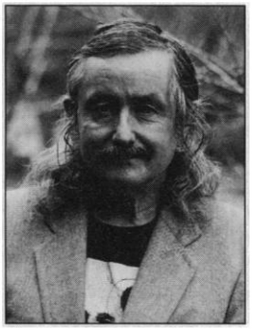
Earthly Politics Boosts Space Probe

Gravity Probe-B, a $500 million test of general relativity, has survived repeated attacks by taking its case to Congress. Now it faces its sternest test

When Stanford University physicist Francis Everitt walked into the office of an Alabama congressman in 1980 to shore up political support for an obscure and costly experiment to test relativity in space, two staffers took him under their wing. For an hour, they lectured him on the Washington lobbying game—who to see, what kind of pitch to make, how to make the critical follow-up. "I was like Margaret Meade going to Samoa—I wanted to know how things worked," recalls Everitt, the principal investigator for a $500 million mission called Gravity Probe-B (GPB).



Super salesman. Stanford's Everitt is the force behind Gravity Probe-B.

He proved an apt pupil: 15 years later, even the waiters and taxi drivers at the Washington hotel he favors greet Everitt by name. This English-born mustachioed scientist has assembled an impressive political coalition that has fended off six attempts by the White House, the National Aeronautics and Space Administration (NASA), and Congress to cancel the project, which aims at proving Einstein right or wrong on his most famous theory.

But now Everitt faces what could be his most serious test. NASA Administrator Daniel Goldin, who is trying to squeeze a growing number of missions into a shrinking budget, has asked the National Academy of Sciences (NAS) to assemble a committee to take a hard look at the project. The committee—a dozen academics led by Nobel laureate Val Fitch—will render its verdict in June. If it gives thumbs down, Goldin has promised to cancel the program, which has already cost almost $250 million. If the panel gives its blessing, then Goldin will have to apply the knife to other projects to carve out the additional $250 million GPB will need to be ready for launch by 2000.

Congress will have the final say when it passes judgment on NASA's budget, and Everitt is busy preparing the groundwork. Over the past decade and a half, he has put together a formidable coalition of supporters on Capitol Hill—quite a feat, considering the esoteric nature of his project: "Talk about general relativity and eyes glaze over," says Representative Norm Mineta (D–CA), who represents the area near Palo Alto, California, where the spacecraft and instruments are being built. "Seldom do you have anyone to carry the message on basic R&D, and Francis conveys it."

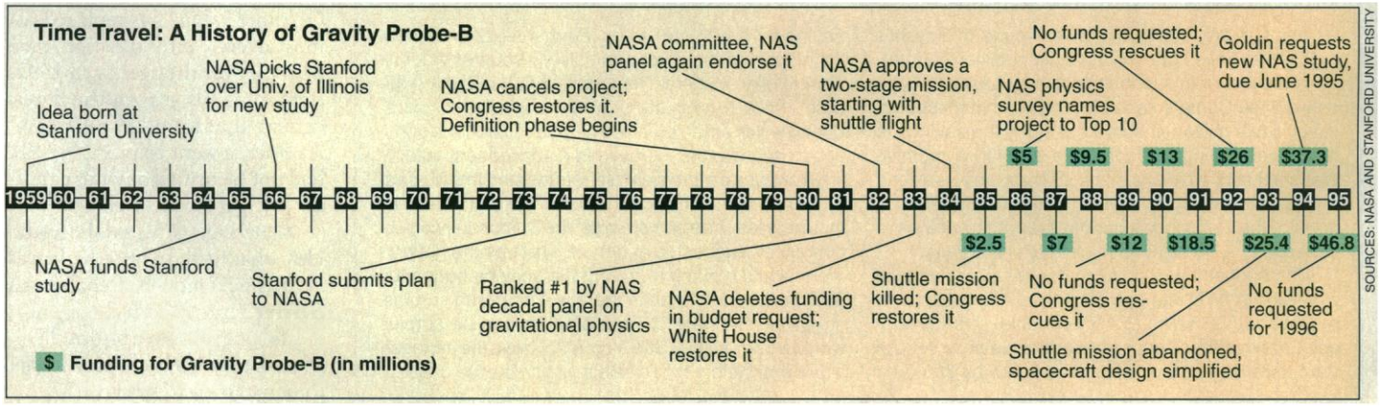
Given his impressive track record, Everitt's tactics would seem to hold important lessons for other scientists worried about preserving R&D funding in a time of growing fiscal austerity. But his unabashed salesmanship—he sends personal Christmas cards to influential lawmakers—angers many scientists. "It's the wrong way to sell a program," says astrophysicist John Bahcall of the Institute for Advanced Study in Princeton, New Jersey, who chaired a 1991 academy panel that outlined astronomy and astrophysics priorities for the coming decade. "There ought first to be a groundswell of support for your program among your colleagues before you go to Congress. GPB is the only program I can remember in 25 years that has achieved such support in Congress with such a broad group of scientists who disagree with it."

