Chapter Fourteen

Telescope Consortium
Paul Leath (1995-2000)

When Allen Robbins stepped down as Department Chairman in 1995, Paul Leath, having recently come back to the Department after fourteen years as Associate Provost and Provost, agreed to lead the Department as its next Chairman. The Department was indeed fortunate in having such capable leadership for the next period in its history. Having come to the Department as an Assistant Professor in 1967, and having served as Associate Provost and Provost in New Brunswick from 1978 to 1993, he had a wide range of experience in teaching, research, and administration, that served the Department well as it moved to consolidate and expand upon the gains that had been made in the previous decade. Few physics departments are able to draw on a leader with such significant university administrative experience and such personal attributes of leadership. Leath continues to serve as Department Chairman as this History is written.

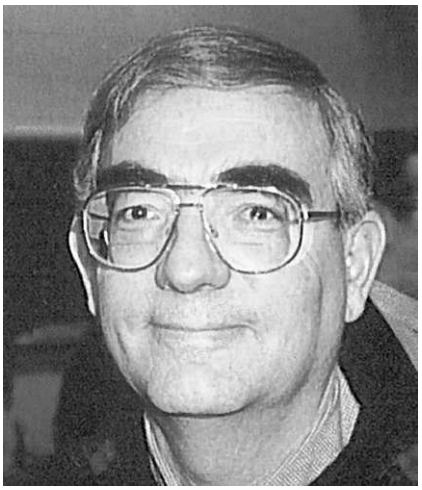

Figure 52 Paul Leath

Paul Leath (1995-2000)

By 1995 the Department was recognized as one of the leading physics departments in the country, as indicated by the 1994 external review. This assessment of the Department was confirmed by the 1993 survey of research-doctorate programs in physics in the United States, published in 1995 by the National Research Council.[1] In that listing, the Rutgers physics program ranked 20th among all institutions in the U.S., and 10th among public universities. This was a dramatic improvement from the 1982 evaluation where the Rutgers program was ranked 33rd among all institutions. In a separate NRC ranking of perceived improvement since the 1982 survey, the improvement of the Rutgers program was highest among the top twenty institutions, and second highest overall. This improvement stood out as one of the most significant advances of any of the departments in the University.[2]

The report of the 1994 External Review Committee was reviewed by the University Committee on Standards and Priorities in Academic Development (CSPAD). The CSPAD report, issued in February 1996, gave the Department of Physics and Astronomy a ranking of 1a (distinguished), its highest grade, and affirmed the conclusion that this large and excellent department had improved itself significantly since the previous review with appointments of high quality. The CSPAD report recommended that the expansion of the experimental condensed-matter physics and astrophysics groups should be balanced by attrition in the nuclear physics area. The report further recommended vigorous recruitment to attract better (although not necessarily a greater number of) graduate students, and the reduction of the teaching loads for the teaching assistants. It also recommended that attention be given to increasing the level of external grant support in the Department, which at an earlier time in the history of the Department was at or near the highest level in the University.

There were additional testaments to the rising stature of the Department. A 1998 issue of *Science Watch* ranked U. S. universities in terms of

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[1] *Research-Doctorate Programs in the United States*, 340, 588.

[2] Much of the material in this chapter is taken from Annual Reports of the Department of Physics and Astronomy.

science citations per paper published over a five-year period (1993-97).[3] In that ranking, the Rutgers Physics Department was listed sixth among all U.S. physics departments, below UC Santa Barbara, Chicago, Harvard, Caltech, and Yale, but above Pennsylvania, Stanford, SUNY Stony Brook, Michigan State, and all other universities.

Also in 1998, *U.S. News & World Report* ranked the Rutgers program 16th in the U.S. in Condensed Matter/Solid State Physics, 7th among public universities, and 14th in the U.S. in High Energy Elementary Particle Physics, 6th among public universities.[4] This assessment was followed by a 2000 *U.S. News & World Report* which ranked the Rutgers physics Ph.D. program 21st among U.S. universities, and 11th among public institutions, in overall reputation.

