

Reagan hails new age of superconductivity at 'pep rally'

President Reagan spoke of "revolution" and, astonishingly, he welcomed it. So did his science adviser, William R. Graham, and Energy Secretary John S. Herrington. Their reason for using the term before some 1300 academic and industrial researchers, laboratory directors, business executives, venture capitalists and government program managers who had gathered in the cavernous ballroom of the Washington Hilton on 28-29 July had little to do with political ideology. Instead, their purpose was to exhort the audience to join forces in a technological revolution that many contend contains the seeds of a US industrial miracle: the development and application of high- T_c superconductivity.

"Science tells us," the President informed the conference participants, "that the breakthroughs in superconductivity bring us to the threshold of a new age." Accordingly, he added, "It is our task at this conference to herald in that new age with a rush. . . . For the promise of superconductivity to become real, it must bridge the gap from the laboratory to the marketplace and make the transition from a scientific phenomenon to an everyday reality, from a specialty item to a commodity."

Objective. Reagan's remarks plainly expressed the objective of the Federal Conference on Commercial Applications of Superconductivity: to let everyone know that the government is mounting a coordinated national effort to make sure that US companies transform the recent discoveries in high-temperature superconducting materials into commercial products before any foreign rivals—notably in Japan. Ever since the first reports of the dazzling discoveries, American scientists, industrialists and politicians have grown more vocal in calling for some sort of national program to counter what H. Kent Bowen, an MIT engineering professor, described to the House Science, Space and Technology Committee on 10 June as a massive R&D effort by Japan's universities and corporations to develop room-temperature

superconducting products first.

At the same hearing, members of Congress displayed the kind of anxieties and handwringing that have not been seen on Capitol Hill since the Soviet Sputniks in 1957. Senator Dave Durenberger, an Independent Republican from Minnesota, crossed Capitol Hill to testify before House colleagues that while the US is first out from the superconductor starting gate, it is likely to stumble along the way to the finish line, possibly in the same way it failed to spur its basic invention of the transistor, integrated circuit and videocassette recorder. "It's high time we changed our traditional business-as-usual approach," he warned. "We invent and our rivals produce. . . . By one estimate I've heard, it takes Japan $3\frac{1}{2}$ years to bring research to the market and this country $7\frac{1}{2}$ years." Durenberger's remarks led Representative Dave McCurdy, an Oklahoma Democrat, to declare: "We may win the Nobel Prizes and lose the global markets. . . . In the race for high-temperature superconductors the stakes are high: billions of dollars in our trade balance and hundreds of thousands of domestic jobs."

Such fears are not baseless, Graham admits. "We're in a different era from the one we've lived in for the last 40 years," Graham stated in his opening remarks at the July conference. "If our technology is going to reach the market and pay off for the US economy, you with US industry are going to have to start ahead and stay ahead of tough foreign competition."

Classroom. Neither Reagan nor Graham nor any of the conference organizers consider high-temperature superconductivity a trivial pursuit. Reagan, an unabashed true believer in the economic value of science as a driver of new technologies, learned the virtues of superconductivity at a seminar by members of the White House Science Council. For an hour on 22 July the Roosevelt Room of the White House became a classroom in which the headmaster was the council chairman, Solo-

mon J. Buchsbaum, executive vice president of Bell Labs, and the student was the President. His tutors were a knowing lot: Edward Teller of the Hoover Institution and Lawrence Livermore Lab on the fundamental science of superconductivity, a disquisition based largely on a briefing he had received a few days earlier at Los Alamos; Ralph E. Gomory, senior vice president and chief scientist at IBM, on potential applications; Edward E. David Jr, science adviser to President Nixon and former vice president for research at Exxon, on opportunities for government, university and industrial cooperation; and D. Allan Bromley of Yale on international R&D.

The President appeared enthralled by Teller's compelling account of the pace of discoveries. "What has happened in the last eight months the optimists thought would take 200 years," said Teller at one point, "while the pessimists were certain it would not happen at all."

By the end of the tutorial, Reagan was "positively enthusiastic" about the subject, Graham recalled. The President seemed to grasp instinctively the implications of recent experiments. When Reagan left the Roosevelt Room to meet several businessmen, "he was bursting with excitement," said Graham. "I have just spent the last hour learning all about recent discoveries in the field of superconductivity," Reagan told his visitors. "Considering the kinds of teachers I've had, I should be an expert on the subject. So fire any questions about superconductivity you have and I'll do my best to answer."

