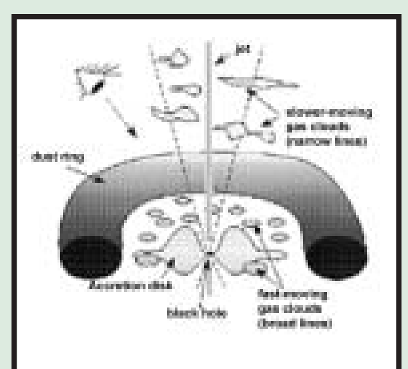
Background: Central collision of two gold nuclei at 130 GeV recorded in the STAR detector. The color of the track represents energy loss of the particle with warmer colors signifying higher energy loss.

Meet Jack Baldwin

Jack Baldwin joined the Astronomy Group in January 2000. He spent most of the previous 20 years as a staff astronomer at Cerro Tololo Interamerican Observatory, a US national observatory located in Chile. While in Chile, Baldwin was heavily involved in the SOAR telescope project, and so was drawn to MSU by our partnership in this 4m telescope.

Baldwin's research centers on the study of quasars. Quasars are extremely luminous events that occurred in the centers of many galaxies roughly 12 billion years ago, at the time in which the galaxies we know today were just forming. These objects can be seen out to great distances, which means that the travel time for the light to arrive from them is a large fraction of the total 14 billion year age of the universe. So astronomers get to see back into time and study the evolution of galaxies and quasars.

A typical quasar occupies a volume only about the size of our solar system, but from that small region generates an outpouring of energy up to 1000 times greater than the combined energy output of all 100 billion stars in the galaxy. The generally accepted model is that this is the release of gravitational potential energy from surrounding gas falling onto an accretion disk around a massive black hole.



Sketch of the central regions of a quasar, according to a widely accepted model .

The gas around black holes produces strong emission lines that Baldwin is studying in order to learn the chemical composition of the gas and about the early stages of the buildup of elements

Dr. Milton Muelder Gives over $300,000 to the SOAR Telescope

Dr. Milton Muelder flanked on the left by George E. LeRoi, Dean of the College of Natural Science, and on the right by Wolfgang Bauer, Chair of the Department of Physics and Astronomy.

The SOAR (SOuthern Astrophysical Research) consortium - in which Michigan State University is a key partner - will play a major role in the next generation of astronomy research in large part due to the development of a state-of-the-art telescope to be located in the mountains of Chile. Few people understand the benefits the telescope will provide quite like Dr. Milton Muelder, a history professor and vice president emeritus who has enriched the MSU community for over sixty-five years as a teacher, administrator and benefactor. He believes in the value of SOAR so much that he recently finalized an irrevocable $305,000 estate gift in support of the telescope. During a presentation to University Development, Dr. Muelder eloquently and movingly summed up why he thought that a knowledge of astronomy was an integral part even of a liberal arts education.

University Development asked Dr. Muelder to express in words the importance of support for the project, and he graciously supplied the following as a contribution to their Development Newsletter: (see inset)

For more information on supporting the SOAR telescope, contact Suzette Hittner, Director of Development for the College of Natural Science, at (517) 353-9855.

Windows And More Windows Of Opportunity:
The SOAR Telescope

"Supremely and ideally perched high in the Chilean Andes and blessed with an atmospheric ambience of dry and infrared air - so coveted by astronomers - the SOAR telescope offers a superb window not only to explore the mysteries of our own galaxy but that of galaxies beyond. We are invited to become interested spectators of scientific probes seeking to unravel the mysteries of the universe, some would say to carry us back virtually to the creation of the cosmos. These are endeavors of majestic proportions.

Repercussions have not ceased from that gigantic bang 13 billion years ago which set the cosmos and all its constituent parts in motion, including the earth and its solar system. Some galaxies have already died, some new galaxies have been formed, and others are being formed. All are in a state of flux. Nature's store of secrets invites continuous explorations and challenges to the human mind. We have been informed that 90% of matter of the universe is missing in the sense that we as yet have no way to detect it. We have gone far in our search for the component parts of the atom, but what of the component parts of the universe? And will the universe continue to expand indefinitely, remain about the same, or slow down and ultimately collapse back upon itself?

In an especially created viewing room on campus, we can have a front row seat to the spectacular scientific probes of our truly eminent MSU scientists - thanks to the magic of spontaneous digital transmissions from Chile. Few research endeavors can match that of the SOAR telescope in the breadth of its audience appeal and participation, not only for scientists in physics and astronomy and their graduate students but the wider academic audience and even the general public.

