

to cover megaprojects. At some point, we may even consider new approaches to treaty agreements to accomplish this end. We are not yet ready to make recommendations...but we are working within the Administration and with Congress on this subject."

Bromley also spoke about the US commitment to "open and equitable access to our educational institutions, not only for the students of this country but for students of any country. Many countries have been eager to take advantage of this access, because it remains a fact that the US has the best system of graduate education anywhere in the world. As a result, nearly half of the engineering students in this country are foreign citizens. The proportions are about the same for mathematical sciences and computer science and just a little less for the physical sciences...As it is, without the very large fraction of foreign students who remain following their graduation to pursue careers in the US, the shortages that we foresee in many of our scientific and technological fields would be vastly worse than is now the case. The US economy already depends on an influx of bright young people from abroad for its health and vitality.

"Regarding exchanges with Europe, we have not yet begun to see the decreases in students from abroad that some predict might be a consequence of European unification. But there is an impression in the scientific community that exchanges of all scientists and engineers between Europe and the US are declining."

He said the US must encourage and support exchanges of American and European scientists and engineers and pointed out that the West German government provides funds for 70% of the exchanges between both countries "in both directions." Bromley used the occasion to propose a US foundation or some similar organization to bring European scientists and technologists to the US "at our expense. Such a program would begin to balance the costs of this exchange with the shared benefits that both we

and the Europeans derive from it."

Beyond basic research, Bromley stated, to the extent that work is done prior to actual product development, "international cooperation will benefit all collaborators." He urged that "cooperative agreements affecting precompetitive R&D should be negotiated on a case-by-case basis. These agreements, however, should be predicated on a relatively simple assumption—that individual investigators and private firms are able to participate in R&D endeavors in the other party's territory to the same extent that domestic researchers can do so. Although there may be projects for which these rules do not apply, we should strive to achieve a level playing field, not only between Europe and the US but around the world."

Opening precompetitive R&D

During a panel discussion at the academy, Paolo Fasella, director general of the EC's science, research and development directorate, told how North American Philips, the US subsidiary of the giant electronics firm in the Netherlands had been prohibited from joining SEMATECH, the US research organization in semiconductor processing, jointly funded by US companies and the Pentagon. By contrast, Fasella observed, IBM Europe has been invited to participate in JESSI, the semiconductor research project in EC's Eureka program. "We should be discussing free and open access to research in the US, not bashing Europe," said Fasella with obvious anger. Jean-Jacques Duby, an executive at IBM Europe, made an attempt to calm the debate by calling for reciprocity.

The instinct for governments to "do something" about developing technologies is understandable but often misguided for both political and economic reasons. Politicians have an urge to protect new technologies for the same reasons they defend their country—the welfare and security of the people. Businessmen are restrictive to protect their company's interests. The fears expressed by Bromley

center on high-technology jingoism, leading to trade barriers and cutting scientists off from other scientists.

In his speech Bromley pointedly observed that "The basic position of the US government toward European unification is that we commend the EC's efforts to increase competition and stimulate economic growth within Europe by removing international barriers. However, we want to be sure that the unification of the European market does not decrease competition between Europe and the rest of the world. In other words, we want to be sure that when trade barriers are removed within Europe, new barriers are not erected between Europe and the rest of the world." He was concerned, he said, about two matters in particular—standards and regulations required of goods and services, which might be set to exclude competition from outside the EC, as in the case of US biotechnology products.

Bromley noted that delegations from Czechoslovakia, East Germany, Hungary and the Soviet Union had appeared suddenly at OSTP "to explore the possibility of upgrading or starting new exchanges and cooperative research programs... The countries of Eastern Europe hunger for Western science and technology. The challenge we both face is to transform and adapt existing arrangements and multilateral institutions so that they can accommodate new relations with Eastern Europe."