Everitt's critics, led by Princeton University astrophysicist Jerry Ostriker, say the program is now running more on political steam than scientific sense, and they have made their case to their colleagues, to Goldin, and to other senior agency managers. They say GPB is no longer a scientific priority because of new evidence that upholds Einstein's theory. And they say its price tag is no longer something NASA can afford on a limited budget. "If we take Dan Goldin's criteria—faster, cheaper, better—and prioritize NASA's various programs, it is not at all obvious that GPB has precedence over others," says Ostriker. "It is not really a question of is this a good thing or a bad thing; it is a question of priority."

GPB supporters say the critics are playing politics, too. Astrophysicists want GPB canceled, they say, to make room for their own pet projects in NASA's shrinking budget. "Let's face it," says Mineta, "the astronomers just don't like this program."

An elegant Thermos

Backers and detractors agree on at least one point: The mission itself is science at its most basic and elegant. Shaped like a squat Thermos bottle, the spacecraft is just that: an insulated and supercooled container encasing four sophisticated gyroscopes. The gyroscopes and accompanying instruments are designed to provide precise measurements to prove or disprove Einstein's contention that a massive rotating body—in this case, the Earth—drags space and time along with it. The mission will also measure the curvature



of space predicted by the theory. "The answer will end up in physics textbooks around the world," says California Institute of Technology (Caltech) physicist Kip Thorne. "It is of great intellectual importance."

But in the 36 years since GPB was first conceived, physicists have not been waiting idly for the mission to confirm or disprove Einstein. Radio observations of superdense stars in the 1970s by Princeton astronomers Joseph Taylor and Russell Hulse provided evidence for aspects of general relativity and won them the Nobel Prize in 1993. By carefully timing a binary pulsar, they were able to show subtle variations predicted by the theory. Equipment left on the moon by NASA astronauts and a Soviet lander also gives physicists a chance to test the theory by using highly accurate measurements of the distance between Earth and its satellite—measurements that have become more exact in the past decade (*Science*, 22 July 1994, p. 482).

Physicists and astrophysicists disagree on how much weight to give these data, however. GPB supporters like Thorne say there have been no qualitative breakthroughs since the early 1980s, when the program was reviewed and praised by an academy panel. But Nobel laureate Charles Townes says, "There was less certainty then about gravitational theory than there is now—and that has reassured people the theory is right."

There is consensus that no serious evidence contradicts Einstein's theory. But Everitt notes that there was no reason to doubt Isaac Newton's explanation of gravity until this century. "One simple observation—a subtle error in the motion of the planet Mercury—undermined Newton's intellectual structure," he told a congressional panel on 16 March. And even if GPB shows Einstein was right, Thorne adds that the spacecraft data will prove a boon to 21st century physicists studying distant stars and black holes.

Apart from the theory, there is concern about whether GPB will work as planned. The spacecraft design is highly complex; its gyroscopes are untested in space, and a space shuttle mission to check out the equipment was canceled 2 years ago to save money. The Fitch panel is considering potentially cheaper and simpler designs, and earlier this month it heard about one alternative from Stanford visiting scholar Ben Lange. Lange says his plan—described in the 13 March issue of *Physical Review Letters*—could greatly improve the experiment's scientific output without requiring the complex cooling equipment in the current GPB design. "It's a creative idea, but the design is about where we were in 1983," observes Brad Parkinson, Stanford program manager and co–principal investigator on GPB.

The endless technical and scientific arguments for and against the mission, however, mask a more fundamental question: Even if GPB works as planned, is it worth the money? A 1991 NASA study led by University of Chicago physicist Eugene Parker concluded that, "if it were a low-cost experiment, there would be unanimous and enthusiastic support for its immediate pursuit." But GPB is not low cost. It is NASA's third largest space science program—and the only one of the top three that has not been radically scaled back since Goldin took over in 1992. Since then he has waged a ferocious war against large and expensive missions that take a decade or more to reach the launch pad. Until last fall, however, he enthusiastically backed GPB and protected it from major restructuring. "He was won over by Francis's magic," says one NASA official, referring to a visit Goldin made to Stanford in 1992. Goldin, a former industry executive, was said to be particularly struck by the program's bright graduate students and innovative management structure.