I harbor the ardent belief that endeavors emanating from this telescope will contribute significantly to making life for us earthlings more meaningful, more exciting, more interesting and even more highly valued by raising our individual awareness as well as that of the general public of our status in a fascinating, moving and ever-changing universe.

SOAR is a multi-institutional enterprise (Chile, Brazil, University of North Carolina and Michigan State University) requiring joint financial funding. It is imperative that MSU not miss this opportunity to make a quantum advance in its astronomy studies."

Dr. Milton Muelder
East Lansing, Michigan

SOAR:

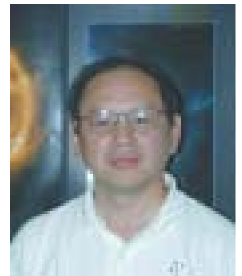
Getting Its Wings

The SOAR 4.2 meter telescope, currently under construction on Cerro Pachon, a 9,000 foot mountaintop in the foothills of the Chilean Andes, will be one of the most sophisticated instruments of astronomical discovery in the southern hemisphere.

With the new technology of its adaptive optics, SOAR (SOuthern Astrophysical Research) will produce sharper images than any other 4-meter telescope and will compete favorably with new 8-meter telescopes that are also coming on-line. This will enable MSU astronomers, both faculty and students, to work in the forefront of studying the nature of the universe at the time the galaxies were still forming, and examining the early history of our own galaxy. Although it is located half a world away from the East Lansing campus, real-time operation of SOAR will be possible from the Remote Observing Center being constructed in the Biomedical and Physical Sciences building, the new home of the Physics & Astronomy Department. The Center, adjacent to the building's atrium, will offer a window for past, present, and future Spartans (as well as the general public) to view firsthand the flow of data from SOAR, as well as participate in the excitement of discovery with MSU astronomers.

Current Status of the SOAR Project The Department of Physics & Astronomy entered the SOAR consortium, which includes Brazil, Chile, the National Optical Astronomy Observatories and the University of North Carolina at Chapel Hill, four years ago with the unanimous and enthusiastic support of the department faculty, the College of Natural Science, and the University. Astronomers at MSU have actively participated in the design and have reviewed not only the telescope itself, but also the instrumentation and control software that will make SOAR such a special tool for discovery. Final design reviews were completed in mid-1999. The mirrors that are the heart and soul of SOAR (including the 4.2 meter primary mirror) have been successfully formed at the Corning Glass Works and ground at into their final shape at Raytheon, Inc. The final "super polishing" step (see photo above) that achieves a surface regularity measured in tens of nanometers will be finished later this year. Aluminizing of the primary mirror will be performed at the Cerro Pachon site in early 2002. The facility itself, the telescope mount, the local observing control center, and the telescope dome, are now being constructed and installed on Cerro Pachon (see photo below). If you wish to share in the excitement of watching MSU's new "Window on the Universe" open, you can follow the construction effort in nearly real time by visiting the SOAR-Cam website at: http://www.physics.unc.edu/~evans/soarcam/soarcam.html

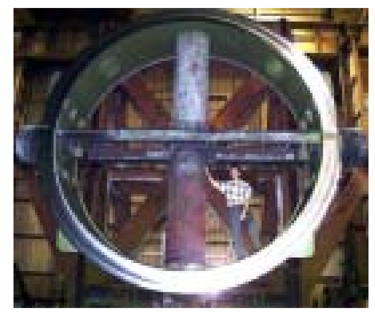
Polishing the mirror



Edwin Loh

Design of the Spartan Infrared Camera MSU astronomers have completed designs for the construction of the Spartan Infrared Camera, a device that makes use of newly available large-format detectors that are sensitive to light in the near infrared portion of the spectrum. A team of experts from the National Optical Astronomy Observatories and other institutions participated in a critical design review of the Spartan camera at the MSU campus in May. The team recommended construction of the Edwin Loh-designed instrument with only a few technical and budgetary modifications. In the infrared, astronomers can penetrate the gas and dust that shrouds some of the most interesting unexplored regions of our galaxy and examine the nature of objects over half of the distance to the "edge" of the observable universe.

Each of MSU's partners are also on schedule with their instrument projects. SOAR is unique in that a full set of instruments with a wide range of capabilities will be available during the early years of its operation.