One of the major goals of the Department Master Plan, endorsed by the 1994 External Review, was the expansion and development of the astronomy program. The prestige and accomplishments of the astronomy/ astrophysics faculty and programs were recognized in the spring of 1999 by the admission of Rutgers to the Association of Universities for Research in Astronomy (AURA). AURA is the national association of major universities involved in astronomy/astrophysics research. It operates national telescopes, and provides assistance to astronomers and astronomy students. Admission to AURA was one of the specific goals of the Department Master Plan. Admission is by invitation, and only programs with sufficient national standing are admitted. Jeremy Sellwood was named the Rutgers representative to the AURA Board of Directors.

The astronomy program at Rutgers took a major leap forward in 1999 by finalizing an arrangement to join a telescope consortium, a goal of the Department for more than a decade. The University joined the South African Government and a consortium of universities in a project to build the 10-meter South African Large Telescope (SALT). Joining the South African Observatory in forming this consortium are a number of international partners. These include, along with Rutgers, The Hobby-Eberly Telescope Board, whose founding partners are the University of Texas and Pennsylvania State University, the University of Wisconsin-Madison,

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[3]*Science Watch, Tracking Trends and Performance in Basic Research*, v. 9, no. 6. p. 4, 1998.

[4]*U.S. New and World Reports*, 1998.

Carnegie Mellon University, Nicolaus Copernicus Astronomical Center (Poland), the University of Canterbury (New Zealand), and the Georg-August University of Göttingen (Germany). The new telescope and observatory will be built near Sutherland, South Africa, in the high desert plateau called the Karoo.

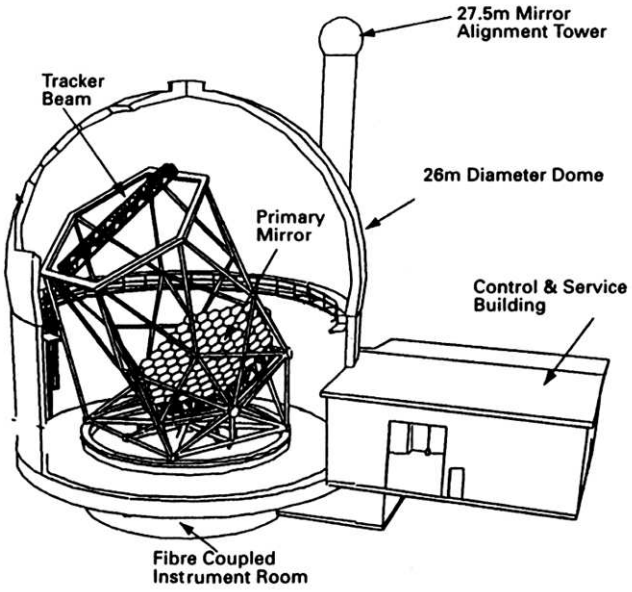

Figure 53 Cutaway View of Hobby-Eberley Telescope Facility on which SALT is Modeled

The SALT project will be the largest single mirror telescope in the Southern hemisphere and the second largest in the world. It is modeled after the Hobby-Eberly telescope at McDonald Observatory in Texas. It's design makes it highly cost efficient, approximately 20% of the cost of a conventional telescope of similar size. It will have a spherical mirror made up of 91 hexagonal segments, whose combined light will be focused into a final image that will be as sharp as the turbulence of the earth's atmosphere allows. To allow for changes due to temperature or movement, each mirror segment will have computer-controlled edge sensors, keeping it in position relative to the others. The primary mirror of the telescope will remain fixed at an angle of 37 degrees to the horizontal. To

enable a star's movement over a period of 48 minutes to two hours to be followed, the imaging instruments will move across a square 12 degrees wide, carried by a robotic tracker. The spherical aberrations of the spherical mirror are substantially reduced by passing the reflected light through a series of mirrors called a "spherical aberration corrector." The effective diameter of the mirror, after this correction, will be approximately 11 meters.

Groundbreaking for the new observatory was held on September 1, 2000, "first light" is expected in 2004, and full operation is expected by 2005. The high light-gathering power of SALT will make it possible to explore the earliest galaxies and quasars, the scale and age of the universe, the life and death of stars in nearby galaxies, and planetary systems around other suns. Some of the most important information from stars and galaxies is contained in the ultraviolet wavelengths. The construction of the telescope will make it more efficient in studying the ultraviolet wavelengths than any other large telescope.