Reagan's wonder and excitement was understandable—typical of the type of contagion that infected those at the superconductivity session last 18 March at The American Physical Society meeting in the New York Hilton (PHYSICS TODAY, April, page 17). The scene of physicists jammed into huge ballrooms and sprawled before video monitors in hotel lobbies all through the night led one wag to characterize the event as "a Woodstock of physics."

Unbounded. The quest for a new class of superconducting rare earth compounds has been bound by few national borders. The first shot in the superconducting revolution was fired last year by two European physicists working for a US multinational computer manufacturer, IBM, at a small lab in Zurich. Their discovery, first reported in a West German journal, *Zeitschrift für Physik*, evoked only ho-hum interest until a meeting of the Materials Research Society in Boston last December, where physicists working at the University of Tokyo and others at the University of Houston confirmed the IBM results. After that, the race for superconductivity was on. As research on the rare earth oxide superconductors continued at labs in Beijing, Caen, Grenoble, Karlsruhe, Tokyo and dozens of other places, the specter of "not invented here" haunted officials in Washington.

The reaction was predictable. Last spring, when Graham and other Administration officials began planning a gala pep rally to importune researchers and businessmen to leap into the superconductivity era, they thought only of those working in the US. Reports in the press that foreign scientists and businessmen were specifically excluded were simply untrue, Graham argues. "We sent invitations to people in American colleges, national laboratories and corporate research centers because they were the ones we wanted to reach," he explains. "But no passports were checked and no citizenship papers were required" at the conference. The motivation for a "US only" meeting, says Graham, was neither secrecy nor xenophobia.

Notwithstanding the government's intention, foreign embassies and scientific societies complained that the American tradition of open scientific meetings for nonclassified research was ill served by restricting attendance. Some American scientists also objected. Ching-Wu (Paul) Chu, whose key discoveries in superconductivity at the University of Houston have made him a cult figure, considered the restriction unjustified. "It is a shame to lessen the flow of information," said Chu, who was born in China and is a naturalized American. "In the long run, everybody could lose by that." When news reporters asked Graham to explain his action, he said: "We wanted to have a domestic forum. . . . We were not reporting research." It is not US policy to close scientific meetings to foreign friends, Graham asserted, "particularly when no classified information is conveyed."

Symbolism. Indeed, foreign observers would have learned little at the confer-

ence besides the government's determination that high- T_c superconductivity be a symbol of US economic turf. Frank Press, president of the National Academy of Sciences, explained the situation well when he stated: "Superconductivity has become the test case of whether the US has a technological future. That future depends on our ability to commercialize our scientific discoveries. If we lose this battle, it will wound our national pride."

So when Reagan appeared at the conference, he was flanked by members of his Cabinet and his key scientific officials: Secretary of State George Shultz, Defense Secretary Caspar W. Weinberger and Energy Secretary H. Ross Perot, along with Graham and Erich Bloch, director of the National Science Foundation. The appearance of high officials in the Administration was meant to lend importance to Reagan's address. Before entering the ballroom, the President's group had watched demonstrations of high-temperature superconductivity performed in an area adjacent to the conference hall.

Beyond the symbolism, however, the Administration has put forward an agenda in the form of an 11-point "superconductivity initiative," which the President announced at the conference. It is intended to expand the transfer of technology from the national labs to industry and enable industry to operate outside antitrust laws—actions that either have been tried before and found wanting or are likely to be opposed in Congress.

Even before the plan was revealed, members of Congress introduced some bills that anticipated White House actions:

► In the Senate last March, Minnesota's Durenberger introduced a bill called the Superconductivity Competition Act of 1987 (S. 880), which attracted 13 cosponsors from both political parties. The bill would create a national commission that would recommend ways to hasten the development of superconductor applications.

