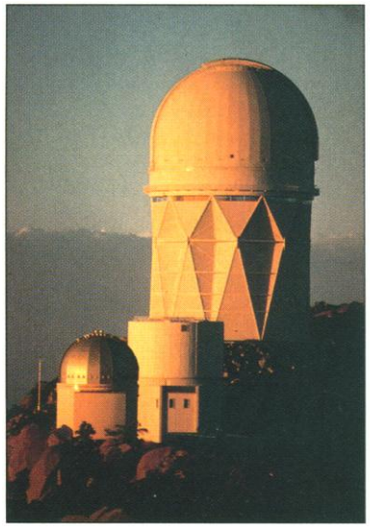
Astronomy's Optical Illusion

There's a boom in new U.S. telescope construction, but this richness is deceptive—there may be no new money to run the new scopes. The result: a looming battle over resources

A little more than two decades ago, Harvard University astronomy graduate student Sandra Faber was scrambling for telescope time. Observing time was (and still is) a scarce commodity for young astronomers. Like many of her peers, Faber found her share on a telescope at Kitt Peak Mountain near Tucson, Arizona, one operated by the National Optical Astronomy Observatories (NOAO). Later in her career, she again used NOAO telescopes to help discover that hundreds of nearby galaxies are streaming towards an area of space that has become known as the Great Attractor.

The U.S. government–owned NOAO, it appears, has been very good to Faber, now a tenured professor at the University of California, Santa Cruz. It was all the more shocking to many, then, when in the spring of 1993 she proposed shutting down its Tuscon headquarters and giving away NOAO's Kitt Peak telescopes. The proposal came in a confidential memo about the outlook for astronomy that was requested by a few colleagues on the National Research Council's Committee on Astronomy and Astrophysics (CAA). Not long after it had been written, says Faber, the memo leaked out, and "it went off like a bombshell." Furthermore, that bombshell has created shockwaves that have traveled far beyond NOAO, stimulating a debate that could affect the entire future of U.S. optical and infrared astronomy.



NOAO

Turf war. Private telescopes *(foreground)* are battling for funding with scopes at the Kitt Peak National Observatory *(large dome)*.

The reason for the memo, and for the explosive nature of the debate, is that Faber and other astronomers at the end of the 20th century find themselves in the peculiar position of having a lot of terrific telescopes but a potential shortage of money to equip and run them. By the end of century, new large telescopes—such as NOAO's twin 8-meter Gemini scopes, the first of which broke ground in Hawaii just last week—are expected to more than double the amount of mirror collecting area, or "glass," available to astronomers. But there's unlikely to be any additional federal money to operate and instrument this new glass. As a result, the National Science Foundation (NSF), which bankrolls most U.S ground-based optical and infrared astronomy, may have to pick some pre-existing observatory pockets for the funds. NOAO and its $29-million budget appeared to be the pocket that Faber had in mind.

In her memo, she argued that private university observatories could operate the Kitt Peak telescopes more efficiently than NOAO, and that the field in general would benefit if most of the government astronomy dollars were funneled to Gemini and new private telescopes. But critics called the plan elitist, condescending, and in the words of one astronomer "a recipe for disaster." They charge that it could leave out in the cold the many hundreds of astronomers who lack access to optical telescopes at their own institutions and who depend on NOAO for their research. The proposal has aggravated an enduring rift between these have-nots and the haves, those who enjoy access to their own glass. "Some people perceive they're fighting for their lives. They may be right," says a prominent West Coast astronomer, who refused to be named.

Prompted by this furor, NSF officials have quickly become concerned about how the agency should deal with its funding constraints in the years to come. "We have a serious problem that needs to be addressed. I'm not sure how it will ultimately play out," says Hugh Van Horn, head of NSF's astronomy division.

Earlier this year, Van Horn turned for advice to the CAA, which named a panel* headed by Richard McCray of University of Colorado to conduct a review of NSF-supported ground-based optical and infrared astronomy. That anxiously awaited report is not due out until December, but *Science* has learned that the panel will not embrace Faber's suggestion and recommend giving away NOAO's Kitt Peak telescopes. But the panel is expected to make a number of other proposals about redistributing money and assets—such as forcing private observatories to set aside time for outside astronomers—that are sure to stir up more controversy between optical astronomy's haves and its have-nots.