President Lawrence signed a memorandum of understanding, officially entering Rutgers into the SALT consortium, and committing the University to a $2.2 million pledge to support the building of the SALT observatory and maintaining the facility over the next decade. The Department hopes to raise an additional $1.2 million in funds for SALT to make possible a 9.6% share of the telescope and telescope time. The Department also wants to raise an additional $450 thousand to create at Rutgers a local control and data receiving station, as well as an astronomical extension to the Math-Science Learning Center, which would also receive data and images from SALT, and provide outreach to Rutgers students and to the public. The Department has already met with some success in raising these funds. The SALT project has been a shot in the arm in the Department's campaign to hire new astronomy faculty members. It will have an enormous impact on the astronomy program at Rutgers in the years to come.

Faculty

Between 1995 and 2000 there were several faculty retirements and resignations, and a number of new appointments. T. Alexander Pond and Allen Robbins retired in 1997, Pond after 15 years as Executive Vice President and Professor of Physics, and Robbins after 41 years on the

faculty and 16 years as Department Chairman. Elihu Abrahams, Theodore Kruse, Peter Lindenfeld, and Richard Plano retired in 1999. Lindenfeld left the Department after 43 years, Abrahams after 41 years, Plano after 39 years, and Kruse after 38 years. The following year, 2000, Ronald Rockmore retired after 37 years in the Department. As Professors Emeriti, some of these faculty members continued their involvement in research programs.

In addition to the seven faculty members who retired, there were a number of resignations. Nathan Seiberg and Stephen Shenker, two members of the original string theory group (NHETC), resigned. Seiberg accepted a permanent position at the Institute of Advanced Study in Princeton in 1997, and Shenker accepted a senior faculty position at Stanford University in 1998. Glennys Farrar Terrano resigned in 1998 to become Head of the Department of Physics at NYU, and Shirley Jackson resigned in 1999 to become President of the Renssalaer Polytechnic Institute in Troy, New York, the first African-American to head a major research university.[5]

These departing faculty members were replaced by several new faculty appointments. In experimental condensed matter physics Michael Gershenson was hired as Assistant Professor in 1995, Sang-Wook Cheong as Professor and Marta Cieplak as Visiting Associate Professor in 1998, and Valery Kiryukhin as Assistant Professor in 1999. Kiryukhin came to Rutgers from M.I.T., and is interested in neutron and x-ray scattering. In experimental surface physics Frank Zimmerman was hired as Assistant Professor in 1995. In condensed matter theory Andrew Millis was hired as Professor in 1998 and Karin Rabe was hired in January 2000. Millis came to Rutgers from Johns Hopkins, and Rabe came from Yale and is joining the Computational Materials Theory Group.

In experimental high energy physics Amitabh Lath was hired as Assistant Professor in January 2000. Lath was on a Rutgers/Fermilab postdoctoral fellowship, and will work with the experimental group at Fermilab. In the New High Energy Theory Center, Sergei Lukyanov was hired as Assistant Professor in 1999, and Gregory Moore as Professor in January 2000. Lukyanov was a Rutgers postdoctoral fellow, working in mathematical field theory, and Moore came to Rutgers from Yale, working

[5]*Rutgers Magazine*, Fall 2000, p.31.

in string theory. In astronomy, Charles Joseph was hired as Assistant Research Professor in 1995, John Hughes as Assistant Professor in 1996, and Arthur Kosowsky as Assistant Professor and Ken-Ichi Nishikawa as Assistant Research Professor in 1998.

Figure 54 Physics Faculty in 2000

Front Row: C. Glashausser, A. Kosowsky, J. Pifer, H. Carr, R. Bartynski, M. Kalelkar, P. Leath, J. Cizewski, N. Koller, G. Goldin, M. Cohen, G. Horton, J. Lebowitz, A. Ruckenstein, G. Kotliar, T. Gustafsson, S. Cheong, T. Matilsky.
Center Row: Harry Kojima, D. Friedan, D. Vanderbilt, C. Joseph, D. Merritt, T. Kruse, J. Bronzan, T. Devlin, M. Croft, S. Schnetzer, W. Kloet, R. Ransome, Y. Sharon, J. Hughes, T. Madey, H. Zapolsky, A. Robbins, R. Plano, P. Cöté, L. Ferrarese, T. Pryor, T. Williams, P. Lindenfeld, M. Cieplak, D. Langreth, R. Jimenez, R. Gilman, R. Rockmore.
Back Row: L. Zamick, S. Somalwar, A. Lath, D. Harrington, K. Rabe, P. Coleman, A. Mekjian, J. Sellwood.