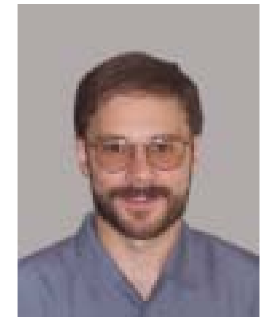
Center section

SOAR Project Financial Summary MSU's financial commitment to the $28 million construction cost of SOAR is $6 million. Already, $2 million has been allocated from internal University resources. The task before us is raising the remaining $4 million of this commitment. A great deal of progress has already been made these past two years. From the generous donations of alumni and friends of CNS, we have raised more than $1.5 million towards the $4 million goal.

The Future Astronomers refer to the date when a new telescope opens its eye on the universe for the very first time as "first light". SOAR construction is now on target to achieve first light in October 2002— only a short time away! We are now making a new appeal in hopes of finishing the fund-raising effort in time for first light. As SOAR opens MSU's window on the universe, we hope that you will participate in one of the greatest exploration adventures in the history of Michigan State University.

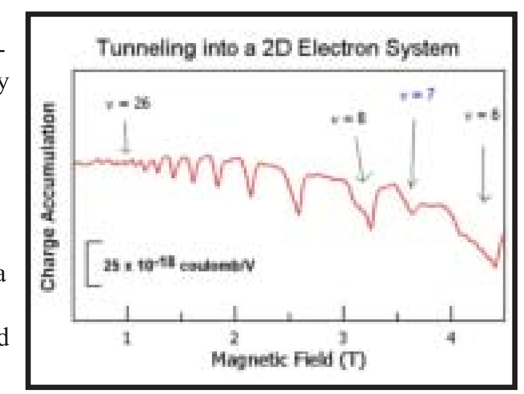
Current exterior and interior

Meet Stuart Tessmer...



Stuart received his Ph.D. in Physics from the University of Illinois at Urbana-Champaign in 1995. He came to Michigan State in 1998, following 2.5 years of postdoctoral research at MIT. His work is focused on applying novel scanning microscopy techniques to probe the behavior of electrons in semiconductors and superconductors. From a technological point of view, these techniques can be used to map-out electronic interactions with defects and interfaces. In cases where the electrons are confined to small dimensions, it is possible to probe fundamental questions such as the nature of electron-electron interactions.

A **c**harge **a**ccumulation **i**maging (CAI) microscope designed and constructed at Michigan State is pictured at the left. CAI was developed by Stuart during his postdoc, together with his colleagues at MIT. It is an incredibly sensitive cryogenic probe of charging within conductors and semiconductor systems. Essentially, as a result of an applied ac excitation voltage, charge runs in and out of a sample. The technique measures the image charge capacitively induced on a sharp tip positioned somewhere near the surface. This signal represents a measure of the local mobile charge within the sample below the apex of the tip. The beauty of the measurement is that the conducting layer can be buried 10's of nanometers below an insulating surface - yet still yield a resolvable signal on the tip. The microscope pictured was designed by graduate student Sergei Urazhdin. Our machine shop staff made the hardware, whereas the sensor electronics and scanning assembly was constructed (and reconstructed) by Sergei, postdoc Illari Maasilta, and graduate student Subhasish Chakraborty.

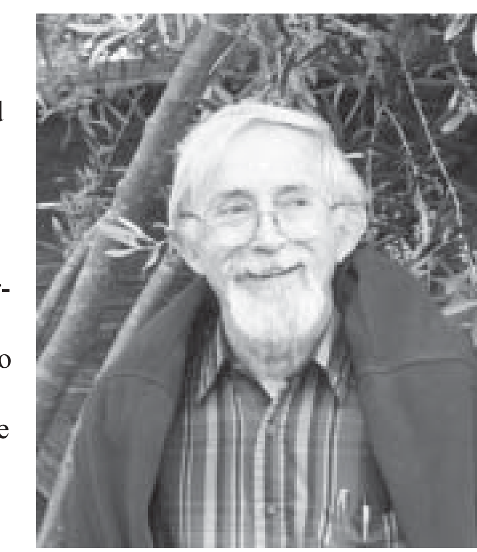


The data pictured here are from an experiment that locally resolves the quantum structure of two-dimensional (2D) electrons in GaAs-AlGaAs heterostructures as a function of a quantizing magnetic field - acquired with the microscope immersed in liquid helium-3 at a temperature of 0.27 K. The dips indicate fields for which the system's compressibility is locally reduced. The sample contains a 3D layer separated by a tunneling barrier from the 2D layer. In this case, the tip's position was fixed while monitoring the signal as a function of applied magnetic field. The dips arise as a result of the 2D layer becoming incompressible (insulating). They are labeled by their filling factor ?, which represents the number of filled quantum levels. In this way, Stuart's group can locally probe physics intimately connected to the quantum Hall effect. Indeed, these measurements are the first of their kind, locally probing a buried two-electron system.