► A companion (H. R. 3024) was presented in July by Representative Don Ritter of Pennsylvania. Supported by ten other House members, Ritter's legislation would establish a National Superconductor Manufacturing and Processing Technology Initiative. Ritter claims he seeks to promote a "team America" approach to superconductivity R&D. His bill calls for creating a coordinating council made up of leading scientists and officials of such government organizations as the Defense Advanced Research Projects Agency, the departments of Energy and Commerce, NSF and the National Bureau of Standards. The council would be re-

sponsible to a national commission similar to the one in Durenberger's bill. Ritter's bill would earmark \$50 million for DARPA, \$12.5 million for NSF, \$12.5 million for DOE and \$5 million for NBS in the first year alone, presumably fiscal 1988, to advance research at universities, national laboratories and industry, especially in manufacturing and processing technologies.

► Still another related bill (H.R. 3048), the National Superconductivity and Competitiveness Act of 1987, was introduced in July by Representative McCurdy, chairman of the science subcommittee on transportation, aviation and materials. It would have the government spend more on superconductivity research than Ritter proposes—\$100 million each year for five years, starting in fiscal 1989.

► On 10 July, New Mexico's Senator Pete V. Domenici introduced a bill (S. 1480) more complicated and comprehensive than Durenberger's that would, he said, "unleash America's greatest trade secret—the national laboratories." It calls for greater industry access to the facilities and technologies in DOE's multiprogram labs and allows the labs to accept up to \$10 million each so that they can take part in cooperative superconductor research projects.

In fact, the President's Superconductivity Initiative, if enacted, would preempt and outspend all four bills. Like many other White House programs bearing the word "initiative," including the Strategic Defense Initiative, Strategic Computing Initiative, Caribbean Basin Initiative and International Youth Exchange Initiative, this one bears some hallmarks of nationalism, secrecy and competitiveness. The initiative contains elements of an Apollo-type "crash" program and includes calls for Congressional action. Its propositions range from promises that the Defense Department will spend \$150 million for superconductivity research for military purposes over the next three years to changes in patent and antitrust laws that would increase protection for manufacturing processes and facilitate joint production ventures. The initiative also would amend the Freedom of Information Act to enable government agencies to withhold scientific and technical data derived from government-owned and operated laboratories if the information was deemed commercially valuable enough that its release could harm US economic interests.

Centers. In addition, the President's initiative would have DOE establish big Superconductivity Research Centers at Argonne, Lawrence Berkeley and Ames Laboratories and a computer database for exchanging information



BILL FITZPATRICK/WHITE HOUSE

Priming the President on high-temperature superconductivity, Edward Teller lectures while other members of the White House Science Council sit across the table from Reagan (in center foreground). Council members seen are (from left) Ralph Gomory, Solomon Buchsbaum, Edward David and I. M. Singer. Flanking Reagan are William Graham, the President's science adviser, and Nancy Riske, assistant to the President for Cabinet affairs.

about superconductivity research. It would set up other research groups within NASA and the NBS lab in Boulder, Colorado, and step up funding of superconductivity research through NSF and DOD. At present, DOD, DOE, NASA, NSF and NBS are spending about \$33 million in fiscal 1987 on high-temperature superconductor research. To help quicken the pace of all this activity, the White House urged all Federal agencies to carry out last April's Executive Order 12591, designed to stimulate the transfer of technology from national labs to private firms and to encourage government, university and industrial cooperation in research. Reagan directed Graham to report back to him by 1 December on how well the executive order was being carried out by all government agencies, particularly in superconductivity.

Graham and Herrington were quickly off and running. Graham announced that he had organized a Council on Superconductivity for American Competitiveness and appointed George A. Keyworth II, his predecessor as Reagan's science adviser, as its chairman. Keyworth, a member of the President's 1984 Commission on Industrial Competitiveness, indicated that the council would serve as a kind of clearinghouse for new superconductivity data that could be useful to an emerging industry. Herrington asked Los Alamos to lead the effort to explore the development of cooperative partnerships with industry, which might lead to commercializing superconductivity discoveries. He also arranged two consortiums of labs to conduct

research on particular aspects of materials processing: Los Alamos, Oak Ridge and Lawrence Berkeley on synthesis, thin films and alternative processing techniques; and Argonne, Brookhaven and Ames on superconductor development. In addition, Herrington told all DOE national labs to increase funding of superconductivity research in the next two fiscal years. Reagan's initiative also would create a small panel of so-called wise men, as an adjunct to the White House Science Council, to advise on research and commercialization policies. To many at the Washington meeting, the concept of a wise-men committee and the rhetoric of some government leaders seemed excessive. The President, for instance, had spoken of "an age of mind over matter" and of superconductivity promising "a quantum leap in energy efficiency that would bring with it a host of benefits, not least among them a reduced dependence on foreign oil, a cleaner environment and a stronger national economy."

