

DEPRESSED BY LACK OF GRANTS AND JOBS, MATERIALS SCIENTISTS WARM TO OSTP PLAN

Topic A in the corridors of the cavernous Cincinnati Convention Center and the nearby bars and restaurants during The American Physical Society's March meeting was the dismal outlook for jobs and grants for young faculty and postdocs in condensed matter physics. Topic B, by contrast, contained a whiff of hope. It was the announcement made by a representative of the White House Office of Science and Technology Policy that a major initiative for advanced materials research is being formulated for President Bush's fiscal 1993 budget. While that budget will not be sent to Congress until January at the earliest, the effect of the initiative, assuming that it goes forward and is then enacted, will be felt later still—months after the new fiscal year begins on 1 October 1992.

That's a long wait for those materials physicists who face a period of personal and scientific pain while they search for funding and employment. Their plight has become steadily worse in the 1980s, even as their field has grown more exciting and exemplary. Still, reaction to the proposed initiative, explained at the Cincinnati meeting by David L. Huber, on leave to OSTP from the Synchrotron Radiation Center at the University of Wisconsin at Madison, was relatively optimistic. Huber had begun his talk before more than 300 physicists, some standing along the walls and in the doorways, amid palpable hostility. When he finished, there was much applause. "It's a good thing OSTP sent him and not some bureaucrat," says Michael Schluter, who heads the theoretical physics research department at Bell Labs. "Dave is one of us and fully understands our problems."

Huber has been designated acting director of a fledgling OSTP organization, the National Critical Materials Council, which deals with government-wide issues relating to strategic as well as advanced materials.

To many in Huber's audience, the initiative is an idea whose time is long overdue. Although the number of

researchers in condensed matter and materials science has doubled in the past decade, along with their output of research papers, funding for those in universities, in national laboratories and even in industry has remained essentially flat, barely keeping pace with inflation. Academic scientists have been forced to turn almost exclusively to their own departments for support of new instruments, and young physicists, some in tenure-track positions at research universities, actually seem to have a better chance of winning a Sloan Fellowship or a Presidential Young Investigator award than of obtaining a regular grant from the National Science Foundation.

Volleys on the battleground

For years the field of condensed matter has been a battleground. Some of the most prominent academics in the field have fought to increase the number of awards and the amount of grants (see *PHYSICS TODAY*, March 1988, page 41). A few, like Philip W. Anderson of Princeton and James Langer of the Institute for Theoretical Physics at the University of California in Santa Barbara, have fired volleys of protest in newspaper op-ed pages and in halls of Congress against funding decisions by NSF and the other agencies that ravaged their research. In recent years graduate students and postdocs in the field have been knocking at the doors of universities for faculty positions and getting few responses. Bell Labs's offer of two new positions last year for condensed matter theorists attracted 120 applicants, all qualified for the jobs.

Opportunities, though not jobs, in the field are increasing. In "Physics Through the 1990s," the survey of the whole discipline conducted by a National Research Council committee led by William F. Brinkman of Bell Labs, condensed matter physics was singularly championed as intellectually stimulating because of "the discoveries of fundamentally new phenomena and states of matter, the development of new concepts and the

opening up of new subfields that have occurred continuously through its 60-year history.... In fact, condensed matter physics is unique among the various subfields of physics in the frequency with which it feeds its fundamental ideas into other areas of science." As a mark of its vitality, the report observed, within the previous six years three Nobel Prizes had been awarded for research in the field—the quantum Hall effect, the scanning tunneling microscope and high-temperature superconductivity.

Of all the branches of physics, condensed matter research has had the greatest impact on technological developments and commercial products, including the invention of the transistor, which led to the miniaturization of electronic appliances, to semiconductor microprocessors and to myriad types of computers. Materials research has brought about fiberoptics for telecommunications, composites for a wide range of products, from aircraft engines to tennis rackets, and artificial "smart" biomolecular materials that organize themselves to resemble membranes and cells in living organisms.

So it was not surprising that D. Allan Bromley, the President's science adviser, exuded enthusiasm about materials research when he spoke at a forum sponsored by the Solid State Sciences Committee at the National Academy of Sciences on 27 February. While the field had been parented by a disparate set of sciences and technologies, he said, "it is really an orphan science." It doesn't fit neatly into traditional academic departments or into government science agencies, he observed. At NSF, in fact, condensed matter physics was ripped untimely from the physics division nearly two decades ago, just as the field was becoming more exciting and attractive for basic research, and folded into a new division with ceramics and electronic materials, polymers and metallurgy, which had been shifted from the agency's engineering division. Along with adopting these fields, the newly formed

materials division took in the Materials Research Laboratories, which were cast out by the Pentagon's Advanced Research Projects Agency in 1972, and the MIT magnet lab, abandoned by the Air Force that year.

