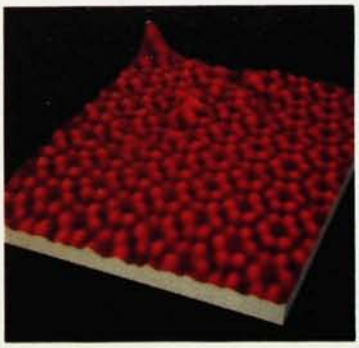
Atoms on the surface of a crystal of Si–Ge alloy. This vacuum-tunneling microscope image shows the (111) surface; it was made by J. A. Golovchenko, R. Becker and B. S. Swartzentruber at AT&T Bell Laboratories.



A celebration of physics

A new survey of contemporary physics finds the field brimming with excitement and activity but laments the lack of young researchers and modern instruments.

The first National Research Council survey of physics, completed in 1966 by a committee headed by George E. Pake of Xerox, consisted of two thin volumes. The second survey was produced in 1972 by another NRC panel, this time under the chairmanship of D. Allan Bromley of Yale University. It filled four books. This month another Research Council committee, under the leadership of William F. Brinkman of Sandia National Laboratory, issues its survey, *Physics Through the 1990s*, in eight volumes: an overview and seven panel reports covering subfields of physics. (Highlights from the seven reports begin on page 28.) In itself, the expansion of the physics survey is telling. Physics is flourishing—intellectually and experimentally. Brinkman proclaims this in his preface: "These volumes document a physics enterprise that is vital, creative and productive."

While the dynamism of the field is portrayed in all three surveys, it is the latest that explains in compelling ways why physics really matters in our society. If the Brinkman report can be said to convey a single message, it is that physics, possibly more than any of the other natural sciences, bears a special relationship with most other disciplines, with many industries and with the nation's defense system. Physics bears a symbiotic connection with other fields—notably with biology, chemistry, materials science, earth and planetary sciences, medicine and engineering. Physics is so prominent and pervasive in fact that some disciplines may even be in danger of losing their traditional identities as they rely upon physics for techniques and theories. At the same time, wholly new scientific disciplines have arisen at the interfaces of physics with one or more sciences. Geophysics, biological physics and microelectronics, for instance, are sustained by the endowment of physics. Thus physics appears to be a field where the sum of the parts accounts for more than the total.

The center of physics shifted from Europe to the US around World War II. Once the US learned the value of the science carried by the European exiles, physics in America advanced by leaps and bounds. Some of the discoveries in the postwar period stand among the highest intellectual achievements—in particular, quantum electrodynamics, superconductivity theory, detection of remnants of the primordial Big Bang, and creation of the transistor and laser. Since the Bromley report appeared 14 years ago, the pace of physics has quickened. Among the new concepts are the electroweak theory, quantum chromodynamics, renormalization-group theory and the idea of the inflationary universe. Experimental advances range from the tunneling microscope to a transcontinental radiotelescope system. What's more, physics is credited with providing ideas and technologies that are central to the nation's economic strength, social progress and military security.

Physics Survey Committee

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Ronald C. Davidson, Massachusetts Institute of Technology
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Improving the human condition

Out of physics have come remarkable developments to improve the human condition. One such achievement is magnetic-resonance imaging, a technique that many in the medical profession believe is likely to be as significant in diagnostic procedures as x rays. The development of MRI depended on microcomputers, which had their origin in the invention of the transistor, and on superconducting magnets, which came about through research in low-temperature physics. The basic principles of MRI did not result directly from those discoveries, but from the pioneering research of Edward Purcell and Felix Bloch, who, the Brinkman report informs us, "were simply curious about how nuclei magnetically interact with matter."

It is understandable of course that the Brinkman committee expresses its pride in the advances and contributions of the field. Scientists in other disciplines are almost as enthusiastic about physics. In the recently released Research Council report *Opportunities in Chemistry* (see page 51), for instance, a committee of leading US chemists hails the arsenal of sophisticated tools that enables their community to solve previously intractable problems and explore heretofore unapproachable regions. The chemistry report provides an honor roll of physics-based instruments that are prized by chemists, including high-resolution magnetic-resonance and mass spectrometers, tunable lasers, synchrotron radiation

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sources and, of course, computers.

