state & society

President requests more support for R&D at NSF and NASA

Citing a decline in recent years in the quality of scientific equipment and in the number of top-ranked laboratories in the US, President Jimmy Carter last November promised that his Administration would provide expanded funds for scientific research and development. In his FY 1979 budget request to Congress, the President has called for a 6.1% increase in the conduct of R&D (from \$26.3 to \$27.9 billion) and a 10.9% increase in basic research (from \$3.3 to \$3.6 billion) among all agencies of the Federal government. According to Frank Press, the Director of the Office of Science and Technology Policy and the President's Science and Technology Adviser, the basic research increase in real dollars is nearly 5%.

Colleges and universities are budgeted to receive \$3.6 billion for R&D from over a dozen different Federal agencies.

Defense-related R&D is up by 8.4% or \$1.1 billion, to \$13.8 billion, and includes a 14% increase in basic-research funding. On the other hand, civilian-related R&D (which does not include space-related activity) is up by only 2.4%, or \$225 million, to \$10.7 billion, reflecting decisions to cut back on development and demonstration programs where potential user demand appears to be low.

In FY 1979 DOE has allocated \$294 million for high-energy physics, \$91 million for nuclear physics, \$334 million for magnetic-confinement fusion and \$126 million for inertial-confinement fusion.

BARDON

In addition, \$30 million has been allocated for nuclear sciences and \$94 million for materials sciences.

NSF's budget for R&D will increase 10% or \$75 million, to \$829 million, including \$755 million for basic research.

NASA expects to increase its support for basic research to \$520 million, an 11.1% increase over FY 1978. Overall R&D obligations for the agency are expected to rise by \$316 million in FY 1979 to a total of \$4.2 billion while facilities construction will decrease by \$9 million.

For NSF an increase of 10% has been requested for support of basic research, up to \$755 million. (See table 1.) At the press briefing for NSF's budget, James A. Krumhansl, who heads the Mathematical and Physical Sciences and Engineering Directorate, stated that the physics program will provide increased funding for instrumentation and will emphasize the greater utilization of facilities. Marcel Bardon, the new director of the physics division, told us that instrument support in various areas of physics will be increased by \$3.4 million. The amount of \$2.2 million will be allocated for instrumentation for users of the Positron–Electron Project (PEP) at Stanford University. In addition, \$9.5 million is budgeted for further work in converting Cornell University's Wilson Synchrotron to an 8 GeV × 8 GeV electron–positron colliding-beam facility and \$1.1 million for development of a superconducting cyclotron for heavy-ion physics at Michigan State University; both facilities (costing respectively \$21 million and \$3 million over three years) are expected to go into operation during FY 1979, according to Bardon. He also told us that \$1.0 million in the forthcoming budget has been allocated for a new Institute of Theoretical Physics. No location has yet been chosen for this Institute.

In the materials-research division, according to the acting director, Howard Etzel, \$800 000–900 000 has been budgeted for modernization of research in-

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Lindenbaum sees economic gains from high-energy physics

"One of the biggest problems facing the high-energy physics community is to convey to the decision-makers and the average American the practical values as well as the intellectual triumphs resulting from increased support of high-energy physics," according to Sam Lindenbaum, a physicist from Brookhaven and CCNY, who recently spent 15 months in Washington as Deputy for Scientific Affairs, High Energy Physics Program, Division of Physical Research, ERDA. He returned to Brookhaven shortly before ERDA became a part of DOE. He recently discussed with us his views on the current status of US high-energy physics research.

Although intellectual curiosity is the major motivation for undertaking high-energy physics research, Lindenbaum argued that support for this field does produce significant economic benefits for the US: "I personally believe that we have entered an era of a mature industrial society where the basic production of standard products is no longer something in which we hold an advantage, and in fact we are at a competitive disadvantage with other countries in many such cases.

"The areas in which we really shine are the exotic technology areas—just those areas that are spun off from frontier research such as that done in high-energy physics. For example, the heart of the modern digital computer, the scale-of-two counter, was invented in nuclear research, the high-energy physics of the late 1930's and the early 1940's. The first modern digital computer was originally developed in connection with the Manhattan Project. The accelerators—the tools of the trade that one uses in high-energy physics—have demanded new exotic technologies that in many cases were developed originally for those accelerators. Other examples include high-vacuum technology of the modern type and the high-voltage equipment industry. The accelerators themselves have been used for medical applications, industrial radiography and for fusion energy experiments."

Another serious problem facing the high-energy physics community in the

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LINDENBAUM

US, according to Lindenbaum, is the inadequate level of funding that the US program receives. He noted that there has been a decrease in funding in constant dollars since the mid-1960's, which leads him to believe that "We are now at that critical point where any further reductions would be quite drastic in their negative impacts, if not fatal to the field, since in order to be effective, it must compete in an international environment. The point is often made that in spite of the fact that we are funded less than the Europeans, many people conclude that we are presently doing better, and that therefore we don't need any more funding. That is a fallacious argument in my view, simply because the proper unit to integrate over is a decade or more."

