research.

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

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 FEINBERGE 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 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. Subscriptions 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'

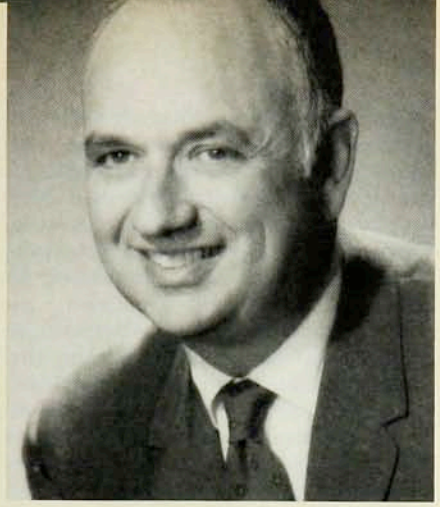
The latest contribution to the long-running debate over the feasibility of an operational defense against Soviet ballistic missiles is a report prepared by a special task force of the Defense Science Board, the Pentagon's senior scientific advisory group. The report, completed by the panel in late June and immediately stamped "secret,"

though still called a draft, leaked to the press in dribs and drabs until Representative James B. Olin, a Virginia Democrat, inserted the full text into the *Congressional Record* on 14 July. It not only endorses the main conclusion of *Science and Technology of Directed Energy Weapons*, issued last April by a study group of The American Physical Society (see PHYSICS TODAY, May, page S1), but in about 2000 words it goes well beyond that 422-page report to state that the Strategic Defense Initiative is far too unconventional, uncertain and undirected for the government to consider elaborate early demonstrations, let alone deployment by the mid-1990s, of any SDI system.

The task force, under the chairmanship of Robert R. Everett, a former president of Mitre Corp, examined SDI's achievements and shortcomings as seen by some experts close to or within military circles. Its report card gives SDI fairly low marks. At one point in the report, written as a memorandum to the under secretary of Defense for acquisition, Robert P. Godwin, the panel asserts that the concept of an SDI system using space-based and ground-based kinetic kill weapons that could be launched in 1994 is "quite sketchy" and "takes the form more of a list of components than of a consistent design."

The panel reached its judgment after eight sessions in which by SDI officials, contractors and scientists presented classified briefings over a period of three months. Although the panel was told that technology for the kinetic vehicles, which are designed to ram enemy missiles and warheads, is either in hand or well along, it finds that "much remains to be done before a confident decision can be made to proceed with the implementation of an initial phase." The task force goes on to say that technology for survivable rocket-powered kinetic kill vehicles positioned on platforms in space is "still uncertain." Indeed, that space-based interceptors (the term the Pentagon now uses instead of "space-based kinetic kill vehicles") are vulnerable to attack from antisatellite weapons and ground-based lasers at virtually any time is "particularly disturbing," the report states.

Questions. The panel argues that precise targeting of an ICBM booster amid the fire and smoke of the launch plume cannot be achieved with certainty right now. In its report, the APS team observed that even in some later phase, when lasers and particle beams might be used, hitting a spot perhaps half a meter across and several meters above the top of the plume of a booster rising at several kilometers per second



EVERETT

would be difficult if not impossible. Tracking an ICBM's plume, said the APS document, will require reliable space-based conventional or optical radar, incorporating a feedback loop to determine if the target is struck and to make corrections automatically if it is not. The APS report suggested that fast-burn boosters would be an effective countermeasure to all directed-energy weapons in an early phase. The Pentagon panel admits that much more needs to be known about various US and Soviet boosters before the problem is solved.

Other serious questions for a Phase I system involve passive infrared sensors to discriminate warheads in space from even the most primitive decoys and debris. Technology for fabricating large infrared focal planes is not at hand, states the Pentagon task force. Accordingly, "there is a major need to create an adequate data base of the phenomenology involved in SDI," the group points out. "There is very little available information on how objects look in space or how rockets look in boost phase. Components and system design are proceeding on the basis of assumptions and calculations which may or may not prove reliable."