Cowen Honors Father with Endowed Chair

Randolf L. Cowen

MSU graduate Randolph L. Cowen of New York has donated $1.5 million to the Department of Physics and Astronomy to create the Jerry Cowen Endowed Chair in Experimental Physics. It is named in memory of Randy's father, to honor his life and physics career at Michigan State University. In 1955, with the support of his wife Elaine, of Okemos, Michigan, Jerry, pictured below, began teaching in MSU's Physics department where he had earned his Ph.D. He excelled in both materials science research and teaching, particularly at the undergraduate level - something he continued to do until weeks before his death in January 1999. His research spanned five decades with many international collaborations. "His passion and commitment to his research became an inspiration for all the members of our family to strive to have an impact in a field that we love," explained Randy. "My father dedicated his life to research in the field of solid state physics. He was always looking for new ways and materials to look at. I want to see MSU have one of the best research efforts in the country in the field of solid state physics so that cutting-edge research can go on," Randy continued, "but also to draw a new generation of physics graduate students like my father to the university." Randy shared that he did not fully appreciate his father's teaching career until he attended MSU as an undergraduate. "Some of my friends who took his courses started to describe my father's enthusiasm in lecturing to large rooms of students," he said. "They took away not only a thorough grasp of the material that he taught, but also a vibrant image of his enthusiasm as he wrote across the chalkboard." Randy, who received his Bachelor of Arts degree in History with a minor in Math from MSU in 1974, is Co-Chief Operating Officer of the Technology Division and a Managing Director for Goldman Sachs, a global investment banking and securities firm headquartered in New York. He and his wife, Phyllis Green, have two children, Sarah and Matthew.



Professor Jerry Cowen

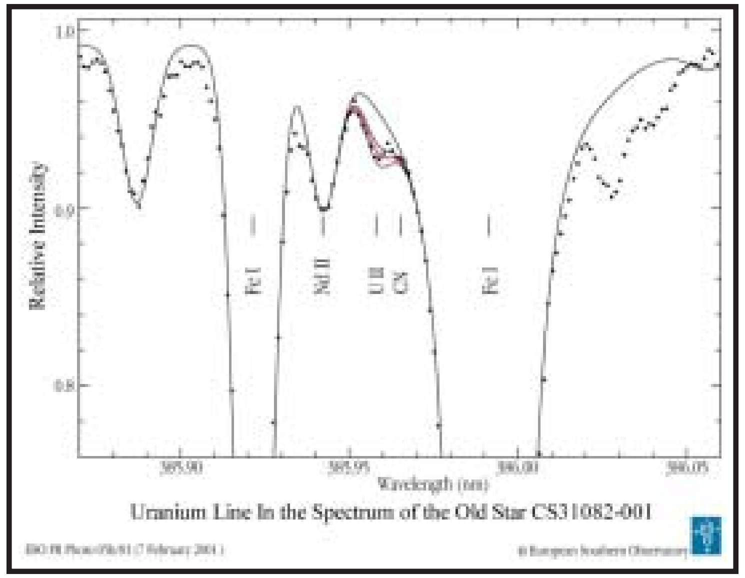
MSU Astronomer's New "Nuclear Clock" Helps to Limit the Age of the Universe

For the past 18 years, Professor Timothy Beers' research has been focused on the discovery and analysis of the first generations of stars to have formed in the Milky Way galaxy. These stars, "jewels of the night" as Beers refers to them, are exceedingly rare in the sky. Yet, at the same time, they are exceptionally valuable probes of the chemical history of our Galaxy. Just like fossils on the earth are used by archeologists to study ancient civilizations, astronomers can use these "metal-poor stars" to reveal the production history of elements by previous generations of stars that formed 10-15 billion years ago, long before the cloud of gas that eventually formed the solar system condensed from the interstellar medium. And recently, one of the stars discovered by Beers has drawn worldwide attention because of the discovery in its spectrum of the presence of the radioactive element uranium, the first such detection of this element outside of the Soar System. The discovery has sparked a flurry of activity by researchers around the world to exploit the measured abundance of uranium in this star as a nuclear "cosmo-chronometer," in order to set limits on the time that has passed since that element was formed in the early Galaxy.