In addition to these fourteen new faculty members, four more faculty members were hired as assistant professors for September 2000. Petr Horava, a string theorist, joined the NHETC group, and three new faculty members joined the astronomy group. Patrick Côté and Laura Ferrarese are observational astronomers who work with data from the Hubble Space Telescope, and will be prime users of the SALT telescope. Raul Jimenez is a theorist in astrophysics and cosmology and an expert on galaxy formation.

These new faculty appointments reflect the strong commitment of the Department to build up its astronomy and experimental condensed-

matter physics groups, while maintaining strength in the high-energy theory and experiment groups.

The faculty members received a number of awards and recognitions, which demonstrate the high regard for these individuals in the physics community. For his outstanding work in mathematical physics, Nathan Seiberg received the prestigious John D. and Catherine T. MacArthur Foundation Fellowship, the Rutgers University Board of Trustees' Research Award, and a $75,000 unsolicited grant supplement from the U.S. Department of Energy. Frank Zimmerman received the Morton M. Traum Award of the American Vacuum Society for the best Ph.D. student paper in Surface Science, and the Victor K. LaMer Award of the American Chemical Society, Division of Colloid and Surface Chemistry, for the best Ph.D. thesis in the U.S. and Canada. He also received the prestigious CAREER award from the National Science Foundation, an award for distinguished young investigators.

Theodore Madey is one of those 50 scientists, whose papers have been cited more than 500 times in chemistry journals from 1981 to 1997. Alexander Zamolodchikov received the 1999 Dannie Heinemann Prize in Mathematical Physics from the American Physical Society. Joel Lebowitz received the 1999 Scientific Freedom and Responsibility Award of the American Association for the Advancement of Science, and the 2000 Henri Poincare Prize of the International Association of Mathematical Physics for his “important contributions to various aspects of equilibrium and non equilibrium statistical physics.”

Other faculty members receiving recognition were David Langreth, who received a 1999 Board of Trustees Award for Excellence in Research, and Noémie Koller, who received the 1999 Douglass Medal. Paul Leath received the 2000 Douglass Medal for his outstanding research, teaching, and long-term support of Douglass College. Joe Pifer received the 1998 Distinguished Service Award of the American Association of Physics Teachers for his work in expanding the Department's undergraduate physics major program to become one of the largest and most successful in the U.S. Shirley Jackson was one of two 1998 inductees into the National Women's Hall of Fame.

Charles Glashausser became Head of the Users Group Board of Directors at the Jefferson National Laboratory in Newport News, Virginia. Terry Matilsky received the 1999 “Professor of the Year Award” from the

Rutgers Chapter of the Society of Physics Students. Jeremy Sellwood received the 1999 Graduate School-New Brunswick Teaching Award for his efforts that strengthened the Astronomy Option in the Department's Graduate Program, for his excellent mentoring of graduate students, and for his classroom teaching.

There were a number of other awards to faculty members. Michael Douglas and Juan Maldacena, a former Rutgers postdoctoral fellow, now a professor at Harvard, shared the 2000 Sackler Prize in High-Energy Physics for their "outstanding contributions to superstring theory." Douglas received the Louis Michel Visiting Professorship at the IHES in Paris, France, where he will spend two to three months each year for a period of five years. Arthur Kosowsky was named a 2000 Cottrell Scholar by the Research Corporation for his work in "microwave background constraints on the universe." Natan Andrei was awarded a highly competitive Lady Davis Fellowship, which enabled him to spend a semester studying in Israel at the Weizman Institute and the Hebrew University in Jerusalem. Mark Croft and Physics Support Specialist David Maiullo shared the 2000 Ernest E. McMahon Award of the Class of 1930 for Public Service, which cited their "accomplishments in teaching and demonstrating physical phenomena to elementary and high school students and teachers, for stimulating the interest of talented students to pursue science, and for extending the resources of the University to the people of New Jersey."