The panel was formed to assist Godwin in a formal review of a plan to deploy a limited "Star Wars" Phase I, which has been urged by Defense Secretary Caspar W. Weinberger. The scheme has the backing of Lieutenant General James A. Abrahamson, SDI's director. But among the Defense Department's Joint Chiefs of Staff and its senior political appointees, as well as within the White House and Congress, many contradictory voices are heard about the idea. Godwin appointed the panel with the approval of the Defense Science Board and Weinberger.

Besides Everett, a computer engineer who once worked at MIT's Lincoln Laboratories, the group consists of General Russell E. Dougherty, retired commander of the Air Force's Strategic Air Command; Harry Gray, retired chairman of United Technologies; Harry Haynes, retired chairman of Chevron; Ralph Lee, retired executive vice president of Hewlett–Packard; Walter Morrow Jr, director of Lincoln Labs; General Samuel C. Phillips, former head of the Air Force Systems Command and a former vice president of TRW Inc; and William J. Perry, a top Pentagon scientist in the Carter Administration and now an official at H&Q Technology Partners in Menlo Park, California. Morrow was a member of the APS team that conducted the study of directed-energy weapons.

Tactic. Approval by this task force would be necessary if early deployment is to gain the support of the Defense Science Board and the Defense Acquisition Board. This is considered important to Weinberger and Abrahamson as a means of legitimizing the controversial Phase I system in the Pentagon and Congress and raising SDI's entire stature among US allies and the public. It also is seen as a tactic for speeding up the program so that SDI is fully converted from theology to technology when the next Administration arrives in January 1989. Even SDI diehards in Congress believe the blessing of the Joint Chiefs is vital before the Pentagon can be given the go-ahead to "bend metal" and actually produce components for Phase I.

Whenever Weinberger and Abrahamson talk about Phase I, they describe the "architecture" outlined in a report by the George C. Marshall Institute (PHYSICS TODAY, January, page 47). This calls for a three-layered antimissile defense using some 11 000 space-based interceptors consisting of small rockets and electromagnetic rail guns, which could hurl projectiles at Soviet ICBMs in the boost and post-boost stages; another 10 000 exoatmospheric reentry-vehicle interceptors set off from the ground against warheads in midcourse; and 3000 high-endoatmospheric defense interceptors to strike warheads that make it through the first two layers. The entire system would need to be supported by additional satellites for communication, surveillance and battle management. Another vital element in the system is supercomputers to feed data to the command and control components.

Abrahamson has told Congress that the cost of such a system would be $40 billion to $60 billion. Phase I would be designed to protect a limited number of military installations, not cities, although it could later be supplemented by more elaborate—and presumably more effective—antimissile defense systems. But the Congressional Research Service reported as recently as 1

August that simply launching Phase I might run as high as $32 billion, not counting the cost of R&D and manufacturing the system, and that deployment of additional phases later on could put the bill up to $1 trillion. The CRS projections vary widely because the launch cost could drop from the current $3000–5000 per pound to something like $400 per pound for low-Earth orbit and from $18 000 to $3000 for geosynchronous orbit if an advanced heavy-lift system is developed.

Evolution. The Pentagon task force, like the APS panel, supported continued research on SDI. Asked to review the prospects of proposed space-based interceptors, the Everett panel evaluated such matters as systems design, cost estimates, development schedules and "milestone decisions." Its report cautions that defensive systems are never built to an immutable architecture. "Enemy reactions, new technology and changing requirements all lead to continual evolution," it says. "The plan to build SDI in phases is therefore reasonable and customary."

Before Weinberger, Abrahamson and other Phase I cheerleaders can find comfort in that statement, however, the Everett panel goes on to warn that none of the current cost estimates are reliable, "even assuming that the current Phase I concept holds. By the time the necessary system and underlying technology work is complete, the design may change considerably and costs change as well. There are also sizable uncertainties in such matters as learning curves for space hardware produced in modest quantities, launch costs and production costs for ir focal planes and hardened high-speed data processing." As for scheduling deployment in 1994 or thereabouts, the panel observes, Congressional support is so uncertain that anything said now is not likely to hold up.