The stars that Beers seeks are deficient in their abundances of "metals" (to an astronomer, any species heavier than helium) by factors of 100 to 10,000 times less than the Sun. Because the Sun formed rather recently in Galactic history, the gas out of which it was formed had been polluted by many previous generations of the element-producing stars. By contrast, at extremely low metal abundance, the stars were formed before the interstellar medium was exposed to the products of massive supernovae, which are thought to be the origin of most of the heavy elements. With the help many international collaborators (as well as numerous undergraduate and graduate students from MSU), Beers and his colleagues have succeeded in finding some 1000 stars with metallicity below 1/100th that of the Sun, and roughly 100 stars below 1/1000th that of the Sun. These stars can be studied relatively easily with the new generation of 8m-class telescopes such as the European Very Large Telescope (VLT, located in Chile) and the Japanese National Telescope ("Subaru"), located on Mauna Kea in Hawaii.

The discovery of uranium came last August, when Beers' European colleagues used the VLT to obtain a high-resolution spectrum (at left) of CS 31082-001, one of the brightest stars in his survey with metallicity below 1/1000th of the Sun. In addition to uranium, the spectrum of CS 31082-001 shows the presence of a host of elements formed in the so-called rapid neutron-capture process (r-process), thought to be associated with massive supernovae explosions. The list of interesting species is long, and includes many rare earth elements never before seen in the spectra of metal-poor stars. The reason so many "exotic" elements are detected in a metal-deficient star is that, for reasons still the subject of investigation, CS 31082-001 has had its r-process elements "boosted" relative to their usual (undetectable) levels by a factor of almost 100 times greater than are found in normal stellar material. One speculation is that CS 31082-001 is a member of a binary system in which its companion, once a much more massive star, underwent a violent supernova explosion that peppered the surface of CS 31082-001 with r-process elements, then collapsed to a black hole.

CS 31082-001 is the second star which has been found from Beers' survey to be greatly enhanced in r-process elements. The previous discovery, CS 22892-052, shows an excess of r-process elements roughly 50 times greater than normal. CS 22892-052 also shows the presence of the radioactive element thorium, which astronomers have been using to set age limits on the Galaxy as well. Thus far, CS 31082-001 is unique in showing the presence of BOTH uranium and thorium. Used in combination, the ratio of these elements provides a much more accurate "clock" than either one of them alone.



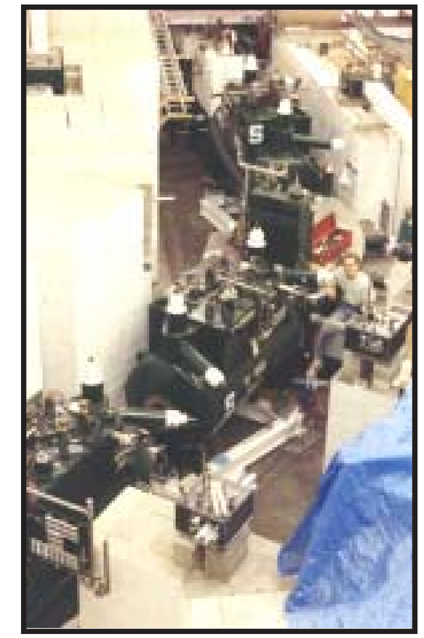
The age limit of 12.5 ⁄3 billion years (reported by Cayrel et al. 2001, Nature 409, 691) is of great importance because it is obtained in a completely different manner than previous estimates of the age of the Galaxy and the universe, which rely on assumptions about stellar evolution, difficult-to-measure distances to faint galaxies, and the behavior of light curves from distant supernovae. In February, Beers and colleagues (including graduate student Ralf Toejnes and faculty member Hendrik Schatz at the NSCL) reported in a meeting in Hawaii that the age of the material in CS 31082-001 is likely to be between 11 and 15 billion years old, based on current nuclear physics information.

Beers is presently on sabbatical at the National Astronomical Observatory of Japan (Tokyo), where he and his colleagues are designing search strategies to uncover an additional 20-30 r-process-enhanced metal-poor stars such as CS 22892-052 and CS 31082-001. They plan to make use of the VLT and Subaru telescopes in order to conduct a "quick survey" of some 1000 metal-deficient stars over the course of the next few years in order to find new cosmo-chronometers. With the additional information these new discoveries will reveal, it is expected that astronomers will finally have the data from which they can not only determine a precise age limit on the Galaxy and the universe, but also account for the production of the majority of elements in the periodic table heavier than iron.