The Brinkman report confirms the old axiom that physics is fundamental to all the natural sciences. Physics is characterized by its enormous diversity and its intricate connections to many other sciences. Whether it is the magnificent complexity of proteins and nucleic acids or the grandeur of the universe, physics provides the principles and models to do the necessary studies.

The report also reminds its readers that physics has both its bright and dark sides. "Physics has given mankind the power to make life better or to destroy it," the report says, and the control of nuclear weapons is mankind's "most urgent challenge." To meet this challenge, the Brinkman committee exhorts the physics community to inform both the general public and political leadership about the scientific issues and technical options. "Physicists must play an essential role in advising and counseling," the report declares. The physics community, even before Hiroshima, took a moral stand on nuclear arms, and later sought to inform the public and its political leaders about the technical implications and consequences of nuclear war.

But it is in advancing knowledge and providing technologies that physics has "helped to transform our daily lives," the report says, "permitting a comfort and freedom of action that make it difficult to comprehend that little more than a century ago, even in the technically advanced nations, most people devoted most of their energy to securing food and shelter." Additional evidence of the success of the field can be found a few pages on in the "Overview" volume of the report, in an explanation of quantum mechanics, originated in the 1920s, as

> the unpredictable path by which new knowledge in physics can shape society. Based on studies of the properties of matter, the spectra of atoms and the motions of charged particles, quantum mechanics provided an extraordinary new framework for portraying physical reality. Quantum mechanics revolutionized our most fundamental concepts of measurement and paved the way to understanding the structure of atoms, molecules and solids. It is now recognized that quantum mechanics is basic not only to physics but to chemistry, biology and many of the other sciences. Beyond this, quantum mechanics has led to the creation of new industries, such as semiconductors and optical communications, and has opened new paths of technology through the creation of exotic materials and devices like the laser.

Another more recent example is the 1947 discovery of the transistor, which contributed to the omnipresent computer. "Nobody can know how society will ultimately be transformed by this revolution," the Brinkman report states, "but the advances have been so rapid that the image of a savings bank with clerks patiently entering transactions by hand, without benefit of automatic data processing, seems almost as remote as a candlelit counting house in a novel by Dickens."

Understanding the natural order

Many developments discussed in the Brinkman report were anticipated at the time of the last survey. These include tunable lasers, molecular-ion spectroscopy, and computer-aided tomography and positron-emission tomography (the CAT and PET so useful to medical diagnosis). Such technical advances have been matched by the intellectual progress. "In deepening our view of nature," the overview says, "physics has profoundly affected our view of mankind, because the underlying assumption of physics—that there is order in the natural world and that the human mind can understand that order—permeates modern thought."

BRINKMAN

Since the 1972 survey, US physicists have won 20 Nobel Prizes, for discoveries that reach from elementary particles to cosmology. Three of the laureates were recognized for new theories about the fundamental nature of energy and matter and their transformations. One current objective in particle physics is to understand the basic properties of quarks and leptons and to develop a Grand Unification Theory that will embrace the three fundamental forces—the gravitational force, the unified electromagnetic–weak force and the strong nuclear force. It has been a dream of physicists to explain all the different manifestations of energy and matter in the universe, from the behavior of the most elementary particles to that of galactic superclusters—or, as Fermilab director Leon Lederman described it to members of Congress on 5 March, to formulate "a theoretical synthesis that . . . achieves what is now being called a complete theory of everything."

Unification in physics also is unmistakable in a different context: the trend toward fewer but more complex, costly and centralized facilities. With this development, however, come some inevitable consequences. These are discussed in the overview volume of the Brinkman report along with such issues as education of the next generation of physicists, choices for major new facilities, relations with industry and Federal agencies in basic research and freedom of international scientific communication and exchange. A supplement within the overview contains sections assessing US physics and research abroad, providing supply–demand projections for students, teachers and graduate researchers and examining the organization and support of physics in universities, national laboratories and industry. Six of the seven other volumes epitomize the advances and opportunities in each of the major subfields, and the seventh covers connections with other sciences and the many faces of physics applications.