Lindenbaum recalled that the center for "frontier" physics was in Europe prior to World War II. Leadership then passed to the US for two reasons: the forced immigration of many top-notch European physicists to the US, and the Federal government's "enchantment with the doings of the scientists during World War II, which led to an enormous infusion of funds into basic research at a propitious moment when the field was changing into a new era—one of mesons, antiprotons and elementary particles."

If the US continues to stay behind the Europeans in funding, Lindenbaum sees the situation reversing itself. Already there are some signs of a reverse "brain drain." Some very prominent European physicists who were postwar immigrants to the US have returned to CERN and other European establishments. Americans are going to CERN to do experiments and some are even becoming staff members at European installations.

A continued US superiority in the high-energy physics field is clearly advantageous, according to Lindenbaum: "This is a very complicated field and when you do it yourself, you develop a capability to not only utilize it personally but to transmit to your students and to your local industries. You get an interplay, a coherent resonant effect between the university community, the industrial community and the scientific community. Something happens which makes the country dynamic and that something does not happen when you say 'Let us use their results.' " He observed that this is precisely why the Europeans have been increasing their funding, instead of depending on our results, which are freely distributed.

It is Lindenbaum's opinion that a 25% increase in high-energy physics funding would ensure our continued preeminence in this field and would probably lead to a more than doubling of our research accomplishments: "One of the reasons why we are so highly leveraged is that a large fraction of the budget is committed to the minimum viable program, and the output of the program is very sensitive to the construction of new types of facilities and the improvement of existing facilities and instrumentation. A large portion of any increase can be used for purposes of that nature, which really then makes the return per dollar come out much larger."

Lindenbaum believes that one of the strong points of the US program is its diversification into several national laboratories that are freely accessible to university researchers, who utilize the majority of the accelerator time. He noted that the management of each laboratory has its own very definitive tastes in research and that this is a definite advantage. To concentrate everything under one management would be a step in the wrong direction: "In research, if one were to follow what everybody thought was the 'hottest thing' to the ultimate, you might end up with a disaster on your hands. You really have to diversify and cover all rational avenues of investigation that make sense and that seem reasonable to support, even though some are less 'hot' than others, because it has been shown time and time again that the so-called 'hot' investigations generally do not pay off as much as the integral of the other investigations."

Lindenbaum went to Washington at the invitation of William A. Wallenmeyer, the Assistant Director of ERDA's high-energy physics program. After reviewing the program, Lindenbaum found that it was near optimal considering the constraints (fiscal, political, economic and sociological) that have been placed upon it. When asked whether he was satisfied with his own performance in his government position, he told us that "In particular I believe I had made the case for the practical benefits to society that spin off from high-energy physics more plausible to many individuals both in, and to some extent outside, of ERDA.

"Furthermore, I believe that my emphasizing that high-energy physics has entered a particularly fruitful era recently was highly beneficial to the program. I pointed out that hundreds of elementary particles that have been discovered were now explained by the four-quark theory. The gauge-symmetry theories, which predict that at higher energies the weak and the electromagnetic forces and even the strong and eventually the gravitational forces will be unified, have been strongly supported by recent high-energy physics experiments. The next generation of accelerators will shed a great deal

Wilson resigns over funding

Robert R. Wilson, director of the Fermi National Accelerator Laboratory since its inception in June 1967, submitted his resignation to the Universities Research Association on 9 February.

In his letter of resignation Wilson warned that "the future viability of Fermilab is threatened because the funding has been below that necessary to operate the existing facilities responsibly. Presently we are operating at about half of our capacity to do physics experiments. This predicament is especially serious in light of the financial resources of CERN, which are considerably more than double our own. Our scheme to leapfrog their financial advantage by increasing the Fermilab proton energy to 1000 GeV through the application of superconductivity has been confounded by indecisive and subminimal support, as have been our modest proposals for intersecting beams.

"Such considerations led me in desperation to the conclusion ... that I should not continue to give the impression that I could responsibly direct Fermilab without a substantial increase in the funding."

WILSON

Wilson has expressed a desire to continue working on the Tevatron (PHYSICS TODAY, October 1977, page 23).

of light on these subjects. Although it is difficult to foretell what the results of these advances will be, one must remember the dramatic impacts on our daily lives resulting from Maxwell's unification of electric and magnetic phenomena and Einstein's unification of matter and energy.

"I also felt that the government administrators both directly concerned with the program and the various decision-making bodies above them can be reached by logical arguments as to why support of high-energy physics is in the national interest both intellectually and practically."