The NSCL Coupled Cyclotron Project

by Orilla McHarris

During the past 4 years, the Coupled Cyclotron Project has been the predominant construction activity at the NSCL. The project involves refurbishing the K500 and coupling it to the K1200 superconducting cyclotron, as well as construction of the high-acceptance A1900 fragment separator. The improved acceleration chain will consist of an Electron Cyclotron Resonance (ECR) ion source injecting low-charge-state ions into the K500 cyclotron to accelerate them to roughly twice the Coulomb barrier, followed by radial, charge-stripping injection into the K1200 for final acceleration to energies up to 200 MeV/nucleon. (The maximum energy achievable with the K1200 depends on the charge-to-mass ratio of the accelerated ion.) The coupled cyclotron facility (CCF) at the NSCL will be the premier rare-isotope user facility in the U.S. Compared to the stand-alone K1200 cyclotron, the CCF will provide much more intense intermediate-energy primary beams. For very heavy ions (A > 150), the CCF will also provide a significant increase in energy. Together with the increased acceptance of the new A1900 fragment separator, intensity gains by factors of 100 - 10,000 will be achieved for most fast beams of rare isotopes. Implementation of the 4-year construction project involved an 18-month shutdown of the K1200-supported experimental nuclear science program. This shutdown began in July 1999 and allowed for reconfiguration of the facility and installation of new equipment. All project milestones were reached on or ahead of schedule. The K500 cyclotron was refurbished and reinstalled (and rotated by 120 degrees) in its vault in 1997. Beam from the renovated K500 was extracted by July 1998. Assembly and testing of the A1900 quadrupole triplets were completed by March 2000. Installation of the coupling line was completed by April 2000. The stripper foil mechanism was installed in the K1200 cyclotron in June 2000. The A1900 magnets were installed in their final locations by August 2000. In October 2000, the first beam was extracted from the coupled cyclotrons: a beam of 1603+ was accelerated to 12.5 MeV/nucleon in the K500 cyclotron, extracted, and transported to the K1200 cyclotron, where it was fully stripped and accelerated to 140 MeV/nucleon. Soon thereafter, beams of 100 MeV/nucleon 40Ar, 85 MeV/nucleon 129Xe, and 140 MeV/nucleon 78Kr were accelerated, and the commissioning team has continued to develop additional beams on the list for the first operating period.. To enhance the scientific reach and productivity of the CCF, the room-temperature ECR ion source has been replaced by a modern, more versatile room temperature ECR ion source based upon the A-ECR design of Lawrence Berkeley National Laboratory. In addition, several new beam lines are being built (including one funded by NASA), and several externally-funded instruments are being added to the previously-existing complement of experimental apparatus. These new instruments include a segmented germanium array for gamma-ray spectroscopy, a large-acceptance "sweeper magnet" for neutron coincidence measurements at zero degrees, a large silicon-strip-CsI charged-particle array, a beam stopping facility (funded by DOE), and a Penning ion trap (funded by MSU) expected to become operational by the end of 2002. Together with the S800 spectrograph, which was completed and used before the coupled cyclotron project, this set of apparatus will facilitate a broad and versatile experimental program. A large new helium refrigeration plant has been added to increase the reliability of operation of the superconducting cyclotrons, the A1900 fragment separator, the S800 magnetic spectrograph, and the beam lines. The completion of the cyclotron upgrade and the new scientific equipment will allow new explorations of the properties of nuclei with unusual ratios of neutrons to protons, the nuclear processes that are responsible for the synthesis of the elements in the cosmos, and the isospin-dependent properties of hot nuclear matter at sub- and supra-normal densities. The NSCL facility will also continue to be available for multi-disciplinary research on problems in condensed matter physics, geophysical science, medicine, and biology. The proposed experimental program is currently being reviewed by the international advisory committee and, as originally planned, should commence in July 2001.

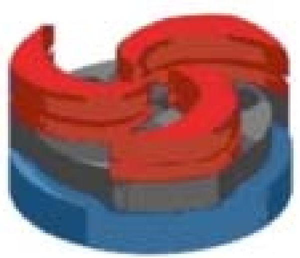


The first section of the A1900 beamline is shown. The exit beamline comes out of the K1200 vault at the top of the picture, and Cyclotron Operator Kevin Edwards is sitting on a part of the shielding wall that was under construction and still low at the time. Part of the first dipole is behind him (only the lower half is there), and the second triplet is next to him.

The 1750 watt helium liquifier formerly used by the U.S. Bureau of Mines in Texas and renovated for the NSCL by Jefferson Lab; the 1500 horsepower helium com-pressor and its backup are in a separate room.

In this photo, the stripper foil mechanism has already been mounted inside the lower half of the "C" dee, and a cyclotron operator (in a "bunny suit" overall) is guiding the whole assembly into the K1200 cyclotron.