Despite the overblown oratory, there is no doubt in Washington that the Administration means business. The trouble is, as many scientists stated at the conference, the frenzied search for advances up the Kelvin scale in new superconducting materials has brought a sharpened sense of the scientific and engineering problems that need to be overcome on the way from the laboratory to the marketplace. The materials are easy to make in small quantities using methods that require little instrumentation. Angelica Stacy of the University of California at Berkeley spoke jocularly of experiments using

the "Julia Child approach"—mixing ceramic oxides in food processors and coffee grinders and baking them at 750–900 °F in microwave ovens.

'Edisonian.' But mass production brings difficulties. The new materials become unstable when exposed to air or moisture. Chu spoke of troubles "controlling the uncontrollable" in the brittle ceramics. The work so far, stated J. Robert Schrieffer of the University of California at Santa Barbara, "can be best described as 'Edisonian'" —that is, performed by trial and error, with little or no theory behind it. The discoverers of high- T_c superconductivity, said Schrieffer, who won a Nobel Prize in 1972, along with John Bardeen and Leon Cooper, for explaining superconductivity at lower temperatures, "have shaken the foundations of the theories."

The challenge to US science and industry is to develop practical high- T_c superconductors before researchers in other countries—notably Japan, but also in Europe. "Japan is well prepared for exploiting this discovery, and the field is well suited to Japanese talents and strengths," cautioned Roland Schmitt, chief scientist at General Electric and chairman of NSF's National Science Board. But Schmitt claims that reports that Japan is out front in the race to find new superconducting materials are premature. Though three Japanese agencies are supporting the research with discretionary funds or redirecting research budgets, Japan has undertaken no massive new government R&D program, he stated. "The fact is that the United States and Japan are reacting in the same way," said Schmitt, who surveyed the Japanese scene firsthand in March and April. "Each has appointed advisory groups and organized many conferences to exchange information."

Even so, Japan has advantages over the US in the superconductor race, Schmitt observed. As they have in other fields, government agencies organize consortiums of industrial firms to devise commercial applications and then turn the companies loose to compete. "That's the Japanese style," said Schmitt.

Europe also is a formidable force, said Mark M. Rochkind, president of Philips Laboratories, a part of North American Philips Corp. At a conference in Genoa last July, some 500 researchers recommended that the European Community set up a superconductivity information network and a research program, possibly through the joint EUREKA project. Rochkind told the Washington conference that European governments had committed \$36 million this year to superconductivity

research.

Reagan's promise of \$150 million in Defense money over the next three years arouses fears that civilian superconductivity research may be slighted.

Covering superconductivity

Heaped on a table near the ballroom of the Washington Hilton during the Federal Conference on Commercial Applications of Superconductivity last 28-29 July were stacks of seven different newsletters reporting about developments in the new breed of high- T_c superconductors. The topic is already the source of a booming business in the solicitation and printing of newsletters, even though it has not yet enabled any commercial or military applications.

The newsletters available so far:

► *High- T_c Update*, self-described as a twice-monthly information exchange about ongoing research in the US and abroad, especially in Europe, Japan and China. It contains brief descriptions of experiments, the compounds used and difficulties encountered, along with possible correctives. It announces meetings, providing telephone numbers of contacts, even when overseas, and often summarizes important sessions. The newsletter is a principal source for preprints and reprints of reports and letters appearing in journals and specifies where copies may be obtained. It is published by the Ames Laboratory of Iowa State University and is available from Ellen Feinberg, editor, 12 Physics, Ames Laboratory, Ames, Iowa 50011. An electronic mail version consisting of updated preprint and reprint lists is accessible over MFENET (address FEINBERG at ISU.MFENET) and BITNET (FEINBERG at ALISUVAX), as well as ARPANET and DIALCOM.