Research

The experimental faculty members were largely engaged in research at other institutions. John Conway, Tom Devlin, Amitabh Lath, Sunil Somalwar, and Terence Watts led a Rutgers high-energy experimental physics group working with the Collider Detector at Fermilab (CDF). Stephen Schnetzer led the Rutgers contingent to construct the Compact Muon Spectrometer (CMS) for the Large Hadron Collider at CERN. Gordon Thomson worked in the area of astro-particle physics, studying the very highest energy cosmic rays as part of the High Resolution Fly's Eye Experiment atop two desert mountains in west central Utah. Mohan Kalelkar, Richard Plano, and Pieter Jacques led a group on the SLD experiment at the Stanford Linear Accelerator Center.

Charles Glashausser, Ronald Ransome, and Ronald Gilman carried out intermediate-energy nuclear physics experiments at the University of Mainz, Germany, and the Thomas Jefferson National Laboratory. Jolie Cizewski's nuclear physics research efforts were focused at Argonne National Laboratory, and Noémie Koller worked at Yale.

The optical observational astronomers, Ted Williams and Carlton Pryor obtained access to major research telescopes at Kitt Peak in Arizona, Cerro Tololo in Chile, the Canada-France-Hawaii Telescope on the Island of Hawaii, and the Hubble Space Telescope. Terry Matilsky worked on the ultraviolet data from the IUE satellite. Jack Hughes used data from the x-ray satellite telescopes, and had several projects on the new Chandra x-ray observatory which was launched into orbit by the Space Shuttle. David Merritt and Charles Joseph used data from the Hubble Space Telescope. The astronomy group, including the several new additions to the faculty, began planning for work at SALT.

Although most of the experimental condensed matter physics research is still carried out at Rutgers, Mark Croft was involved in x-ray absorption spectroscopy at the National Synchrotron Light Source at Brookhaven. There has been a dramatic shift in the way in which experimental physics is done from the time at the end of World War II, when all of the experimental physics was done at Rutgers, to the present when most of the experimental physics research is carried out at other institutions. Although data is often taken at other institutions, the analysis and interpretation of the data generally is done at Rutgers.

The New High Energy Theory Center (NHETC) remained the best such group in the country. Outstanding new additions to the faculty helped to offset the departure of two of the initial members of the group, Nathan Seiberg and Stephen Shenker. The Center continued to attract as visitors a large number of the best theorists in the world.

Another new center, which had been discussed for a number of years, was finally brought into existence in 1999. The condensed-matter theory group, one of the 3-5 best such groups in the country, created the Center for Materials Theory (CMT). This Center, within the Bureau of Physics Research, was created to coordinate the programs in theoretical condensed-matter and materials physics. Professor Emeritus Elihu Abrahams was named the first director of the new Center, which attracted several major new grants, including a major subcontract from the NSF

Materials Research Science and Engineering Center (MRSEC) at the University of Maryland. There were many visitors to the Center, and a large number of postdoctoral fellows, about twenty in 2000-2001. These postdocs include the very best junior scientists from around the world in materials theory. The Center, through Andrew Millis, was a partner (with Indiana, Colorado, and UC-Santa Barbara) in establishing (with support from the NSF and Lucent Technologies) a U.S. Summer School in Condensed-Matter and Materials Physics, held for the first time in summer 2000 in Colorado. The new CMT is destined to become a major national center in materials theory.

Some of the exciting Departmental research results are described in the following paragraphs.

In astrophysics, Jack Hughes used data from x-ray satellite telescopes to measure the Sunyaev-Zeldovich Effect from the most distant cluster of galaxies yet observed, and thereby measured directly the Hubble Constant, and hence the age of the universe. David Merritt and Charles Joseph used the Hubble Space Telescope to study the supermassive black holes at the center of galaxies. Their new results provide the first conclusive evidence for such black holes seen in the velocities of the stars in the galaxies. As a result of this work, they discovered a new, super-massive black hole in the center of the galaxy NGC 2841. Jerry Sellwood made many discoveries in galaxy dynamics. In particular, he showed that the warps of galactic disks can be created by friction between the disk and the halo of these galaxies.