One section addressing milestone decisions that have to be made by the Defense Acquisition Board was deleted from some versions of the panel report. That section was deleted, according to one of the panel's members, because there was no way of evaluating the gaps in either the current design or the key technologies to enable the Joint Chiefs to be sure that the system would meet their requirements. However, an earlier draft of this section appears in the version that Congressman Olin placed in the *Record*.

Defiance. The report provides additional ammunition to members of Congress who would like to zap or cap the SDI budget. Though a Defense appropriations bill is unlikely to be passed before fiscal 1988 begins on 1 October, the House and Senate have both indicated where they stand on SDI. The House voted to reduce President Reagan's request for $5.9 billion to $3.1 billion, which is more than $600 million below SDI's current account. In the Senate, the Armed Services Committee recommended $4.5 billion. Senate Democrats are holding the entire military budget hostage to SDI—in open defiance of Reagan and, surprisingly, public opinion. Polls have shown that between 60% and 82% (depending on the way questions are asked) of the US public favors developing the President's vision of a missile shield.

The Pentagon, meanwhile, operating on the strategy that the best defense is an offense, released the first formal description of Phase I, presumably now given the official title of Strategic Defense System—1. Like the Everett report, SDS-1, contained in a document 2 inches thick, was issued for use by the Defense Science Board and Defense Acquisition Board. It calls for at least 13 major tests of six different systems, including a space-based interceptor rocket, sensor satellites and a communications network, over the next five years. The experiments would provide the first glimpse of technologies needed for a low-tech Star Wars, and all are designed to comply with the "narrow" or traditional interpretation of the 1972 US–Soviet Antiballistic Missile Treaty.

None of the tests involve the exotic laser or particle beams that the public mind usually associates with Star Wars. More than half of the proposed space experiments for SDS-1 would consist of attempts to intercept missiles in flight using infrared guidance to direct a small rocket, sometimes called a "smart rock." Two tests would involve launching state-of-the-art satellites to detect and track missiles in their boost and post-boost phases.

The SDS document covers the environmental effects of testing on 15 DOD sites, including the Kwajalein Atoll in the Pacific.

—Irwin Goodwin

Supreme Court bars creationism in schools

In a setback for religious fundamentalism, the US Supreme Court overturned on 19 June the 1981 Louisiana law requiring that "creation science," the Bible's account of the origins of life, must be taught in public schools whenever the concept of evolution comes into the curriculum. By a 7–2 decision, the court agreed with two lower courts that Louisiana's Balanced Treatment Act violates the First Amendment to the Constitution, which forbids government from making any law that endorses the "establishment of religion"—a precept that has been construed traditionally as meaning that government at all levels has no business promoting religion in classrooms or anywhere alse.

Writing for the majority, Justice William J. Brennan Jr, the senior member of the court, called the Louisiana legislature's claim that the law had the secular purpose of "protecting academic freedom" simply a "sham." Brennan's 17-page opinion states that "The preeminent purpose of the Louisiana legislature was clearly to advance the religious viewpoint that a supernatural being created humankind." Brennan's prose is precise: The law's "primary purpose was to change the science curriculum of the public schools in order to provide persuasive advantage to a particular religious doctrine that rejects the factual basis of evolution in its entirety."

New strategy. The Supreme Court's ruling culminates a six-year legal battle that began when the Louisiana legislature passed the Balanced Treatment Act in July 1981—though the law was never carried out because it was immediately challenged in the courts. Ironically, the legislation had been carefully crafted as a strategy to avoid the constitutional problems that defeated somewhat similar laws in Arkansas and Mississippi in recent years. It did not mention God or religion and plainly required the teaching of information that it termed "scientific evidences," which included passages from Genesis, alongside the body of knowledge known as evolution. The Balanced Treatment Act required that evolution be taught "as theory, rather than as proven scientific fact" (PHYSICS TODAY, February 1987, page 64).

Brennan's opinion in *Edwards v. Aguillard* (Case No. 85-1513) is extraordinarily clear about the issue: "If the Louisiana legislature's purpose was solely to maximize the comprehensiveness and effectiveness of science instruction, it would have encouraged teaching of all scientific theories about the origins of humankind. But under the act's requirements, teachers who