NSF Physics Section Discusses Support Policies and Prospects

How is physics supported by the National Science Foundation? PHYSICS TODAY recently visited Wayne Gruner, head of the physics section, and the seven program officers who administer funds for physics research. These physicist-administrators told us how they handle proposals and how scientific choice is made—usually in their opinion, by the physics community itself, not the administrator. The recent financial squeeze on basic research and the emphasis on applications by some of the mission-oriented agencies is making more work for NSF.

Roughly half the physics money from the foundation is given by project grant, administered by the physics section. But NSF as a whole also supports physics through institutional grants, departmental grants, fellowships and educational improvement. In fiscal 1969 the physics section gave $31.7 million out of a total budget for the mathematical and physical sciences division of about $89 million (see table).

No major field of physics gets its main federal support from NSF. Grant support for university research by NSF is roughly one-fifth of the federal total given to universities. AEC gives roughly 55% and the three defense agencies (Office of Naval Research, Air Force Office of Aerospace Research and Army Research Office) give about 15%. Most of the balance is given by the Advanced Research Projects Agency and the National Aeronautics and Space Administration.

We sat one summer day in NSF headquarters (in a modern Washington office building) with Gruner and the physics-section program officers: Langdon T. Crane Jr (atomic and molecular physics), J. Howard McMillen (elementary-particle physics), Paul F. Donovan (intermediate-energy physics), William S. Rodney (nuclear physics), Howard W. Etzel (solid state and low-temperature physics), Joel A. Snow and Bernard Chern (theoretical physics).

"How do you handle proposals?" we asked. People are encouraged to contact NSF informally first, by letter, phone or informal visit. The stock answer to inquiries is, "If it's basic research we're interested"; most other government agencies are usually interested in applied research.

In the proposal itself, the principal investigator gives a report of his own career, where his project fits into the field, and a description of his school if it is small. Then the program officer chooses reviewers typically between two and six in number. "Where else can you find a peer system without peer?" Donovan quipped.

The reviewer is asked to comment on both the man and the scientific merit of the proposal. If the man is young and just starting out, he may be at a disadvantage because he is relatively unknown, Etzel explained; program officers sometimes send such a proposal to the man's thesis adviser to learn about his potential.

Fairness. "How do you prevent the technique of 'You scratch my back; I'll scratch yours'?" We were told that the average reviewer is conscientious, tries to be fair, and besides, if he praises unworthy proposals, there may not be enough money left to support his own project.

Many people serve as reviewers; Etzel noted that he cannot use any one expert like Charles Slichter, Erwin Hahn or Charles Kittel every week: "They'd get worn out." Many reviewers are not themselves grantees, and some come from industry.

The program officer must watch out for personal rivalries and for the reviewer who gives consistently low ratings. "You must calibrate your reviewers," Rodney explained. Pirating of ideas from proposals is almost unknown, he said.

After evaluating the reviews the program officer decides whether or not to recommend a grant. Then the proposal goes to Gruner, William E. Wright (head of the division of mathematical and physical sciences), Randal M. Robertson (associate director for research) and Louis Levin (executive associate director) for a final decision. (Many critics have objected to the proportion of physicists in the government who are responsible for public administration. Not only Gruner but also Wright and Robertson are physicists, and the foundation's

NSF Physics Grants in Fiscal 1969

Subfield	*Amount (millions)*
Atomic and molecular	$ 2.46
Elementary particles	11.56
Nuclear	8.02
Solid state	4.63
Theory	3.74
Facilities	1.30
Total	$31.71

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first two directors, Alan T. Waterman and Leland Haworth were physicists. But the recently appointed third director, William D. McElroy, is a biologist; so is Levin.)

Despite the number of approvals required on a grant, the program officer is expected to make the real decision in most cases because of his intimate knowledge. In difficult cases, he can ask advice from the section's advisory panel, which has 11 members from industry and academia. The panel meets twice a year to comment on general policies and emphasis. Proposals are reviewed throughout the year.

Some scientists complain about the time and effort consumed in writing proposals every couple of years. But Donovan feels that it is extremely healthy to reflect periodically on your progress and plans. He noted that major laboratories require internal proposals even if no external agency forces them to make them.

From time to time some government agencies have experimented with five-year continuing grants. Most of the prospective clientele did not want them because their budgets would be fixed for such a long time.