LOCKHEED

Cool theory. The satellite will test general relativity using four gyroscopes inside a supercooled container.

But the spell was broken by the current budget realities confronting NASA. The funding crunch has sharpened competition between fundamental physicists and astrophysicists, who traditionally hold sway with NASA. The top priorities for astrophysicists are the Stratospheric Observatory for Infrared Astronomy (SOFIA) and the Space Infrared Telescope Facility (SIRTF)—programs that have existed only on paper for more than a decade.

"These are two rather different fields with different intellectual content and cultural milieus," says physicist Thorne. "Much of what is going on is a turf battle between two fields—between astrophysicists who see GPB funds and say the program isn't worth the money and physicists who see the effort as fundamental."

NASA managers have long been aware of this tension. "There is an unresolvable philosophical difference in how scientists view this mission," explains a 1991 internal memo from NASA's astrophysics division.

An inside look

It was in this charged atmosphere that France Cordova, Goldin's new chief scientist, began to hear complaints last year about the technical and scientific viability of GPB. She says Goldin heard them, too. "This all happened little by little," Cordova recalls. "Then he said, 'France, should we be taking a look at this?' " Taking the cue, Cordova organized a series of meetings last summer at NASA headquarters between Goldin and senior scientists, including critics and supporters. In October Goldin asked the academy to review the technical and scientific aspects of the program.

Goldin and Cordova hoped to resolve the GPB issue before February, when the 1996 budget request was sent to Congress. But the academy refused to be rushed, insisting it needed until June. In the meantime, Goldin dropped an administrative bombshell: Rather than keeping GPB on the books, NASA's proposed budget for 1996 contains an asterisk, with fine print noting that a $50 million request is on hold pending the report's completion.

The budget request also raised eyebrows among space scientists by seeking $49 million for SOFIA and $15 million for SIRTF. Although some say NASA has traded GPB for the infrared facilities, officials bristle at the suggestion. "That's strictly coincidental," Dan Weedman, NASA astrophysics division director, told the agency's space science advisory subcommittee earlier this month.

GPB supporters, most of whom decline to be identified, blame Cordova for the latest attack on the program. They say she convinced Goldin to reconsider his support for the program to free up money for other initiatives. "It is clear their motives were to kill this off," says one Washington official who has closely watched the program. "They thought they could use other science communities to do it for them." Cordova's background—she headed the astronomy and astrophysics department at Pennsylvania State University—makes her less sympathetic to the project, they believe. Adds Mineta, "She's a closet opponent."

Cordova dismisses the idea that her back-

ground colors her view of GPB or that she opposes the program. "I am a Stanford graduate," says the chief scientist, who received a B.A. in English there before attending graduate school at Caltech. "I received my Ph.D. in physics, not astronomy, and in my heart I am deeply attached to the issues that physics poses. Since I was a little girl I wanted to be a nuclear physicist."

Now GPB's fate lies squarely in the hands of the Fitch panel. Most panel members declined to discuss the study, but sources close to them say the majority are sympathetic to the program—particularly because its charter does not call for the group to compare GPB with astrophysics missions. "The report from the academy is going to be positive, and Goldin won't have any way to withstand Congress' desire to put [funds] back," predicts one NASA manager.

If that's so, Goldin will be ready: On 9 February he ordered his managers to find ways to factor in GPB's $50 million without increasing the agency's overall 1996 budget, according to other sources. Only a small portion—under $10 million—would come out of the hide of astrophysics programs, they add. Mineta says he will abide by the Fitch panel recommendations, but he is confident GPB will come through with flying colors. But Representative Anna Eshoo (D–CA), who represents Palo Alto and also backs the program, is less sanguine, as GPB is not in NASA's formal budget request. "It's hard to be optimistic about the future of the program in Congress," she said last week.

She may be underestimating Everitt. And now that he knows his way around Washington, he clearly relishes the challenge of a political fight. "It's a chess game, sort of like the one in Alice in Wonderland except played with real people," Everitt says.