Tom Banks made major contributions to high-energy cosmology. He and his students showed that string duality symmetries can be used to avoid some of the singularities in cosmological theories, but that the true Big Bang singularities can not be removed. He also worked out the theoretical constraints on cosmology and supersymmetry breaking that are imposed by Mbrane theory. Joel Lebowitz carried out very successful simulations of the phase-segregation kinetics in a three-dimensional A-B alloy including elastic interactions, which is a first for these realistic simulations. Herbert Neuberger devised a new algorithmic method for implementing chiral symmetry in simulations of high-energy particle interactions on a lattice. This would be a major breakthrough if it can be implemented on present-day computers.

Paul Leath (1995-2000)

In condensed matter theory, David Vanderbilt developed a predictive theory of the structural and dielectric properties of an important class of ferroelectric materials in which alloy disorder is important. He also carried out a theoretical analysis of the bonding and electronic properties at the interface of silicon with silicon dioxide, the most important semiconductor-insulator interface in present-day integrated circuits. Lev Ioffe proposed a way of using Josephson junctions between conventional (s-wave) and the new high T_c (d-wave) superconductors to make qubits (basic units) for the realization of a quantum computer. Paul Leath discovered that the delaminations that occur when a randomly disordered crystal is pulled apart change from being fractal to crystalline in shape as the fracture goes from being tough to brittle. David Langreth provided, for the first time, the theoretical answer to how long it takes for the Kondo effect to develop. This answer is highly relevant to the new quantum dot single-electron transistors, but also in numerous other areas of chemical physics, surface physics, and condensed-matter physics.

In nuclear theory, Larry Zamick found new symmetries in the energy state structure of certain nuclei. These symmetries have recently been found experimentally as predicted in $^{50}Cr^{51}Cr$.

In experimental high-energy physics, Tom Devlin played an important role in the discovery of the B_c, the last meson in the standard model. Stephen Schnetzer and Sunil Somalwar played a major role in the construction of the KTeV experiment at Fermilab. The very first results, originating from the work of Somalwar, gave a new measurement of the direct CP-violation parameter in neutral kaon interactions. This work has made it possible to rule out the existence of light gluinos, which had been predicted in several models of supersymmetry. Richard Plano, Mohan Kalelkar, and Pieter Jacques worked on the SLD and Ba Bar experiments at the Stanford Linear Accelerator Center (SLAC), which reported precise measurements of several important parameters in high-energy particle interactions.

In experimental nuclear physics, Jolie Cizewski was part of an international team at Argonne National Laboratory, studying the limits of stability of rapidly rotating heavy, fissionable nuclei. They found a surprising barrier to fission of these heavy nuclei, even with high angular momentum. Noémie Koller and her group reported on the structure and magnetic moments of rapidly rotating and highly deformed atomic nuclei

in several publications. Charles Glashausser, Ronald Gilman, and Ronald Ransome were leaders in a collaboration at the Jefferson Laboratory in Virginia, which showed that the electric and magnetic forms of the proton have different shapes. This result means that the distribution of electric charge and magnetic moment within the proton are significantly different.

In experimental condensed matter physics, Eva Andrei discovered a new class of non-linear behavior in superconducting materials. This phenomenon in the dynamics of magnetic vortices in superconductors, which has received a lot of attention, allows the sample to retain a long-term memory of the ac-driving frequency of the vortices. Sam-Wook Cheong and his students showed that the dramatic changes in the colossal magnetoresistance of alloyed manganites is related to the percolation of metallic ferromagnetic regions through the insulating regions. Ted Madey and his group discovered a giant enhancement in electron stimulated desorption of negative chlorine ions from surfaces, when freon molecules are coadsorbed onto a surface with water ice. This discovery has important implications for the destruction of atmospheric ozone by freon in the stratosphere. They also showed that the sodium vapor found in the atmospheres of Mercury and the Moon can be generated by solar photons striking the sodium-bearing rocks on the surface.