Balance. Throughout most of his career a physicist is influenced by NSF, Gruner noted: in grade school, high school and college by way of curriculum reform and NSF teacher institutes; in graduate school through fellowships, research assistantships, traineeships and sponsored research (in which he may work under a professor's grant); then as a postdoctoral fellow and finally through his own grant.

Gruner feels that what he calls "longitudinal balance" in government treatment of a particular science needs more examination. Just as we should be concerned with a proper transverse balance among astronomy, psychology, geology and so on, we should be sure that "what you do with a high-school student is consistent with what you do to him as a graduate student and later as a 35-year-old associate professor."

The NSF education divisions are organized longitudinally, "by the chronological age of the victim." Nobody within this group specializes in physics support.

"There's a bad tendency when you're running an operation like this. Much of what you do in year n is already committed because of things you did in year $n-1$ or $n-2$," Gruner said. He feels that they should set aside some of their operating budget for nonrecurring things, but they have never really done so. If a physicist needs a piece of equipment that costs about as much as his whole annual operating budget, NSF treats it as a nonrecurring item and pays for it out of a separate facilities budget. Recently Robert Dicke got a computer out of the facilities budget. The Cornell 10-GeV electron synchrotron, too, was built out of the facilities budget but is operated (for $2.65 million per year) with regular physics-section funds.

Dumping. The federal government pours money into pure physics research through many funnels. In the past few years some have shown signs of clogging. Congressman Emilio Daddario observed not long ago that the mission-oriented agencies have been dumping their programs on NSF.

The Defense Department for example, decided four or five years ago upon a systematic withdrawal from high-energy physics. After formal high-level conferences at the White House Office of Science and Technology and the Bureau of the Budget, most of the $6–7-million program of the Office of Naval Research was transferred to NSF. The three-year transfer has just ended. One notable project that ONR dropped and NSF picked up was the superconducting linear accelerator of William Fairbank, Robert Hofstadter, Alan Schwettman, and their collaborators at Stanford. (The Navy continues to support parts of the Stanford program not related to the accelerator itself.)

The NSF physics section received money specifically earmarked for projects previously supported by ONR; but a lot of the projects are being funded at a reduced level.

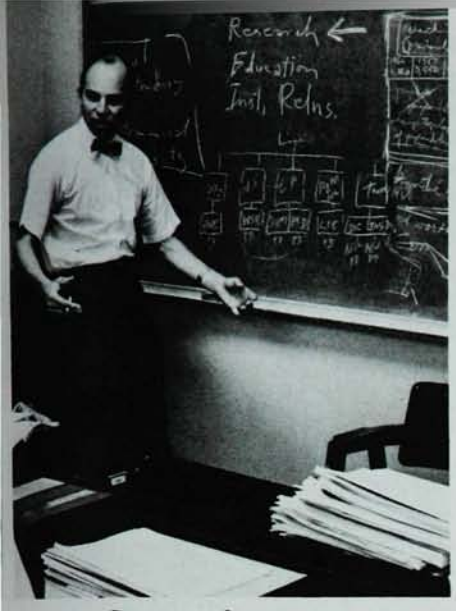
Recently the Air Force cut its solid-state budget by $900 000; support for mechanical properties of solids (25–30 contracts) was cut off entirely.

Despite such cuts, the Defense Department still supports academic physical sciences about as much as it did five years ago, Gruner said. But about $20 million of it now goes through Project Themis, which supports interdisciplinary and programmatic efforts. Snow noted that Themis programs are "more end-use oriented. Some of the grants go to second-line institutions and sometimes to undistinguished investigators."

Crane observed that some parts of the Defense Department are showing "a greater interest in hard-nosed relevance. There's a pressure to ask people to direct themselves toward very applied problems." In the shrinking money market the National Aeronautics and Space Administration is showing a tendency to demand relevance, too, he said.

"People in the mission-oriented agencies are not capricious in what they support," Snow said. "They feel just as responsible for the people they support as we do. We have a whole overlay of interagency committees, mostly headed by NSF people, that tries to see that things don't fall between chairs and to coördinate the actions of the different agencies in an informal way to protect the university community from injury."

Although a high-energy physics shift is visible, decisions in atomic and molecular physics are more diffuse, Crane said. There may not be a conscious decision to terminate support of a physics field. But several project officers may decide to stop small, low-visibility projects, which together amount to a fair sum of money. "Their objectives are changing with time, and people are either being terminated or reduced in support. They appear on our doorstep saying



Gruner makes a point

25 or 30% of their money has been cut. It's very hard to deal with this kind of problem, because you can't say that the man is really out of business. He just starves slowly, and eventually his equipment becomes too obsolete to undertake very meaningful research or innovation. But he's still alive."

