successful, it will help strengthen a center of physics that is getting stronger in many other ways too. Princeton University, using money in part from rents at Forrestal Center, a research park it established on Route 1 in 1972, is planning to build a materials science and processing center, probably near its Engineering Quadrangle, where a computer science building already is going up. The university also is establishing an optoelectronics center. In Princeton's stellar mathematics department, people are hard pressed to remember the last time anybody turned down a tenured offer. Over at the Institute for Advanced Study, which is unconnected formally but informally very connected with the university, everything is humming along much as ever under the new leadership of Marvin Goldberger (see interview, page 65).

At Exxon R&E in nearby Annandale, the staff has had to go through a difficult adjustment in the wake of drastic cuts and a controversial corporate decision to ditch research on photovoltaics and semiconductors. But now that the staff has been streamlined to concentrate primarily on polymers, complex materials and complex fluids—areas in which the lab can be confident of long-term support from the parent company—the lab seems destined to remain a world leader (see PHYSICS TODAY, July 1987, page 59).

Things also seem to be humming along nicely at AT&T Bell Labs, a fission product of the Bell system divestiture (see PHYSICS TODAY, May 1984, page 77). Although some critics maintain it is not quite the outstanding lab it was before the divestiture, physics seems to be in quite good shape.

Rather than dwell on the major big shots, the focus in the following stories will be on two central Jersey institutions that appear to be benefiting from their fortunate neighbors: Rutgers University, which is turning its physics and mathematics departments into world-class teams, and the David Sarnoff Research Center, which has been adjusting to a more competitive environment in the wake of its divestiture by GE following the GE–RCA merger.

—WILLIAM SWEET

RUTGERS BUILDS PARTICLE THEORY, SURFACE SCIENCE AND COMPUTATION

The State University of New Jersey at Rutgers, never considered to be in the same class with the great state universities, not to speak of the great private institutions of higher learning, has taken everybody by surprise during the last two years by enormously strengthening its physics department and related programs. Rutgers may soon rank among the world's most prestigious universities in physics and mathematics.

The most recent development was the decision to hire, as a prepackaged group, four superstring theorists and to make them the nucleus of a new theory center. Not long before that the university announced it was bringing in Theodore E. Madey from the National Institute for Science and Technology (formerly the Bureau of Standards) to head up the Laboratory for Surface Modification. Madey carries the title New Jersey Professor of Physics, and the surface science lab has become a member of a New Jersey research consortium organized under the aegis of Sematech. Rutgers mathematician Daniel Gorenstein has been put in charge of a newly established Center for Discrete Mathematics and Theoretical Computer Science, one of the National Science Foundation's newly designated science and technology centers. Integrally connected with the new mathematics center is a well-established Center for Mathematics, Science and Computer Education, headed by mathematical physicist Gerald Goldin. New buildings are planned for the physics department and the mathematics center.

What accounts for all this? One factor, possibly even a precondition, is a mathematics department that has been getting steadily stronger for many years. Probably the flashiest recent acquisition is Martin Kruskal, who is coming from Princeton University; others include Abbas Bahri, Haim Brezis, Henryk Iwaniec, Ionnis Kratzas, Martin Kruskal, Herbert Robbins and Endres Szemredi. Partly because of the role of Joel Lebowitz as an organizer of conferences in statistical mechanics, the math department is well known to physicists. Independently of that, the university has been a magnet for mathematical physicists: The latest tenured appointments in mathematical physics include Antii Kupiainen and Tadeusz Balaban.

Asked to assess the importance of Princeton and other physics institutions in the area as drawing cards, people at Rutgers express some doubts. The physicists and mathematicians don't like to think of themselves as an appendage of Princeton, understandably, and they wonder whether candidates being recruited might actually worry about the prospect of being second-class citizens. "The proximity of Princeton might help but it might also be a negative factor," comments Felix Browder, the university's vice president for research. On the other hand, Browder credits Marvin Goldberger of the Institute for Advanced Study for being "very interested in building theoretical physics in central New Jersey," and he says there has been a good personal and professional relationship between Edward Bloustein, the president of Rutgers, and Harold Shapiro, the president of Princeton. "Everybody's working together," Browder says, "and connections clearly are getting closer with places like Exxon, Bellcore, AT&T and Sarnoff."

Browder himself was brought to Rutgers about two years ago from the University of Chicago, where he had been chairman of the mathematics department for more than a decade. An important part of his mission was to help make use of the state's "excellence budget," a special fund established at the behest of New Jersey Governor Thomas H. Kean to provide Rutgers with money to spend in areas where it has a shot at attaining world-class status. The fund, which has totaled about $25 million during the last four or five years, enables the university to endow new chairs in promising fields. One such chair has gone to Norman Zabusky, who left the University of Pittsburgh to become State of New Jersey Professor of Computational Fluid Dynamics in the department of mechanical and aerospace engineering at Rutgers. (Zabusky and Kruskal are credited with the discovery of solitons.)

Presiding over the excellence fund, in addition to Bloustein and Browder, are the university's provost, Paul Leath, and the executive vice president, Alexander Pond, both physicists. Leath has been at Rutgers for about 20 years, and Pond came to Rutgers from the State University of New York at Stony Brook, where he was instrumental in building up that physics department.