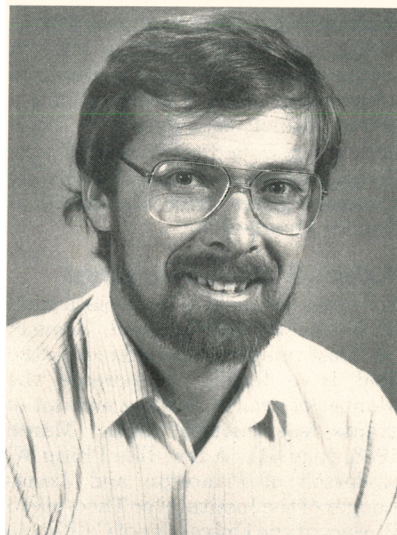
Bromley had been telling materials scientists for months to keep hope alive. He has indicated to visitors at his office that he intends to propose a government-wide materials program, with synthesis and processing as a centerpiece of the fiscal 1993 budget. In his remarks at the National Academy meeting he repeated his plan to elevate materials science and technology into a full-scale Presidential initiative. The fiscal 1992 budget, sent to Congress a few weeks before his talk, recognized the importance of the field, said Bromley, by requesting an additional \$25 million for NSF to fund individual investigators and small groups, primarily in electronic and photonic materials and biomolecular materials.

Condensed matter theory has fared badly in NSF's materials division in recent years, by contrast with the applied sciences and engineering subfields in the division. The 1992 budget asks for a \$1.3 million increase for all materials theory at the agency, without specifying exactly how much of this would go to condensed matter. Theorists like Anderson are wary of such vague allocations. He voiced his concerns at a hearing last March before the House science research subcommittee and urged NSF to return condensed matter theory programs to the agency's physics division, where it is likely to get a fair shake when funds are divvied up for basic research.

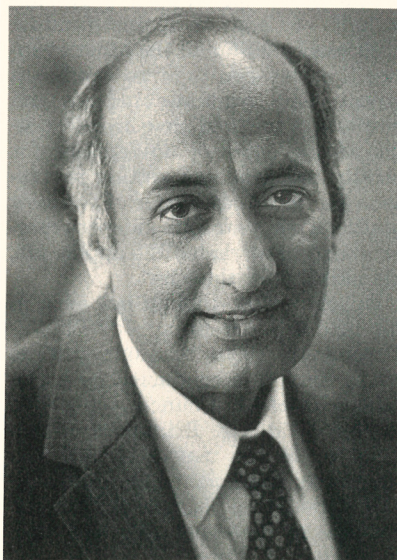
In his talks to materials researchers, Bromley claims that the Federal government spent about \$1.4 billion on materials R&D in 1990, as much as 85% of that amount on advanced materials. While the figure seems implausibly high, it is within hailing distance of the estimate made by a group of condensed matter physicists under Schluter's chairmanship, who issued a report last year on "Opportunities, Resources and Problems" in their field. Bromley's bottom line can be accounted for by including funds for a broad range of technological developments in materials processing—for, say, fighter planes and space systems. Both calculations included materials R&D at the Department of Energy, NASA, the Defense Department, NSF, the National Institutes of Health, the National Institute of Standards and Technology and even the Bureau of Mines, which old-timers on Capitol Hill still believe is



Huber: Shaping a Bush initiative.



Schluter: Sensing a growing crisis.



Chaudhari: Surveying the whole scene.

the most relevant agency when the subject of materials comes up.

Contrary to Bromley's optimism, the Schluter report, which analyzes funding actions over the past decade, comes to a depressing conclusion: Describing the field of condensed matter as "seriously threatened," the report finds "an unprecedented mismatch—a growing divergence between a rapidly increasing level of activity and personnel and an effectively decreasing level of support for research."

The number of senior scientists, postdocs and graduate students supported in NSF's materials research division has steadily increased in recent years, and the success rate of proposals submitted for competitive peer review has improved from one in five in 1988 to one in four last year. In the same period, however, the median size of a grant has dropped from \$85 200 to \$78 400, the steepest decline of any of the disciplines represented in the agency's mathematics and physical sciences directorate.

'Times are out of joint'

"The times are dramatically out of joint for condensed matter physics," warns the Schluter report. "In an era where this field has become one of the very most active and relevant of the sciences, its future is in jeopardy."

The most comprehensive examination of the needs and opportunities in materials research appeared in "Materials Science and Engineering for the 1990s: Maintaining Competitiveness in the Age of Materials," a report by a National Research Council committee headed by Praveen Chaudhari of IBM and Merton C. Flemings of MIT (see PHYSICS TODAY, February 1990, page 70). Among its findings, the committee said that materials research was central to eight key US industries, from aerospace to telecommunications, collectively employing 7 million people and enjoying combined sales of \$1.4 trillion in 1987. When briefed on the conclusions, officials at the agencies and members of Congress asked for the committee to provide recommendations for actions. As a result, four regional meetings involving some 400 scientists and engineers were held last year. These led to "A National Agenda in Materials Science and Engineering," a 36-page report that became the major theme of the SSSC forum at the academy in February. The agenda calls for "a strategic, goal-oriented planning process" for the entire field, involving universities, industry and government laboratories, and for improving communication among all three. It recommends

that universities, industry and the national labs jointly initiate generic R&D projects and encourages them to exchange their scientists and engineers. The report also encourages universities to bring their curriculums up to date for both undergraduates and graduates and to provide state-of-the-art instruments in their labs. Finally, it unabashedly argues for Federal agencies to ramp up their materials R&D budgets by \$1.25 billion more than their current expenditures over the next five years. The report admits that while funding will be high, "we believe this increased level of support will be required if the US is to remain competitive with the rest of the world."