Graduate students. Gruner said he hopes professors will take on slightly fewer graduate students for the time being. "I don't think we have enough information yet to recommend consciously valving down on graduate students. It may be that the graduate students are valving down on themselves more than is consistent with good public policy . . . We're terribly concerned."

What about the graduate student who wants to continue his thesis research after his doctorate and cannot do anything else? Gruner said, "You have to distinguish between substantively prepared and emotionally prepared."

Chern remarked, "You find more and more professors telling their students, 'Although this is the subject you're working on here, you shouldn't consider yourself a failure if you finally wind up working on pollution problems.' "

Snow said, "There are some students so locked up in their intellectual efforts that they really don't give a thought to what their careers will eventually be."

Scientific choice. How does the federal government control transverse balance? Donovan feels that "the scientific community itself really has the largest say about which segments of science are supported. All the agencies respond to proposal pressure. The community is really very ingenious in doing the research it wants to do. Maybe the time constant isn't instantaneous, and maybe it shouldn't be."

Snow added that the peer review shows "what problems and what people are really hot." Donovan offered an example: In nuclear physics the introduction of tandem accelerators and solid-state detectors six or seven years ago suddenly made the field more productive and interesting. This revolution in technique made about 150 accelerators noncompetitive for nuclear research. So NSF suggested that the National Academy of Sciences sponsor a study of new uses for low-energy accelerators (now published); these include applications in solid state, astrophysics and atomic physics.

Plasma physics, too, has had a revolution, Crane observed. In 1966 the National Academy Physics Survey Committee (headed by George Pake) noted that plasma physics was not as healthy as other physics subfields (PHYSICS TODAY, April 1966, page 23). One problem was that universities did not consider it quite as "respectable" as other fields, Gruner said. Then new experimental procedures began producing meaningful data. Proposals started coming in and NSF decided to

CRANE DONOVAN

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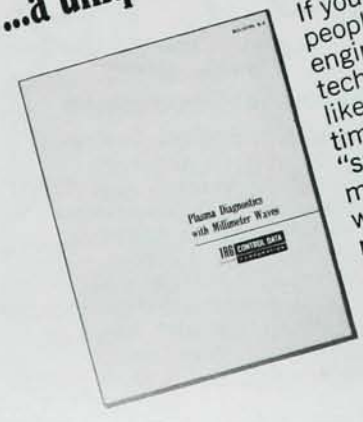

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direct some of its available growth into plasma physics.

"Support the man, not the project," used to be a motto around the Office of Naval Research. Gruner says the idea still has a lot of merit. Suppose you have a solid-state physicist who years ago determined "to devote his energies and efforts very fiercely and singlemindedly to a single class of problems." If he is a good man all the agencies supporting solid state know him and his work. "Really the allocative process has occurred a long time ago. We can only shim it up."

In theoretical physics, Snow remarked, it is easier to change your field and respond to new ideas. For example the theory of phase transitions was moving slowly until five or six years ago. "Then work by Michael Fisher, Cyril Domb and M. F. Sykes focused a lot of attention on critical phenomena. People spontaneously quit working in other fields and started sending in proposals on phase transitions." Now both the physics and chemistry sections support a lot of such work. Snow concluded it would have been impossible several years ago to forecast that the theory program would support a lot of phase-transition studies.

Although everyone climbs on the bandwagon when a field becomes popular, Rodney remarked, eventually the momentum carries the support too far. "Then we put on the brakes and say that's enough of that."

Gruner went on, "We've been explaining what I used to call the linear-amplifier theory of public support. But it's obvious that the federal government can't spend indefinitely between $1.5 and $2 billion a year on fundamental research without influencing the direction of it. The influence is subtle; it has to be exerted gently; it has a long time constant."

One strong influence lies in the facilities budget. Thus, for example many people are now interested in accelerating heavy ions to produce very heavy transuranic elements. After many National Academy committee meetings, proposal evaluations and external peer evaluations, a government scientific-policy decision will be made on heavy-ion accelerators. Then the very existence of a large facility will have its influence on "how an awful lot of very smart people are going to want to spend their time." —GBL □