Even so, he doesn't recommend that young scientists book the next plane to National Airport in the hope of advancing their programs. "I worked on GPB for 15 years before I once visited Washington" to lobby Congress, Everitt insists. "First you have to have your technical and scientific act together. And don't blithely assume that the world owes you $500 million. It doesn't."

Love him or hate him, it's hard to deny that Everitt's act, both scientific and political, is first-rate. "He's such a delight," says Representative Mineta. "And he is one heck of a salesman."

–Andrew Lawler

ECOLOGY

NRC Urges Sea Change in Marine Studies

Ecologists and conservationists have succeeded in making biodiversity a household word, largely by focusing attention on a few land ecosystems such as the tropical rain forests. But 70% of the Earth is covered by water, and so far the marine environment has been virtually ignored—a situation that ought to change, according to a National Research Council (NRC) report published this week. The report, entitled "Understanding Marine Biodiversity," outlines a research agenda for exploring the understudied biodiversity of the oceans. "It's time to step up to the problems of marine biodiversity as we did 20 years ago in the tropical ecosystems," says James Carlton of Williams College and Mystic Seaport museum in Mystic, Connecticut, who is co-chair of the report.

Other biologists point out that overfishing, pollution, and other human activities have already damaged economically important coastal areas and fishing stocks. "It's important at a minimum to inventory and assess marine stocks and the biodiversity of the oceans—if only to assure the sustainability of one of the world's major food sources, seafood," says Rita Colwell, president of the Maryland Biotechnology Institute. (She is also president of *Science*'s publisher, the American Association for the Advancement of Science.) Many biologists acknowledge that a big boost in spending isn't likely. But the report says the field could also benefit from a new emphasis on systematics and a shift in focus away from isolated bays or reefs to whole regions of the ocean.

The report's authors found plenty of warning signs that the oceans are in trouble. Take Chesapeake Bay. One hundred years ago it supported vast reefs of oysters, which were capable of filtering all the water in the bay every week. Today, overharvesting, local pollution, and disease have decimated the population so that the surviving oysters require a year to filter the bay's water. The shift has cascading effects up the food chain, because the amount of organic matter in the water column, nutrient dynamics, and light levels have all been dramatically altered. The report is peppered with other examples, from declining Caribbean reefs to exhausted fisheries on Georges Bank.

In spite of such warning signs, few marine extinctions have been documented (*Science*, 18 February 1994, p. 918). But then, scientists have only just begun to explore the diversity of life in the sea. While terrestrial biologists often discover new species, genera, or even families, the oceans have been so poorly investigated that marine scientists find entire new phyla. The report cites one group of tiny algae, the prochlorophytes, which were not discovered until the mid-1980s, but are now known to contribute up to 40% of the primary productivity of some areas of the ocean.

"It's time to step up to the problems of marine biodiversity. ..."

—James Carlton

To shore up the effort, the report gives strong support to a chronically weak discipline—the systematics of marine organisms. "People have been afraid to put systematics in their grant proposals because they feared it was perceived as old hat. We're asking them to come out of the closet," says Cheryl Ann Butman of Woods Hole Oceanographic Institution, the other co-chair of the initiative.

But the report also notes that understanding marine systems requires more than just systematics. In the past, ecologists have tended to zoom in on one piece of marine habitat, studying competitive interactions in a patch of rocky intertidal real estate, for example, or predation on part of a single coral reef, says Phil Taylor, program director for biological oceanography at the National Science Foundation (NSF). The new report reflects a growing consensus that researchers must explore the larger scale factors that control diversity, because far-flung regions of the ocean are tightly linked by water flow. For example, to study the settlement of young oysters and other mollusks in Chesapeake Bay, it's also necessary to study the health of nearby areas, such as Delaware Bay, as larvae travel freely between them.

The report's message is winning support from terrestrial biodiversity experts, such as E. O. Wilson of Harvard University, who says he welcomes the entrance of marine animals "onto center stage in biodiversity studies." But the recommended large-scale research costs money, and although the report calls for "major new funding," few researchers are optimistic about their prospects right now.

Still, the initiative itself was sponsored by the federal agencies that fund the bulk of marine research—NSF, the Office of Naval Research, the National Oceanic and Atmospheric Administration, and the Department of Energy, as well as the National Biological Service. Even if big new grants must wait, the new research priorities are likely to appear in the funding patterns of these agencies, says Taylor. One way or another, fish, clams, reefs, and whales may join trees and birds in the biodiversity spotlight.

–Elizabeth Culotta