Indeed, with EC-92 and with Eastern Europe moving toward democracy and, of all things, capitalism, there is a palpable excitement in Europe—a belief that the Age of Europe may be dawning. Only six years ago, William A. Nierenberg, then director of the Scripps Institution of Oceanography, informed the National Science Board after a trip abroad that Europe's scientists and engineers spoke of a pervasive "Euro pessimism." At the academy conference, Josef Rembser, director general for research in West Germany's Federal Ministry for Research and Technology, expressed the current attitude as "Europhoria."

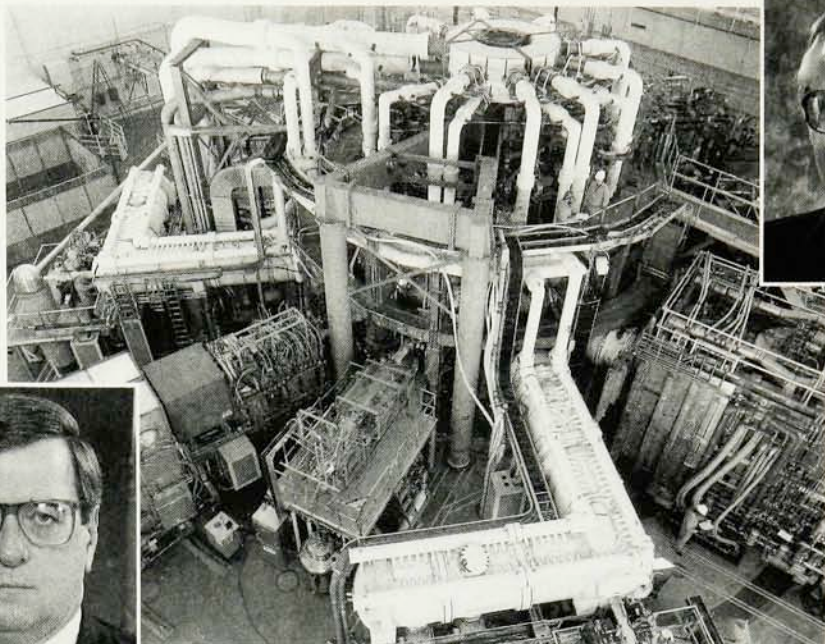
—IRWIN GOODWIN

SCIENCE FRICTION: FUROR OVER FUSION PROMPTS DOE TO SEEK EXPERT ADVICE

Robert O. Hunter Jr is gone but not forgotten in Washington. Soon after he arrived at the Department of Energy's Office of Energy Research in August 1988, Hunter quietly devised a scheme to redirect the controlled

fusion program. It included cutting \$50 million from magnetic confinement fusion and transferring the funds to a rival approach, inertial confinement fusion. It also called for postponing construction of the Com-

pact Ignition Tokamak at the Princeton Plasma Physics Laboratory while more theoretical and experimental research is done on plasma confinement in tokamaks, compact toroids and reversed-field machines.



Princeton's tokamak after seven years still falls short of achieving energy breakeven. As the centerpiece of the US magnetic fusion program, it is being evaluated by a Department of Energy advisory panel, headed by H. Guyford Stever (right inset), reviewing a plan for magnetic and inertial confinement fusion devised by DOE's former research chief, Robert Hunter (left inset).

It was not surprising that Hunter's radical plan met with heated reactions at places that surely would be impaired by a cutback in magnetic fusion—principally Princeton, but also Oak Ridge, Los Alamos and Lawrence Livermore national laboratories, GA Technologies and several universities. Princeton would bear the brunt of any program change, for it had counted on building the CIT reactor, at a cost variously estimated at \$450 million to \$750 million.

To be sure, any reduction is bound to be keenly felt, since DOE has run its magnetic fusion program on a declining budget throughout the 1980s. Its current budget is \$320 million, down from \$345 million in fiscal 1989.