The Brinkman report is, in sum, a celebration of contemporary physics. The historical paradigm is probably the period of Galileo Galilei and Johannes Kepler, when the telescope and microscope brought forth bold new insights that revolutionized thought on many subjects, including the place of man in the universe, and raised questions that are still at the frontiers of research.

Asking the right questions

When the survey was begun, early in 1983, it was to be completed within one year at a total cost of about $700 000. It has taken three years. Even so, to have expected a comprehensive survey of the entire physics enterprise in one year might possibly have been unreasonable. One of the original purposes of the survey was to identify the promising physics projects that ought to be high on any list of priorities for Federal funding. But the opportunity to influence the Federal budget in fiscal 1985 was lost some time ago and with it possibly the last chance to have any meaningful effect on major physics programs and facilities during the rest of the decade. Science budgets for fiscal 1986 and 1987 have taken their lumps from the agencies and Congress under the budget-reduction scenario that would eliminate all the red ink by 1991. Still, the report sends an impressive message to science policy makers on matters they ought not to ignore.

Accordingly, the committee asked and answered some tough questions, including the following: What is the US position in world physics? Is the nation's scientific support system adequate for the best physics, in both small projects and large ones? What problems do universities face in educating the next generation of physicists? Will physics continue to provide the trained scientific and technical practitioners who are likely to be needed through the 1990s?

The answers are not always pleasant. The problems that are most in need of solutions mainly concern the future of physics in universities and, in the end, go largely unresolved in the report. Among the problems: the changing styles of doing physics, which involve ever larger research facilities and ever smaller numbers of US-born graduate students and postdoctoral researchers; the present unattractiveness of university careers in physics teaching and research; the funding of more applied physics and more defense work by government agencies, to the detriment of pure research conducted in academe; and the implications of tighter security measures for basic research.

The important issues before physics today have far-reaching consequences for industry, government and the whole society. Thus, the concerns expressed in the first few pages of the report are part of a far greater anxiety about the health of the nation's research universities. This matter was examined recently by a panel of the White House Science Council (PHYSICS TODAY, March, page 65).

According to the overview,

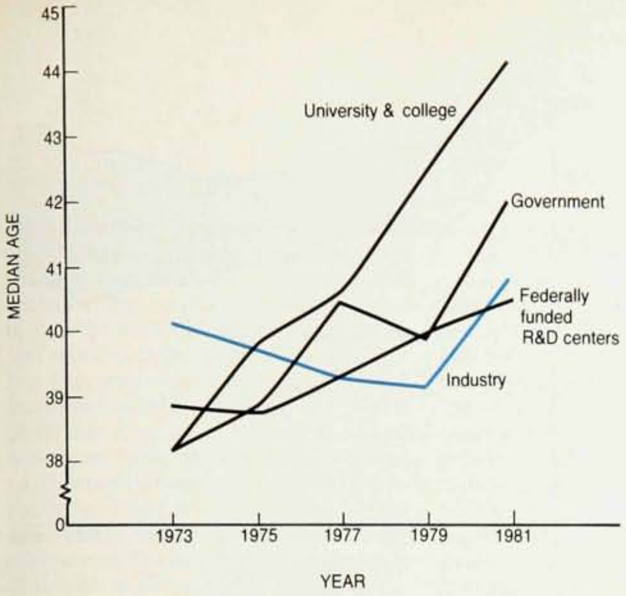
> Retirements from physics department faculties will begin to occur at an increasing rate starting in the early 1990s. To meet the need for faculty replacements, steps should be taken to ensure the continued ability of universities to attract highly qualified young physicists to work in an academic setting. The need is particularly acute in fields where research is carried out by small groups. Such groups make an exceptionally strong contribution to educating new physicists. To enhance the attractiveness of academic research, the difficulty in obtaining modern instrumentation in university research laboratories and the difficulty in obtaining support for research groups must be addressed.