String quartet

The four string theorists who will be arriving at Rutgers this fall are Daniel Friedan (University of Chicago),

Thomas Banks (University of California, Santa Cruz), Nathan Seiberg (Institute for Advanced Study) and Steven Shenker (University of Chicago). Popularly known as "the string quartet," they were offered a package deal when university recruiters who were seeking one or another of them realized that they could get all the people they wanted by making a concurrent offer to all four. (While the term string quartet originally referred to a noted article by Gross, Harvey, Martinec and Rohm, it seems destined now to stick to the Rutgers team.)

Commenting on the quartet, Edward Witten of the Institute for Advanced Study says, "It is clear that Rutgers has hired some of the most original and independent-minded theorists in superstrings and conformal field theory." All four have had a big influence in recent years, Witten said. For example, Friedan and Shenker, working with Emile Martinec of the University of Chicago, solved the longstanding problem of the fermion vertex operator; Banks, working with Michael Peskin of SLAC, made an important contribution to string field theory; and Seiberg, with Gregory Moore of the Institute for Advanced Study, "enriched our understanding of so-called rational conformal field theory."

To some people, the decision to hire the quartet smacks of faddishness and politics. "It has all the elements of the bureaucratic process," remarks a physicist-turned-mathematician at New York University's Courant Institute. "Physics always has to have something flashy to sell, and a superstring is something you can sell to somebody like Reagan."

Responding to that kind of complaint, Browder says that he discussed the issue with Sheldon Glashow, a well-known critic of superstring theory, and that Glashow "answered his own question." Glashow told Browder he thought it was strange that half the world's theoretical physicists—*and the better half at that*—were doing string theory.

Besides, observes Leath, the quartet is to become the nucleus of a general theory center, not a center dedicated solely to string theory, and even if superstrings do turn out to be a flash in the pan, these are all first-rate people who one way or another will find very interesting problems to work on.

Allen Robbins, the chairman of the physics department, points out that the department already was strong in other aspects of theory and that recent appointments are making it stronger still. Condensed matter theorist Elihu Abrahams was elected last year to the National Academy of Sciences. The department has lured condensed matter theorists B. G. Kotliar and André Ruckenstein from MIT and the University of California, San Diego, respectively. Astrophysicists David Merritt and Carlton Pryor are coming from Canada's Institute for Theoretical Astrophysics and from Vanderbilt University.

Experimental work in the department is concentrated largely in solid-state physics, especially superconductivity and superfluidity, and in elementary-particle physics.

Discrete mathematics

Browder says people sometimes ask him how you spell "discrete" when conversation turns to the Center for Discrete Mathematics and Theoretical Computer Science.

The center is one of 11 selected last year by NSF from 323 proposals. It is jointly sponsored by Rutgers, Princeton University, AT&T Bell Labs and Bellcore. About 75 mathematicians and computer scientists from the four institutions are expected to participate in its work, and it is supposed to receive nearly $10 million in NSF funding over the next five years. The focus during the first year will be on discrete and computational geometry, a key element in robotics and computer design according to Gorenstein, the center's director.

A Center for Mathematics, Science and Computer Education, which was founded in 1984 at the behest of an organizing committee headed by Joseph Rosenstein, jointly sponsors education programs with the Center for Discrete Mathematics as an integral part of the NSF-supported mission. The education center has a number of ongoing projects, including a "discrete math project," in which area teachers are familiarized with algorithms and graphs, and a precalculus project aimed at the junior and senior years of high school, both run by Rosenstein; an elementary school math project; and the Secondary Science Modules Project, run by George Pallrand of the Graduate School of Education and Sidney Millman, a former physics research director for AT&T. (Pallrand and his colleague Peter Lindenfeld described the modules project in the October 1986 issue of PHYSICS TODAY). Lindenfeld, the most recent recipient of the American Association of Physics Teachers Robert E. Millikan Award, is chairman of the executive committee of the math and science education center.

The general philosophy of the math and science education center, says its director, Goldin, is that "excellent education must be based on close collaboration between scientists, mathematicians and teachers, meaningful partnerships between precollege education, university and industry, and an emphasis on the learning process as well as end results."

Surface science

Even before the arrival of Madey from the Bureau of Standards, the Rutgers Laboratory for Surface Modification was doing well, having recruited both Torgny Gustafsson and Robert Bartynski from the University of Pennsylvania. The capture of Gustafsson was featured, in fact, in a *Time* magazine article about corporate raiding!

The surface lab is a participant in a Sematech-sponsored consortium on surface science, in which the David Sarnoff Research Center also is an important player. But that is another story. . . . —WILLIAM SWEET

SARNOFF CENTER GIRDS LOINS FOR GLOBAL COMPETITION IN HDTV

Several years ago, when General Electric gave the RCA David Sarnoff Research Laboratory to SRI International, rumor had it in the greater central Jersey area that Sarnoff staff no longer had anything meaningful to do and that the lab was just collecting patent income from past inventions. That was not the case. Under the terms of the divestiture, GE was continuing to collect the patent income and Sarnoff staff, faced with the prospect of having to become self-supporting, were busily looking for new things to invent.

There was something about giving the lab away that left the impression that Sarnoff was worthless, or at least worthless to GE, and that SRI was doing everybody a big favor by taking over the lab. But those impressions also were off target. In fact, the transfer left the lab in sound financial condition for the short term, good prospects for the longer term, and with a continuing strong link to GE and, more generally, the consumer electronics industry.