Huber informed the physicists in Cincinnati that OSTP is "paying a good deal of attention" to the report and would be sure to include data and views from industry as well as the academic community in preparing its initiative. While the details still need to be worked out, the proposed initiative is likely to be similar in style to those the Bush Administration put forward in the 1992 budget request last February for high-performance computing and communications, for global climate change research and for science and engineering education (PHYSICS TODAY, April, page 79). Like those, the materials initiative would be spread across all the relevant agencies and coordinated by an inter-

agency body called the Federal Coordinating Council on Science, Engineering and Technology (known familiarly as FCCSET—pronounced "fix it").

OSTP and the White House Office of Management and Budget have already asked a FCCSET panel to prepare an inventory of all Federal activities in materials, including the current spending levels for each agency, to identify overlaps and opportunities for collaboration. A report will be circulated to all the agencies for comment this summer. Bromley expects OMB to shape up a dollar request by the end of the year for Bush's approval as a full-fledged Presidential initiative.

—IRWIN GOODWIN

NSF'S NEW \$50 MILLION EQUIPMENT PROGRAM TO AUGMENT RETOOLING ACADEMIC SCIENCE

The "instrumentation gap" persists in academic physics and astronomy. Failure to replace aging scientific instruments with new, state-of-the-art apparatus in physics and astronomy departments and to modernize deteriorating and often dilapidated physics laboratories threatens to drag faculty research and graduate education in American universities down from their preeminent heights. Physics and astronomy department chairmen informed the National Science Foundation in 1986 that as much as 35% of their research equipment could be considered obsolete. Now an NSF report of a follow-up survey of the departments in 55 universities and colleges statistically selected to represent 174 of the largest institutions, each spending more than \$3 million annually on science and engineering R&D, reveals that 46% of the instruments used in 1989 were considered inadequate, an increase of 12% since the last survey, three years earlier.

Even in the 20 largest universities, which house a high proportion of the nation's total instrumentation inventory, 20% of the department heads complained that their current equipment is generally so poor that faculty investigators cannot do important research in their specialties. Only 9% of the department chairmen rate their equipment as excellent—a drop of 2% since the last survey. Outside the top 20 institutions, 52% of the department heads in physics and astronomy described their current instrumentation as inadequate.

Worse yet, the NSF report, "Academic Research Equipment and Equipment Needs: 1989," released on

21 May, shows that for physics and astronomy departments that are not within the big 20 research universities, the sources of funding for new equipment have begun to dry up. Indeed, these academic administrators characterize the quantity and quality of their research instruments as in decline. This situation, says the report, is in contrast with that in chemistry departments, which boast of widespread improvements in equipment at both large and small research universities.

The report notes that there has been a "pronounced upward shift" to big-ticket instrument systems in physics and astronomy to enable researchers to perform experiments they can't do now. It argues that physics and astronomy are worse off than other scientific disciplines because the research relies on more specialized and more sophisticated instruments.

A 'continuing investment'

Testifying before committees of Congress on NSF's budget, Walter E. Massey, the agency's new director, emphasized the need to modernize the academic infrastructure as "a continuing investment" in education and research. Massey observed that universities have deferred maintaining and purchasing capital equipment for classrooms and labs for nearly two decades because operating costs have risen rapidly while Federal support of research infrastructure has fallen.

His laments have been endorsed by the Association of American Universities and the National Association of State Universities and Land-Grant Colleges, which are admittedly not

entirely objective in appraising the subject. Their report, "University Research Facilities: A National Problem Requiring a National Response," urges the Federal government to support competitive matching grants for institutions that need to upgrade their research equipment and laboratories. Similar pleas had come before in the White House Science Council's 1986 report "A New Partnership," which claimed it would take \$1 billion per year for a decade to deal with "the inadequacy and decay of the physical plant and the obsolescence of the equipment pool" at US universities.

One of the authors of the White House report was D. Allan Bromley, then director of the A. W. Wright Nuclear Structure Laboratory at Yale University. Bromley and the chairman of the panel that produced the report, David Packard, cofounder of Hewlett-Packard and a former deputy secretary of the Defense Department, warned that the accumulated shortfall in the capital base for university research could wreck the engine of American science, thereby weakening the nation's economy and security.

"One conclusion is clear," said the Packard-Bromley report. "Our universities simply cannot respond to society's expectations for them or discharge their national responsibilities in research and education without substantially increased support."

In 1989, when Bromley became President Bush's science adviser and director of the White House Office of Science and Technology Policy, he vowed to improve the situation. His first opportunity came last year, in