Graduate Program

The Department gave considerable attention to improving the Graduate Program. As a step in this direction, the Department introduced a two-semester "Seminar in Physics" course, in which faculty members discussed the research opportunities available in their groups, and the career options available to the student upon completion of the Ph.D. Careful attention was given to monitoring the progress of a graduate student in identifying an appropriate research advisor. Professor Eugenia Etkina from the Graduate School of Education introduced a new one-credit course for graduate student teaching assistants on teaching physics. The course received much attention and was featured in the August 1999 issue of the British journal *Physics World*.

The Department played a national leadership role in innovations in graduate education in the physical sciences. The National Academy of Sciences Committee on Science, Engineering, and Public Policy (COSEPUP) issued a report "Reshaping the Graduate Education of

Scientists and Engineers" in 1995. Following that report, the Association of AAU Graduate Schools instituted a clearinghouse for descriptions of successful graduate programs and policies. In summary descriptions of innovative programs and policies in graduate education, these reports cite the activities of the Graduate Program in Physics and Astronomy at Rutgers for innovations in "increased program breadth" and "career advising."

As a further recognition of the quality of the Graduate Program, it received grants from the Department of Education Program in Graduate Assistance in Areas of National Needs (GAANN), which supported a total of thirteen graduate fellows with annual stipends of $15,000 and over $10,000 in educational funds for tuition, fees, and other expenses.

An indication of the stature of the program was contained in the Roster of Physics Departments, September 1998, which listed Rutgers, with 17 Ph.D.'s awarded in 1997, as the 20th largest physics Ph.D. program in the U.S., and the 13th largest among the public universities.

The first reunion of the Department of Physics and Astronomy was held at the Centennial Meeting of the American Physical Society in March 1999. About fifty alumni, as well as many current and former faculty and colleagues, and many present graduate students, attended.

The Graduate Program in Physics and Astronomy produced graduates of considerable accomplishment. Among the top graduates were Lee Bernstein, with a Ph.D. in experimental nuclear physics in 1994, who was offered an assistant professorship at Yale, and Philippe Pouliot, with a Ph.D. in high-energy theory in 1996, who was the top postdoctoral candidate in 1996 with nine offers from the best places. Kalman Pelhos received the 1999 Nottingham Prize, which is awarded annually for the best student paper, based upon a Ph.D. thesis, presented at the annual Physical Electronics Conference (PED) of the American Physical Society. This is the oldest and one of the most prestigious national prizes available to young surface scientists. Kalman is the first Rutgers student to win the prize, but Torgny Gustafsson won it as a new Ph.D. in 1974.

Other graduate students receiving recognition included Cara Rakowski, who was awarded the Amelia Earhart Fellowship for 2000-01 from Zonta International for Research in Aerospace-Related Sciences and Engineering. Graduate students Vincent Jacobs, William Ratcliff, and Shadow Robinson were selected as fellows in the NSF program, "Building

a Learning Community in Science and Mathematics through Education Partnerships," and will be working in local middle schools on that project.

Undergraduate Program

The Department gave considerable attention to its undergraduate courses. In 1995-96 there were about 2700 students enrolled in the introductory courses, most of them taking a laboratory. The Department received high marks on the student evaluations conducted by the Teaching Excellence Center. The Department ranked highest among the natural science departments for courses at the 100 level. The success was due in part to the gateway courses, Extended General Physics 201-202 for science majors, and Extended Analytical Physics 115-116 for engineers. These courses begun by George Horton, had a major impact on the retention rate of underprepared students. Horton and Suzanne Brahmia, who ran those extended courses, received national attention for their work in those courses at the 1996 AAPT meeting, and the courses were featured in the cover article of the March 1996 issue of *The Physics Teacher*.[6] The Department, as a whole, won the 1998 Rutgers Award for Programmatic Excellence in Undergraduate Education, with a prize of $10,000. Mohan Kalelkar replaced Joe Pifer in 1999 as Associate Chair and Director of Undergraduate Programs.