"House of cards"

From outside the astronomy community, all this worry may seem absurd: With an estimated half-billion dollars slated for or already invested in new large telescopes, U.S. optical and infrared astronomy is arguably entering a golden age. "I see a field that has a large amount of exciting work ahead for it," says Peter Strittmatter, director of the University of Arizona's Steward Observatory. The world's largest optical telescope, the Keck 10-meter reflector on Hawaii's extinct volcano Mauna Kea, is now producing data, and its twin neighbor, Keck II, will be completed in a few years. And a host of powerful 4- to 8-meter telescopes have either come on-line, are under construction, or should be ready by the end of the decade. Among the latter is the $176-million Gemini project; NSF's contribution of $88 million to the international endeavor reserves half of the time on the Gemini telescopes for U.S. astronomers.

Yet in the midst of this astronomical boom, Faber, NSF officials, and dozens of other leading astronomers interviewed by *Science* warn of a potential bust. "Our present richness is very superficial. It's all a house of cards that could collapse tomorrow," Faber says. "It seems foolish to build huge new facilities and tell the community to just look at them because we don't have the money to run them," adds Van Horn. Driving the field's concern is the state of NSF's astronomy budget, which is expected to be around $112 million in 1995. In the last decade, this budget has not kept pace with inflation, and NSF officials don't envision a boost any time soon. "We have been told to expect flat budgets for the next 4 to 5 years," warns Van Horn.

*The McCray panel members are Bruce Carney (University of North Carolina), Jay Gallagher (University of Wisconsin), John Huchra (Harvard-Smithsonian Center for Astrophysics), Ken Kellerman (National Radio Astronomy Observatory), Anthony Tyson (AT&T Bell Laboratories), Judith Pipher (University of Rochester), and Robert Rosner (University of Chicago).

Though frustrating, flat budget projections are increasingly common in all areas of U.S. science. So why should there be such apprehension among astronomers? The quick answer is the anticipated impact on the NSF astronomy budget of the Gemini telescopes. Though NSF has specifically set aside money for the construction of Gemini, no such special arrangement has been made for its operating costs, which include power, maintenance, and staffing. NSF estimates that the U.S. portion of the operating budget will amount to more than $5 million a year, an amount that NSF apparently will have to cut from someone else's funding.

That's just one source of pressure on NSF's astronomy budget. The other major one is the cost of instrumenting major modern telescopes. Gone are the days when relatively cheap photographic plates would do for capturing the light of stars. Astronomers today demand multiobject spectrographs and photometers, high-resolution spectrographs, infrared cameras, and mosaics of charge-coupled devices (CCDs), the light-sensitive electronic chips that have revolutionized the field. "Instruments are the whole story now," says Donald York of the University of Chicago. "An 8 meter with a poor instrument is no better than a 4 meter with a good instrument," says NOAO director Sydney Wolff. But these devices, which range in price from $2 million to $5 million, don't come cheap.

The thorny issue of affording instrumentation is made even thornier by a pattern that prevails at private institutions that have their own telescopes. These institutions, which have historically dominated U.S. optical astronomy and today still account for more than 80% of the collecting area of U.S. telescopes, have a formidable record of using the romance of astronomy to raise capital to build telescopes—witness Keck I and II. Yet they have never been as successful at collecting money for the less glamorous task of operating and instrumenting their telescopes. As a result, private observatories traditionally turn to NSF grants. And, as the area of private glass more than doubles during the next 5 years (see chart above), the demands on NSF to ante up more funds will grow stronger. "You don't make the best use of [the new telescopes] by starving them of instrumentation money," scolds one private observatory director, who asked not to be identified.