The situation has cultural roots, the Brinkman committee acknowledges. These were identified in 1983 when a Presidential commission issued *A Nation at Risk: The Imperative for Educational Reform*. That report summarized the trouble in a chilling statement: "For the first time in the history of our country the educational skills of one generation will not surpass, will not equal, will not even approach, those of their parents." The Brinkman report, in its assessment of the problem, cites the National Science Foundation's 1980 report *Science and Engineering for the 1980s and Beyond*, and then asserts that "the fraction of students who have any contact with physics is so small that we are becoming a nation of scientific illiterates. Our standards for secondary education in science and mathematics are woefully below those of Japan, the Soviet Union and many of the European countries. The majority of high-school physics teachers are underqualified; the supply of qualified new teachers has essentially vanished." Though the Brinkman committee was not asked to examine the matter, it observes that "we would be negligent not to emphasize the critical nature of the problem and not to endorse efforts to improve secondary education, particularly education in science." It goes on to extol the National Science Foundation for reestablishing its science and engineering education program in 1984 after it had been summarily killed a few years before (PHYSICS TODAY, January 1985, page 55).

The education–research connection

The Brinkman report considers the nation's educational condition to be grim and getting worse each year. The committee is blunt about the situation: "Because it is vital to the health of physics and because we find it to be in difficulty, university research is the central issue of this report. Most nations isolate forefront research from their educational institutions; the United States does not. On the contrary, student participation in research at the highest professional level is at the heart of US graduate education. This tradition is widely regarded as a special source of strength in physics."

It happens that more than half of the nation's basic research is carried out within universities, where 53% of PhD physicists work, and that most basic research in physics is done not by teams at large facilities and national laboratories, but by small groups in their own labs, most often in universities. Small-group physics, performed primarily by a principal investigator



Median age of physicists is increasing in all sectors of employment. The aging will continue to be pronounced in academe, where most full professors are at least a decade away from retirement. Federal policies and the economic slowdown in 1979–81 caused funding cutbacks or fewer hirings at government and industrial labs.

and a few graduate students or post-docs, "constitutes the backbone of university research," says the report. The committee claims that much of condensed-matter physics, as well as atomic, molecular and optical physics, certain aspects of astrophysics, nuclear physics, biophysics and medical physics, operates in this style and that those subfields predominate in industrial physics, essentially because they contribute greatly to commercial electronics and optics.

"Most areas of small-group physics usually advance by a multitude of discoveries that fit together to reveal a major scientific advance, in contrast to research that is organized around a single conceptual theme," says the report. Sometimes, though, it is hard to point to a single theory, experiment or technique that revolutionizes a particular subfield. Surface physics is such a case. The report argues that the astounding progress in surface physics is the result of theories and experiments of many small groups using different techniques—some novel, others traditional.

More than 70% of the physics PhDs in the US are awarded for research done in small groups, and more than half of all doctorates are in condensed-matter physics or in atomic, molecular and optical physics. It may be that the variety of research styles and importance of individuality in these subfields are just the sort of factors that attract many young scientists and nurture their need for initiative and innovation—precisely the virtues that the report insists are needed for physics to continue its rapid intellectual advance.

But all is not well in academic small-group research. The most serious problems are the perpetual underfunding of academic research, which results in shortages of up-to-date instrumentation—particularly large, expensive items such as laser systems, molecular beam epitaxy machines and surface-scattering apparatus—and the inordinate amount of time spent by researchers in acquiring grants, not infrequently too paltry for the group to carry out its work to the fullest capability. In addition, physics is confronted by an increasing reluctance of Americans to pursue research careers in a society that values those professions with less rigorous intellectual requirements and more immediate prospects of financial rewards.

Pursuing new opportunities

Solving such problems will not be easy. Two panels reporting to the Brinkman committee concluded that "to allow a reasonable number of groups to pursue the new scientific opportunities, and to allow some young investigators to enter the field, the level of operating funds must be doubled [in academic research] over about a four-year period." The recommendation for sharply increased funding for basic research is virtually identical to ones from other sources—particularly in *Opportunities in Chemistry* and in *A Renewed Partnership*, the report of the White House Science Council panel mentioned above. As matters now stand, a "healthy" university research group works with a budget in the range of $200 000 to $400 000. Out of this, the group must pay for its equipment. Of course, some groups may obtain as much as $1 million per year, but these are exceptions. The average grant for many small academic research groups is roughly $80 000 a year. "To allow independent group activity in physics to flourish," says the Brinkman report, the base support of the work in universities needs to be augmented by $70 million per year in 1985 dollars for each of four years.