► *Inside Energy*, a 10-page weekly that covers virtually everything about energy—including bills in Congress; actions taken by the Department of Energy, the Nuclear Regulatory Commission, the Commerce Department's Bureau of Land Management, and the US Geological Survey; and, most recently, developments in superconductivity. The 27 July issue, for instance, examines a Senate bill (S. 7) known as the California Desert Protection Act, which would double the acreage restricted to wilderness and conservation, thereby

Some scientists are worried that DOE and NSF will simply reprogram funds from already hard-pressed existing research into high- T_c superconductivity.

—IRWIN GOODWIN

limiting excavation and exploitation of rare earth elements considered necessary for the new superconducting materials to only one existing operation—a mine run by Molycorp Inc, a subsidiary of Unocal Inc. The publication may be purchased from McGraw-Hill Inc, 1221 Avenue of the Americas, New York, New York 10020.

► *Materials and Processing Report*, a monthly compiled by MIT's Materials Processing Center. Its 4 July issue features a report on last April's hearings on high-temperature superconductivity before the House Committee on Science, Space and Technology. The paper contains informative accounts of high- T_c superconductivity research performed at the Naval Research Laboratory, National Bureau of Standards, MIT, BASF in West Germany and Mitsubishi Metal Corp in Japan. It also presents useful details on patent applications for new materials—though none in this issue relate to high-temperature superconducting compounds. A calendar of materials meetings appears on the back page. The publication is available by subscription from MIT Press Journals, 55 Hayward Street, Cambridge, Massachusetts 02142.

► *New Technology Week*, which calls itself "the newspaper of superconductors/materials sciences/power electronics/high-energy physics," published by the same people who put out *The Energy Daily* and *Defense Week*. Because the newsletter covers a wide range of subjects, it is not surprising that high-temperature superconductivity gets small play. Still, the paper provides concise and timely accounts of Congressional actions of interest to physicists, mainly those in industrial settings. The 27 July issue examines the newly organized Council on Research and Technology, known more familiarly as Coretech, a Washington lobbying group whose members include some of the largest research companies and universities in the US. Subscrip-

tions may be obtained from King Communications Group Inc, 627 National Press Building, Washington, DC 20045. ► *Superconductivity*, whose charter issue appeared in time for the July conference, a readable and newsy weekly that goes beyond the handouts from members of Congress and research labs by actually interviewing people. As such, it attempts to predict government trends and commercial implications. Among the items in the first issue is an evaluation of the new bill (S. 1480) introduced by Senator Pete V. Domenici of New Mexico that seeks to aid R&D for superconductors, advanced semiconductors and mapping the human genome. It tries to describe projects undertaken by states and universities. The newsletter may be obtained by subscription from Business Publishers Inc, 951 Pershing Drive, Silver Spring, Maryland 20910. ► *Superconductivity News*, which made its debut for the Washington meeting and appears directed, according to its own editorial description, at venture capitalists and investment brokers. The first number contains a few plainspoken summaries of research and a calendar of conferences in the US and elsewhere. The newsletter promises to concentrate on examining applications, both real and prospective, evaluating companies and listing stock prices. It does not plan to provide information about research papers, which *High- T_c Update* provides without charge. The newsletter is a monthly purchasable from Superconductivity Publications, Suite 2000, 65 Jackson Drive, Cranford, New Jersey 07016. ► *Superconductor Week*, another weekly that first appeared at the Washington conference. While it covers basic research work in the US and elsewhere, it promises to emphasize government actions, such as grants and contracts for superconductivity R&D, antitrust regulations and bills introduced in Congress. "The Washington conference and the President's initiative made it plain that superconductivity is going to have many consequences for public policy," says the newsletter's editor, C. David Chafee. "Our main mission is to keep readers up to date on policy matters." It is available on subscription from Atlantic Information Services, 1050 17th Street NW, Washington, DC 20036.

—IRWIN GOODWIN

DOD Science Board finds SDI Phase I reasonable but 'sketchy'

The latest contribution to the long-running debate over the feasibility of an operational defense against Soviet

ballistic missiles is a report prepared by a special task force of the Defense Science Board, the Pentagon's senior

scientific advisory group. The report, completed by the panel in late June and immediately stamped "secret,"