NSCL CCF Inauguration



On July 27, the NSCL hosted a gathering of over 400 guests to celebrate the completion of its new state-of-the-art Coupled Cyclotron Facility (CCF), a $20 Million construction project, which was delivered ahead of schedule and on budget. Among the speakers was Governor John Engler, who pointed out the importance of research in the physical sciences for the Michigan economy. The new CCF will ensure the continued international leadership of our nuclear physics group for at least the next 5-10 years. With an eye on the future further down the road, we are competing to build the Rare Isotope Accelerator, a next generation facility that could cost more than $0.5 billion. Governor Engler expressed his strong support for this plan.

Visit the NSCL web site at http://www.nscl.msu.edu

Michigan Governor John Engler speaking at the Inauguration ceremony of the CCF, Friday July 27th at the Wharton Center Pasant Theater.

Lite Lab $2,100,000 NSF Information Technology Research Grant

MSU received one of the largest grants from the NSF's Information Technology Research (ITR) program, a $2.1 Million award over the next five years. The principal investigators, Gerd Kortmeyer, Edwin and Deborah Kashy, Cheryl Speier, and (front row, with LITE lab personnel in the back row) will build a nationwide network of Internet servers for the creation, publication, and delivery of online teaching content in a collaborative manner. This new effort represents a synthesis of the very successful CAPA, MultiMedia Physics, and **L**ecture**ON**line programs. Many tens of thousands of students are expected to benefit from this innovative use of computer and information technology.

LITE is on the web at http://lon-capa.org

Principal Investigators and LITE Lab Personnell, clockwise from left: Gerd Kortemeyer, Wolfgang Bauer, Scott Harrison, Guy Albertelli, Benjamin Tyszka, Deborah Kashy, Vihjia Tsai, Lissa Anderson, Jeremy Wells, Alexander Sakharuk, Cheryl Speicer, Jim Keller, Edwin Kashy

Alumni News

by Julius Kovacs

We have collected information that we have received from some of our alumni/alumnae since the last newsletter and we report it to you below. Please send us information about yourself that we may include in the next newsletter. We have a database of about 2500 alums for whom we have addresses (there are many more we aren't getting to because we lack addresses) so the information below is but a small fraction of those from whom we'd like to get email (kovacs@pa.msu.edu) or paper correspondence. For your information, we are also maintaining web information about our degree recipients and so far we have completed it back to the late '60s for some of the degrees. We invite you to browse these pages and if you don't see your name, let us know (or if you see any errors in the information about your degree, point out to us what needs correction). To see these pages, get on the Physics-Astronomy home page (http://www.pa.msu.edu), click on the Alumni/News button and scroll down to Graduate Announcements to get to the various buttons that will lead to the pages for our various degrees. Work is still in progress collecting information about the names and dates of recipients of BS degrees in Astronomy & Astrophysics pre-1980, before the former Astronomy Department was merged with Physics, and, of course, getting those names on the web for persons who received degrees earlier than the ones we have listed.

Don Keck (BS'62, MS'64, and PhD '67) was one of the recipients of the Presidential Medal of Science & Technology presented by President Bill Clinton in November 2000. He was cited along with two others from Corning, Inc. "for the invention of low-loss optical fiber, which has enabled the telecommunications revolution…" Don Keck is vice president and technology director of optical physics technology at Corning.

Michael Bozack (BS'75, MS'77) who received his PhD at Oregon Graduate Institute of Science and Technology in 1985, is Associate Professor of Physics at the Surface Science Laboratory in the Department of Physics at Auburn University participating in the Center for Advanced Vehicle Electronics funded by the NSF and various industrial contributors.

Jeroen Thompson (BS'00) has completed his first year of graduate study at the University of Connecticut. He was a TA in introductory astronomy this past academic year and expects to do condensed matter research.

John Gentry (MS'87) reports the birth of a son, Daniel P. in July 2000. He and his wife reside in Freeport, Illinois where he is a medical physicist at a University of Wisconsin Physicians Clinic in Freeport. He has produced several publications and given talks on Oncology Management.

Donald O. Van Ostenburg (PhD'56) recently retired from DePaul University. He sent us a photograph taken on the PA Building steps of **Olen Kraus** and **John Michaels** who also completed PhDs at MSU, both under the guidance of Robert Spence.