Lindenbaum observed that the Washington environment is entirely different from the one that is found in active research. He advised that government experience can be very valuable if an individual is "well impedance-matched" to the Washington environment. According to Lindenbaum, "it takes an individual with a broad enough viewpoint so that he can communicate with the people involved on a level that they consider understandable and do it in a way that they can relate to." —CBW

NSF and NASA budgets

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strumentation at the 15 NSF-supported Materials Research Laboratories. Funds to continue the construction of synchrotron-radiation facilities at the University of Wisconsin and Stanford University have been requested. Wisconsin's Aladdin storage ring, expected to cost $3 million over a three-year period, will produce radiation from 1 eV to 2.5 keV and with a wiggler will reach 10 keV; it will become even more intense in those spectral regions that overlap Wisconsin's 240-MeV Tantalus I storage ring. Some 30 to 40 ports are planned. The three-year, $6.7-million expansion of the Stanford Synchrotron Radiation project at SPEAR will add by 1980 seven new beam lines serving 14 monochromators. The construction of a multipole transverse wiggler operating at 18 kG will yield a flux up to about 10 keV. In FY 1978 $4 million was allocated for construction components at Wisconsin and Stanford and $1.5 million for operating expenses for existing facilities at these locations; the breakdown for FY 1979 is not yet available. Etzel also said that construction is slated to begin during the forthcoming fiscal year on a second-generation 30-tesla hybrid magnet at the Bitter National Magnet Laboratory.

William E. Howard III, director of NSF's astronomical-sciences division, told us that the $78-million Very Large Array radiotelescope project near Socorro, New Mexico has been allocated $12.2 million for further construction and is now expected to be completed in FY 1980. At present, 10 of the 27 antennas are operating. When the Array goes into full operation in FY 1981, it will have a resolution of 0.6 seconds of arc at an observing wavelength of 6 cm and 2.1 seconds of arc at the 21-cm wavelength of neutral hydrogen.

NSF's new Applied Science and Research Applications Directorate (the successor to the RANN program) is budgeted at $73.9 million, which includes a $6.9-million deferral from FY 1978 and a $9.1-million increase in new obligational authority. Jack T. Sanderson, who heads ASRA, told us that earthquake research is slated for an increase of $8.3 million up to $26.4 million in FY 1979 and that the program for applied physics, mathematics, biological sciences and engineering (within the division of applied research) is budgeted at $10.4 million, an increase of $1.0 million over FY 1978.

NASA. As it did last year, R&D accounts for about 75% of NASA's total budget authority request of $4.372 billion. The Space Shuttle has been allocated $1.439 billion, space sciences (which includes physics and astronomy, lunar and planetary exploration and life sciences) allocated $513.2 million and space and terrestrial applications allocated $283.4 million. (See table 2.)

In the physics and astronomy category, there are two new programs, both involving the Sun. The Solar Polar mission, which will be jointly funded by the European Space Agency, will involve sending two spacecraft into solar orbits that will be inclined about 88° to the ecliptic or solar equatorial plane. (Previous spacecraft have never been inclined more than 15°.) From Earth orbit the Space Shuttle will launch both spacecraft simultaneously within a 10-day launch window in February 1983 along paths that will allow them to rendezvous with Jupiter in May 1984. Observations are expected to begin in September 1986 at a time when the Sun will be in one of its relatively quiet periods. The spacecraft

Table 1. NSF physics-related research

	(estimates in millions of dollars) FY 1978		FY 1979	
MATHEMATICAL AND PHYSICAL SCIENCES AND ENGINEERING DIRECTORATE				
Mathematical sciences		21.5		23.1
Computer research		16.6		18.1
Physics				
Elementary particles	22.7		25.4	
Intermediate energy	9.7		10.7	
Nuclear	12.0		12.8	
Atomic, molecular and plasma	5.9		6.5	
Theoretical	6.2		7.5	
Gravitational	2.3		2.4	
Total physics		58.8		65.3
Chemistry		43.6		47.7
Engineering		45.6		49.6
Materials research				
Solid-state physics	10.2		11.4	
Solid-state chemistry	4.5		5.0	
Quantum solids and liquids	4.9		5.1	
Metallurgy	7.1		7.0	
Ceramics	3.1		3.3	
Polymers	3.5		3.8	
Materials Research Laboratories	17.4		19.0	
National Magnet Laboratory	3.7		4.0	
Synchrotron-radiation facilities	5.5		5.9	
Total materials research		59.9		64.5
Total		246.0		268.3
ASTRONOMICAL, ATMOSPHERIC, EARTH AND OCEAN SCIENCES DIRECTORATE				
Astronomical sciences				
National astronomy centers (except VLA)—operation	27.7		29.3	
Research project support	15.6		16.5	
Very Large Array—construction and operation	13.7		14.6	
Radio-spectrum management	0.1		0.1	
Total astronomical sciences		57.1		60.5
Atmospheric sciences		55.0		59.1
Earth sciences		34.3		38.5
Ocean sciences		58.0		63.3
Arctic research program		5.7		5.9
Total		210.1		227.3