Squeezing the national scopes

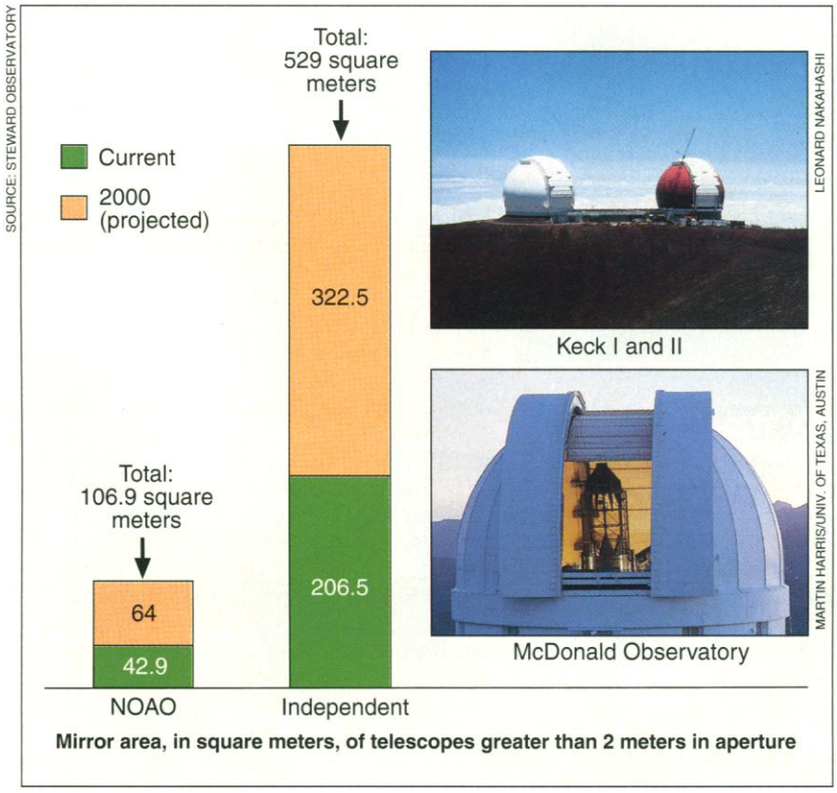
To get out of the squeeze imposed by Gemini's operating costs and the rising instrumentation demands of influential private observatories, NSF needs to cut somewhere or find ways to make its money go farther. For reasons of fairness, the agency can hardly steal from the $40 million allocated for radio astronomy to finance optical and infrared astronomy, says Van Horn. Two other options, reducing funds directed to individual grants and instrumentation R&D in optical and infrared astronomy, also seem taboo, he says. Both were high priorities in the influential blueprint for astronomy in the 1990s written a few years ago by a committee chaired by John Bahcall of the Institute for Advanced Study at Princeton University.

The only budget left to trim appears to be NOAO, which got its start in the late 1950s. Before then, U.S. optical astronomy had almost exclusively been the practice of a few universities, primarily in California, that had parlayed private philanthropy or state funds into large telescopes. In 1957, to provide a wider slate of astronomers with telescope access, a group of seven universities successfully petitioned NSF to establish the Kitt Peak National Observatory (KPNO). In 1963, NSF then created the Cerro Tololo Inter-American Observatory (CTIO) at a site in northern Chile, followed in 1976 by Sacramento Peak Observatory in California, home to solar telescopes. In 1982, NSF combined the three to create NOAO.

By many measures, NOAO has been a resounding success. "We get a lot of good science out of NOAO," says Massachusetts Institute of Technology astronomer Paul Schectman. When he spoke before the McCray panel recently, Schectman emphasized NOAO's accomplishments by giving the committee a "Top 10" list of influential observations made at Kitt Peak. His list included the detection of the first gravitational lens, the first strong evidence for a supermassive black hole in the galaxy M87, and the discovery of a huge barren stretch of space known as the Bootes void. In terms of quantity, the national center also stands out: Within the last 5 years, NOAO observations generated some 3500 papers.

The national observatory has also performed another vital task, say many astronomers. NOAO has "enfranchised" a larger community of graduate students, postdocs, and faculty members than private observatories can support. "There is a substantial number of astronomers who base their scientific vitality on data from this place," says Richard Green, deputy director at NOAO, noting that the national observatories support more than 1000 visitors each year, despite rejecting more than half of the proposals submitted to them. "The national observatories are critical to the well-being of the astronomical community," agrees Ohio State University astronomer Jay Frogel.

But many elite members of that community, the haves, have always looked down their noses at NOAO, say its advocates. There's a "certain level of contempt for NOAO" among the haves, claims University of Massachusetts astronomer Steve Strom, one of the most outspoken NOAO supporters. "Many of [the optical and infrared community's] most senior and influential voices are located at institutions which have their own facilities and with few exceptions have never accepted the notion that the



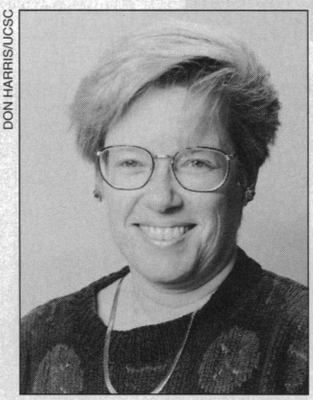
Expanding telescope universe. The NSF astronomy budget, expected to remain flat over the next 5 years, will have to be stretched to cover a bonanza of new telescopes.

U.S. national observatory should take the lead in developing frontier facilities and instrumentation," he wrote in one of many letters posted to an electronic archive set up by the McCray panel. And that lack of acceptance, he holds, has translated into a lack of support.