By contrast, the ICF project, operated in DOE's classified defense program, continues to command slightly increased funding—from \$163 million in fiscal 1989 to \$166 million this year. Because ICF experiments are intended to create, in essence, miniature H-bomb explosions in the laboratory, they are highly synergistic with nuclear weapons development, high-power lasers and particle-beam drivers, computer codes and materials technology. The military nature of ICF research, taking place at Los Alamos, Livermore, Sandia, the Naval Research Laboratory, KMS Fusion and the University of Rochester Laboratory for Energetics, makes it a prime target as part of the so-called peace dividend

that many members of Congress are seeking as they attempt to reduce weapons budgets in the wake of democratic developments in Eastern Europe and the Soviet Union.

Hunter's plan included construction of an experimental Laboratory Microfusion Facility, which could generate fusion yields greater than 30 microjoules to advance nuclear weapons physics and simulate commercial power capabilities. The estimated cost of such a facility ranges from \$700 million to as much as \$2 billion. A recent interim report by a National Research Council panel led by Steven E. Koonin of Caltech listed as its first recommendation that the government support "a concerted national effort to resolve the most important remaining physics uncertainties about laboratory ignition" before it decides whether to build a Laboratory Microfusion Facility. In the meantime, the panel urged DOE to upgrade most of the ICF experiments because "existing facilities are not being fully utilized and important experiments are not being done."

Partisans and the nonaligned

Magnetic fusion is a different story. Last summer, after a yearlong study, another Research Council committee, this one headed by Irvin L. (Jack) White, president of the New York State Energy Research and Development Authority, issued a report calling for an immediate 20% funding increase for magnetic fusion, fol-

lowed by an additional 25% rise in the mid-1990s. The report, "Pacing the US Magnetic Fusion Program," proposes that the government heap more money on the proposed megaprojects—the CIT and the International Engineering Test Reactor, known by its initials as ITER, now being designed by a collaborative team at the Max Planck Institute for Plasma Physics in Garching, West Germany.

Hunter immediately shelved the White report and persisted with his plan to reduce the magnetic fusion budget. So when Princeton scientists and lobbyists learned that Energy Secretary James D. Watkins had endorsed Hunter's "reprogramming action," they launched an assault on all fronts: Thomas Kean, New Jersey's Republican governor at the time, called on President Bush; the state's Democratic senators, Bill Bradley and Frank Lautenberg, spoke with Watkins; Representative Robert Roe, a New Jersey Democrat who heads the House Committee on Science, Space and Technology, demanded an explanation from Hunter.

At a half-dozen daylong hearings on Capitol Hill last year, Hunter and other fusion specialists were grilled relentlessly on fusion science and policy. The difficulty of achieving fusion power "has been underappreciated," testified David Baldwin, director of the Institute for Fusion Studies at the University of Texas in Austin. "As a consequence, the pro-

gram has been oversold." But not underfunded, observed J. Bennett Johnston, the Louisiana Democrat who is chairman of the powerful Senate Committee on Energy and Natural Resources. To be sure, since the early 1950s, DOE and its predecessor agencies have spent about \$5.4 billion on fusion research. "The days of willy-nilly expenditures on fusion... are over with. We've got to demand a higher degree of success than we have in the past," said Johnston.

Hunter's plan was explosive. Among the repercussions was Hunter's abrupt departure from DOE last October (PHYSICS TODAY, January, page 49). Before he left, Hunter handed Watkins a list of fusion scientists he hoped would be named to advise DOE on the nation's entire fusion program. Watkins was uncomfortable with Hunter's choices, and on 5 March, Watkins announced a 19-member Fusion Policy Advisory Committee, only half of them from

Hunter's list.