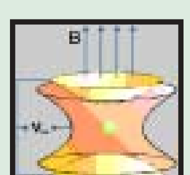
Douglass Darrow (BS'82) is on the research staff at Princeton University's Plasma Physics Laboratory. His chief research interest is in energetic ions in the tens to thousands of keV energy. This past fall he was promoted to Principal Research Physicist at the laboratory. **David P. Ball** (BA'81) completed an MS in Nuclear Engineering at the University of Washington in 1984 and is currently a Senior Project Engineer at General Motors in Warren, MI.

Finally, we can't end this news-about-alumni section without saluting the retirements of Professors **Neal Prochnow**, **John Shepherd** and **Curtis Larson** from the Physics Department faculty at the University of Wisconsin, River Falls. While, as far as we know, none of these three has had any formal affiliation with MSU, their influence upon their graduates had a noticeable impact upon the quality of students entering our graduate program. During their tenure at UWRF perhaps twenty or more students who received their bachelor's degrees from there entered our graduate program and quickly passed through our graduate program with flying colors and went on to successful careers as University Professors and industrial researchers. **Richard Peterson, Raymond Kozub, Robert Melin, Charles Stirrat, Lilian Hoines, Terry Awes, Bruce Hasselquist, Erik Henderson, Lowell McCann** – these are just a few whose names come immediately to mind when we try to recall who from UWRF completed PhDs at MSU. Thank you Neal, John and Curt. May you enjoy a wonderful retirement.

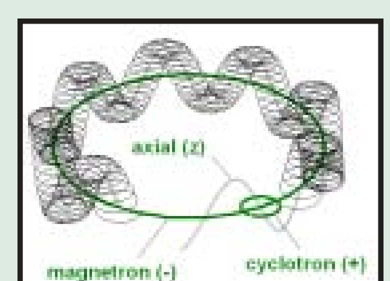
Meet Georg Bollen...

After finishing a four year term as the leader of the ISOLDE physics group at the European Research Laboratory CERN in Geneva, Georg Bollen became professor at the Ludwig Maximilans University in Munich. He stayed there only six months and accepted an offer to come to MSU and NSCL where he arrived last summer (June1). His wife, Magelone, and sons Anton and Viktor have joined him in East Lansing. Daughter, Anne, has remained in Germany to continue her studies.

Bollen's specialty is the trapping of ions in devices called ion traps and to apply this atomic physics technique to nuclear physics. He was a main player in developing Penning trap mass spectrometry for its application to rare isotope beams. Atomic mass measurements provide insight into how strongly the nucleons in a nucleus are bound together. Nuclear structure effects like shell closures, pairing and nuclear deformation can be observed and data be provided that are relevant for nuclear astrophysics and for tests of the fundamental interactions. The ISOLTRAP experiment at CERN, which has been led by Bollen for many years, is today the most successful enterprise of this kind. It has provided substantial information on nuclear binding energies at various regions of the nuclear chart and demonstrated the power of the approach. Bollen has initiated and conducted several projects in which ion traps and trapping techniques are used for the manipulation and improvement of rare isotope beams, for example in the context of their post-acceleration.



Principle of a Penning ion trap, left figure, and ion motion, right figure. A strong magnetic field B (several Tesla) and a weak electric field created by voltages applied to three electrodes provide forces that allow a particle with charge q to be confined in space. From the observation of the characteristic motion of the trapped ion (bottom) the cyclotron frequency ?c=q/m(B of the ion can be determined with high precision and its mass m be determined.



Bollen's research plans at the NSCL focus mainly on precision experiments on rare isotope beams at low-energy. Such beams will be available in the near future and will be produced by stopping the existing fast beams in a gas cell and by re-forming them into a slow ion beam. These new beams will add an important new facet to the already rich experimental program at the NSCL. The so-called LEBIT (Low-energy beam and Ion trap) project is still in its design and construction phase but when completed it will allow techniques like Penning trap mass spectrometry, laser spectroscopy, or precision decay studies of trapped ions and atoms to be applied to the beams produced at the NSCL. Presently, Bollen and his group of a post-doc (Stefan Schwarz) and two students (Ryan Ringle and Tao Sun) are working on the design of the experimental area, which includes several experimental stations. Ion traps will be employed to accumulate, cool and bunch the rare isotope beam in order to improve its quality and to tailor it to the needs of the experiments. An important experimental program at LEBIT will be the study of nuclear binding energies of isotopes with extreme neutron-to-proton ratios. The LEBIT Penning trap mass spectrometer will use a superconducting magnet with a 9.4 T field, which is the highest so far used in any nuclear physics trap experiment. This high field will allow access to the most exotic isotopes with half-lives as short as a few milliseconds.