Some of the committee's other recommendations concern the importance of the large research facilities that are so essential to many subfields of physics. Discovery of the most elementary particles, such as the J/ψ in 1974, the Υ in 1977 and the W and Z in 1983, would not have been possible without massive accelerators. Synchrotron light sources and atom- and ion-scattering machines make possible the development of advanced semiconductor devices and new classes of materials. In recommending large facilities, the survey committee relied on the priorities set in the last two or three years by such groups as the High-Energy Physics Advisory Panel, the Nuclear Science Advisory Committee and the National Research Council's Major Materials Facilities Committee. The Brinkman committee attempted to rank the various machines in importance, but quickly gave up hope of ever deciding which facilities would top the list without regard to the subfield. Instead, the committee simply endorses the major recommendations of the advisory groups within each subfield:

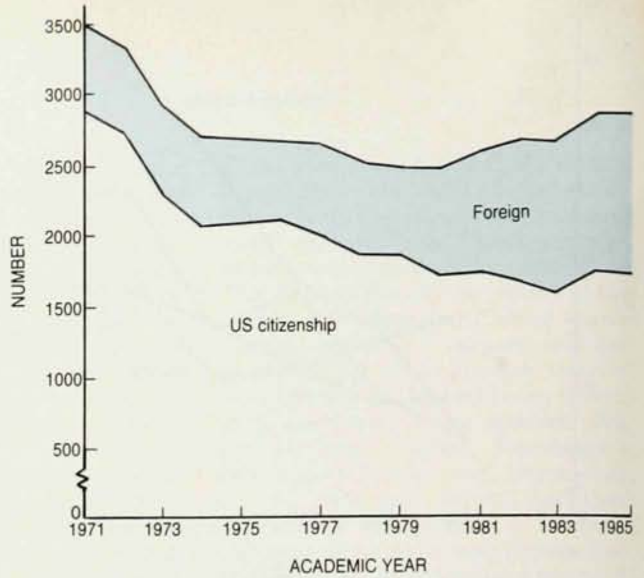
▶ In particle physics, construction of the 40-TeV Superconducting Super Collider, extensions of the 100-GeV electron–positron collider now being built at the Stanford Linear Accelerator Center and modification of the proton–antiproton collider at the Fermilab Tevatron to operate at 2 TeV, providing the highest-energy particle collisions in the world until an accelerator such as SSC is operating

▶ In nuclear physics, construction of the 4-GeV Continuous Electron Beam Accelerator Facility to investigate quark–gluon aspects of nuclear matter and of the Relativistic Nuclear Collider with an energy of the order of tens of GeV per nucleon for beams of heavy ions with atomic numbers up to that of uranium

▶ In condensed-matter physics, completion of the current generation of synchrotron-radiation facilities "as soon as possible . . . to serve the short-term needs of the next three to five years," as well as a new generation of synchrotrons taking advantage of undulators and wigglers, along with new neutron-scattering facilities

▶ In plasma physics, support of vigorous research programs to study confinement and stability in fusion plasmas by both magnetic and inertial

Enrollments of first-year graduate physics students of US origin have decreased since 1971, while those of foreign nationals have continued to increase. Foreign students currently number over 1000, about two-fifths of the total first-year graduate physics student population.



confinement techniques and to investigate the properties of ignited plasmas, the next major frontier in magnetic fusion, by building a facility for the Burning Core Experiment

▶ In gravitational physics, strong support for NSF's program in gravitational-radiation research and construction of the Long Baseline Gravitational Wave Facility

▶ In cosmology and cosmic-ray physics, endorsement of NASA's science program as "sound and forward looking," with such instruments as the Hubble Telescope, Cosmic Background Explorer, Gamma Ray Observatory and Advanced X-Ray Astronomy Facility, and support for an upgrade for the Utah Fly's Eye ground-based facility to conduct air-shower studies of cosmic rays.