The panel is headed by H. Guyford Stever, an all-purpose advisory committee chairman, who served as director of the National Science Foundation and, at the same time, science adviser to President Ford. It has avowed partisans of magnetic fusion and obvious proponents of inertial systems, but most of the members are nonaligned, neutral or without commitments. The full committee: Robert Conn, a UCLA nuclear engineer who has made his career designing large fusion reactors; T. Kenneth Fowler, former director of the magnetic fusion lab at Livermore; Melvin Gottlieb, onetime director of the Princeton Plasma Physics Lab; Marshall N. Rosenbluth, a plasma theorist who was at the Institute for Advanced Study and Princeton before being lured away to the University of Texas and from there to the University of California at San Diego; R. Bruce Miller of Titan Corp; Robert Sproull, president emeritus of the University

of Rochester; Barrett Ripin, head of the Naval Research Lab's space plasma branch; John Foster Jr, retired vice president for science and technology at TRW and former director of Livermore; Roger Batzel, another former director of Livermore; Ira Bernstein of Yale; E. Linn Draper Jr, chairman and president of Gulf States Utilities; Harold K. Forsen, senior vice president at the Bechtel Group; William Herrmannsfeldt of SLAC; Charles Kennel of UCLA; Arthur Kerman of MIT; Kenneth Klier, dean of Purdue University's School of Science; John Landis, senior vice president of Stone and Webster Engineering; and Richard Wilson of Harvard University.

The committee's first meeting was held at DOE headquarters on 23 March. Stever plans to deliver a preliminary report in July and a final report by September—in time for DOE's preparation of its fusion budget for fiscal 1992.

—IRWIN GOODWIN

WASHINGTON AND OREGON UNIVERSITIES TO RUN NEW NUCLEAR THEORY INSTITUTE

In recent years, nuclear physics has been described in evocative terms: The National Research Council's weighty survey "Physics Through the 1990s," more familiarly known as the Brinkman report, spoke in 1986 of major experimental advances in nuclear physics, "myriad ways in which nuclear physics has an impact on the other sciences and on society at large" and "exciting prospects for the future." When he was President Reagan's science adviser, George A. Keyworth II repeatedly told Congress, in advocating such costly new starts as the Continuous Electron Beam Accelerator Facility (now under construction at Newport News, Virginia) and the Relativistic Heavy Ion Collider (to be built at Brookhaven National Laboratory), that these machines were vital to "the renaissance now under way in nuclear physics." In May 1988, a panel of the Nuclear Science Advisory Committee observed that new experimental findings "continue to test the limits of our understanding of the nucleus" and "demand new descriptions at both the phenomenological and theoretical levels." As its principal recommendation, the NSAC panel, led by Steven Koonin of Caltech, concluded that nuclear theory needed to be strengthened and, to that end, the panel urged the creation of one or more national



Henley: Helmsman for the time being.

nuclear theory centers.

It so happens that the Department of Energy's Office of Energy Research, which funds most of the nuclear science in the US, never formally responded to NSAC's unanimous endorsement of the Koonin panel's proposal. It did something better. On 27 January, it approved the decision of NSAC to award the new Institute for Theoretical Nuclear Physics to a consortium of the University of Washington, University of Oregon and TRIUMF, the University of British

Columbia's 500-MeV cyclotron laboratory near Vancouver.

The institute is to be established at the University of Washington in Seattle, where it will be housed temporarily in the Applied Physics Lab. It will be managed for the time being by Ernest M. Henley until a permanent director is appointed, possibly before the end of the year.

The new institute has two main objectives: to provide scientific leadership and intellectual stimulation for the increasingly interdisciplinary nuclear theory community through visitor programs, seminars, workshops and summer studies; and to contribute to the training and nurturing of graduate students and postdoctoral fellows in the field.

The idea for an institute of nuclear theory has been marking time for some 20 years. But the countdown didn't really begin until the National Science Foundation launched the Institute for Theoretical Physics in September 1979 at the University of California, Santa Barbara. When that institute was first bruited, there were doubts about the wisdom of a centralized theory center with a large proportion of US and foreign visitors, staying typically from a few months to a year. Some predicted that the center would siphon funds from individual investigators. What's more,