A major new initiative to restructure the General Physics course was undertaken in 1999. The course had an unwieldy enrollment of 1750 students, plus another 300 students in the off-sequence course, each semester, and was taught using traditional lecture and recitation techniques. For the time being, the General Physics course will be taught only on the Busch Campus. The new course, Physics for the Sciences, was offered at The Cook and Douglass campuses. The traditional recitations were replaced by workshops utilizing cooperative group-learning techniques. Basic homework problems were done via the Internet before class, so that the workshops could focus on more thought-provoking problems specifically designed for the cooperative effort. The laboratory was integrated into the overall course, with laboratory-based conceptual

[6]"The Rutgers Physics Learning Center", B. Holton and G. Horton, *The Physics Teacher*, v. 34, p.138, 1996.

problems, and there was a significant reduction in the number of topics covered in the course.

In addition to the new Physics for the Sciences course, a new course, Elements of Physics, was offered for the first time in 1999-2000, primarily for students of the College of Pharmacy, which had shifted over to a new six-year Pharmacy Doctorate Program. The course on the Greenhouse Effect for nonscience students was also revived in 1999-2000.

Ted Williams and Carlton Pryor completed installation of the new 0.5 meter instructional telescope in the Serin Observatory dome in 1996. This telescope was used in all undergraduate astronomy courses, and in a new junior-level course in observational astronomy designed to make use of the new telescope. This was a revival of a junior level course in observational astronomy given seventy years earlier in the Schanck Observatory. In subsequent years, some physics instructors made occasional use of the Schanck Observatory, and as well as a small telescope on the Busch Campus. The new telescope was also used in twice-monthly viewing sessions for the public.

The undergraduate physics major program graduated 35-40 physics majors per year, with a total of almost 160 majors in the Department. This gave Rutgers one of the largest physics major programs in the United States. Many of the graduates went on to the best graduate schools, but some also went on to medicine, law, science writing, management, and architecture. In 1998 the American Institute of Physics Statistics on Undergraduate Physics Programs placed Rutgers tied for fifth with UCLA in the U.S. in the number of bachelor degrees in physics awarded per year. Harvard, M.I.T., UC-Berkeley, and the University of Washington granted more such degrees in 1997.

Outreach

Members of the Department contributed in reaching out to the public through a number of different activities. A donor, Henry Irons, endowed an annual Henry and Gladys V. Irons Lecture in Physics & Astronomy. The first lecturer was Professor Michael S. Turner of the University of Chicago, who gave a public lecture on May 4, 1999 on “The Earliest Moments of Creation.” Each December, the Department hosted the annual New Jersey Physics Olympics, sponsored by the New Jersey Chapter of the AAPT. In 1998 the event was organized by Michael

Molnar and David Maiullo, and attracted 230 students and 20 high school teachers.

Mark Croft began an annual Christmas Lecture in the week after Christmas, 1998, drawing a large number of families with children. Maiullo and Croft conducted many public demonstration shows of physical phenomena in local schools and on local television. Terry Matilsky and Eugenia Etkina began a new project, the Summer Astrophysics Institute, in the summers of 1998 and 1999, to teach 20 high school students and 120 teachers from 10 New Jersey high schools how to do research in x-ray astrophysics via the internet.

Laboratory Administrator Michael Molnar was cited in *Newsweek*[7] for his work on the astronomical basis of the Christmas Star. His book, *The Star of Bethlehem: the Legacy of the Magi*,[8] received high critical praise from a number of individuals, including Dr. Owen Gingerich, Professor of Astronomy and the History of Science at the Harvard-Smithsonian Center for Astrophysics. In his book, published by Rutgers University Press in 1999, Molnar proposes that the star of Bethlehem was the planet Jupiter, seen in the constellation Aries the ram.

Future

Rutgers, which began as a small private Dutch college, has become one of the great state universities in the United States. Physics and astronomy, which were taught by one or two faculty members for the first 140 years, came to be one of the largest and strongest departments in the University. The Department is widely recognized for its outstanding research accomplishments, for its significant instructional innovations, graduate and undergraduate, and for its service to the public. With a strong faculty and the continuing capable leadership of Paul Leath, the Department is likely to move further ahead in the years to come. It is to be hoped that the University will continue to nurture this great resource.

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[7]*Newsweek*, December 14, 1998, p. 53.

[8]Molnar, *The Star of Bethlehem: the Legaxy of the Magi*.