In addition to advancing the subfields, a complete range of computers, from microcomputers to supercomputers, need to be provided and upgraded from time to time, with adequate access for researchers who have come to depend on them to control apparatus, run experiments and gather and analyze data. In this connection, the report applauds the Department of Energy for providing access to supercomputers at its fusion center at Lawrence Livermore and the new facility at Florida State University, NSF for supporting a national center for computing in atmospheric physics and its five new supercomputing centers for university researchers, as well as NASA, the Defense Department and the National Bureau of Standards for providing access to scientific supercomputers.

While the current demand for and supply of physicists in our society appear to be in reasonable balance, the Brinkman committee considers this state precarious. "The supply of PhD physicists for industry and government has been sustained only because of the decline in the number of academic positions and the increase in foreign graduate students," says the report. In the 1970s, about one-fifth of the physics grad students were foreign citizens—a total of some 600 each year. Then as the number of first-year graduate students plunged to its nadir in 1980 and began to rise again, a major change in the citizenship rolls of these students became apparent: Two-fifths of the first-year physics grad students—more than 1000 in all—were foreign nationals. This influx of foreign students—a disproportionate number from Asia and the Middle East—blurred another trend: The decline of US students in graduate physics continued until 1984–85, when their enrollments began to rise.

"If there had previously been concern about the availability of highly trained physics manpower in the US, these data only heightened it," says a section of the overview supplement on the education and supply of physicists. "What lay behind the continued decline in US graduate students? Although there were few academic opportunities, the general employment situation for new physics PhDs was healthy. Job offers were plentiful and starting salaries were high. Were the front-page breakthroughs in the biosciences, the new technology excitement of computer science and the financial rewards of the professions drawing bright potential physics students away? Such changes in student career directions could have a major impact on a comparatively small area of concentration like physics."

Benefits of foreign scholars

The committee is convinced that:

> ...the US benefits both directly and indirectly from the flux through its institutions of foreign students and postdoctorates. Many of the young scientists from abroad are among the intellectual elite of their countries; these scientists provide strength and diversity to our programs through their mutual interactions with our physicists. During periods in which too few of our students enter physics as a profession, foreign graduate students and postdoctoral associates often elect to remain here and fill the needs of educational, industrial and government institutions....
>
> Most..., however, do not remain in the US permanently and for that reason one might question the significant expenditures we make on their education and training. By any measure, our nation remains one of the most advanced in physics education and training. Unquestionably, then, we share the responsibility with the other developed nations to make good use of the opportunities that we can offer. The opportunities are substantial: 95% of the world's new science is produced by only 25% of the countries of the world. Unless the talents of capable individuals in the underdeveloped nations can be effectively used, the bases for creating technological changes in these nations will not be realized.

So the education and training of scientists from less developed lands is accompanied by expectations that they will return home to raise the economic and social conditions by their own bootstraps. This, says the Brinkman committee, is "cost effective by any measure. If we were to elect to donate the money that it costs to educate foreign physicists here, it is unlikely that we could find any other way in which it could be used quickly and efficiently to raise the scientific and technological level in the recipient's home country."

Changing patterns of employment also appear to worry the Brinkman committee. "The steady growth of industrial employment of physicists reflected the favorable climate in that sector as well as the closing of academic doors," says the report. Few industrial physicists were engaged in basic research, however; rather, they could be found in engineering or related applied sciences. By contrast, jobs for physicists at the national laboratories, which had remained virtually unchanged during the otherwise "Soaring Sixties," increased steadily through the 1970s, providing a congenial home for some aspects of basic physics research that had normally been carried out in universities. But during the 1980s a shift in emphasis took place as the national labs turned to more applied research to deal with a diversity of missions.

'Graying of physics'

The picture is complicated further by the "graying of physics"—the fact that physicists everywhere in the US represent an aging population. The graying factor is most prevalent at universities where physicists were recruited for tenured faculty positions immediately after the Soviet Union launched its first Sputniks in 1957 and sent the US education system into orbit in rapid response. The nation's military and space build-ups were paralleled by build-ups of scientists and engineers. NASA's founding in 1958 was accompanied by the National Defense Education Act, dedicated to training more technical people. Job openings in academe during the 1960s were matched by increased Federal grants for university research. In the period 1968–73, when the number of PhDs in physics topped 1400 each year, Federal support of academic research had already peaked, but science students always seem to lag behind the marketplace in the choice of careers. In the years since, as statistics compiled by the American Institute of Physics (and used in the Brinkman survey) show, physics graduates and PhDs moved out of academe into such rapidly expanding disciplines as systems engineering, electronics and computer science. Out of 27 000 holders of physics PhDs in the US in 1981, 10 400 were doing nonphysics work. That physics PhDs often abandon their chosen discipline for other fields is a continuing trend, according to studies conducted by AIP researchers.

The declining number of physics PhDs and their exit to other professions has left the community aging, most markedly in academe. In the early 1970s the median age of physics faculty members was 38. By 1981 the median age was 44—the oldest group among all science faculties.

"By the middle of the 1990s the retirement rate [of physics faculty] is expected to increase significantly as a result of the large number of entries in the 1960s. The supply of entrants into the physics labor force could decline at the very time that retirements will be most numerous," the report states in a supplement to the overview volume. "Although pleas for a return to the high production level of graduates during the late 1960s would be inappropriate, concern over the effects of a potentially diminishing labor force is warranted."

Therefore, the Brinkman committee recommends:

▶ Doubling the number of predoctoral fellowships, now totaling 45 to 50 each year, to help reverse the decline in US-born grad students

▶ Attracting the best and brightest to academic careers by enlarging such programs as the Presidential Young Investigators Awards and the Department of Energy's Outstanding Junior Investigator Program; at the same time, Federal funding agencies and business corporations need to help attract and support young scientists at universities

▶ Simplifying the nation's immigration laws for foreign-born physicists who want to pursue permanent research careers in the US

▶ Encouraging more women and students from minority groups that are underrepresented in science to become physicists.

In a short section at the end of the overview, the physics survey committee calls on DOD to "restore its investment in long-range fundamental research and strengthen its connections with the research community for the mutual benefit of science and national security." The new University Research Initiative, proposed in DOD's fiscal 1987 budget, may help do this. So may removing much of the applied research disguised as basic research in DOD's 6.1 budget category. In addition the committee argues that "only a small section of American industry has corporately supported research" and urges the government and industry to "create an environment, perhaps through tax incentives, that encourages industrial participation in basic research."

The Brinkman committee reserves some of its most forceful and eloquent language for its remarks defending the open exchange of scientific information across borders. "For science to flourish, scientists must be free to communicate freely and to move freely. Any interference with these basic principles is a loss for science, a loss for the offending nation and a loss for the dignity of mankind." Such strong statements seem aimed at both the US and USSR—at the current obsession in the White House and Defense Department with restricting the outflow of scientific information and data, even when unclassified and of only remote military potential, and at the obdurate unwillingness of the Kremlin to allow certain scientists to emigrate or travel in the West.

A supplement to the overview states:

> In recent times, there has been an increasing tendency to regard certain scientific and technical information as 'privileged.' Attempts have been made to restrict or prevent its flow to our political adversaries by means that fall short of actual classification. The ultimate objective of such measures is to slow down the acquisition of our technology by those with whom we are currently at political odds. However, attempts to impede the dissemination of scientific information will inevitably impede our own progress. Scientific secrets are not state secrets; they are held by nature. Our adversaries are as free to try to learn them as we are. . . . It is the judgment of those who have studied this complex matter that national security is best served by a policy that stresses scientific and technical accomplishment rather than curbs on the free flow of information.

In a previous section, the report speaks of physics as "an international enterprise because physical principles know no national boundaries. Physicists everywhere are eager to share in the stimulating exchange of ideas. . . ."

Physics Through the 1990s is available from the National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418, or from the American Institute of Physics, 335 East 45th Street, New York, New York 10017, at $160 for the set of eight volumes. Each volume may be purchased separately from the same organizations. The overview volume, for instance, sells for $14.95 paperbound and $24.95 clothbound.

—Irwin Goodwin □