For NOAO's critics, the heart of the matter appears to be an unresolved debate about the purpose of this national center. "Its mission is confused. Is it there to serve to the masses or be at the astronomical cutting edge?" asks Frank Bash, head of the University of Texas' McDonald Observatory. If truth be told, acknowledges Wolff, NOAO has always tried to do both. And astronomers like Faber charge that serving the masses has led NOAO to duplicate research efforts at private observatories and compete with them head to head for scarce funding. That redundancy is is something astronomy can no longer afford, suggests Faber in her memo. "The importance of uniqueness in a healthy national facility cannot be overemphasized," she wrote.

The memo

It is that desire for NOAO to be unique that drives much of the reasoning behind the Faber memo. While many saw her treatise as an all-out attack on NOAO, particularly KPNO, its stated purpose was to improve the national center by focusing on services that it can provide uniquely. For example, she praised CTIO, because it offers U.S. astronomers a rare chance to view the southern skies.



DON HARRIS/UCSC

But the telescopes at KPNO, all of which are 4 meters or smaller, are in terms of aperture just "one among many," Faber wrote. In the memo, she proposed that NOAO concentrate its money on CTIO and Gemini and that NSF give KPNO's telescopes away to universities and consortia. NOAO could then buy back chunks of observing time on its old scopes to fulfill its charter of providing access for the whole U.S. community. This would fit in with an overall goal, according to the memo, to "channel as many NSF dollars to university and private groups as possible."

Such sentiments quickly raised the hackles of the have-nots, who argued that the plan would significantly reduce the amount of observing time available to the national community at a whole. Many saw Faber's prescription as a return to the old days of astronomy when only a few large departments thrived. Faber's memo, went one letter sent to the McCray panel, "reads like the astronomical equivalent of a health reform package written by the insurance industry." Furthermore, say some critics of the memo, the first priority for any taxpayer money should be to finance the national observatories, not private efforts.

NOAO's defenders have also taken Faber's memo to task for what they call unwarranted assumptions about the operating costs of the observatory. She wrote that NSF can save money by having universities operate KPNO telescopes in a "leaner and meaner" style. Why? Because NOAO, she claimed, spends a good deal of resources "hand-holding" visiting astronomers. It has a large staff, extensive documentation, and specialized software to make it easier for observers working on unfamiliar telescopes to get their data in the few nights allocated to them.

"Our present richness is very superficial. It's all a house of cards that could collapse tomorrow."

—Sandra Faber

Staff at NOAO and supporters call such criticisms unfair. Green argues that directly comparing a national observatory's costs with those of private ones ignores their very different missions and clientele. "Once you compare apples with apples it turns out our national observatories are much less costly than major foreign national observatories," adds Geotz Oertel, head of the Association of Universities for Research in Astronomy, which manages NOAO for the NSF. Furthermore, says Green, NOAO has already cut expenses by 30% in the last decade, and any further decline in its operating budget may mean the closing of telescopes.

Quid pro quo

If these arguments have not convinced the private observatories, they have apparently received a favorable hearing from the McCray panel. McCray says his panel will not endorse Faber's call to give away or auction off KPNO. "We cannot privatize NOAO. We're not going to recommend shutting down Kitt Peak or anything of the sort. We're 100% committed to a strong NOAO," McCray flatly states. "I think Kitt Peak has made an impressive case to the panel. Closing it would be a setback," adds the University of North Carolina's Bruce Carney, another member of the panel.

In fact, the McCray panel is actually looking at ways to expand the amount of observing time available to the national community without spending more money. The most significant recommendation expected in the final report, according to many familiar with the panel's deliberations, will be to pursue a funding strategy called "quid pro quo." This would require private observatories, in return for NSF money for instruments, to set aside a certain amount of observing time for outside astronomers.

Yet this "nationalizing" of the private observatories inspires concerns among those who run them. Foremost is the belief that to accommodate researchers unfamiliar with the quirks of their telescopes, the observatories would need to do the same hand-holding that Faber spoke of derisively in her NOAO memo, dramatically driving up their costs. "I'm not sure I'm keen" on the idea of quid pro quo, admits the University of Chicago's York. Neither is Bash, who says, however, that it will be the price his observatory has to pay for instrumentation funds.

In addition to quid pro quo, the McCray panel is examining a number of cost-saving options as part of its plan. One is remote observing, which could reduce the amount of funds needed for astronomers to travel to NOAO telescopes. They are also looking at "queue scheduling," in which observing efforts using the same instrument are scheduled back-to-back. Instruments are swapped on and off telescopes depending on a particular project's needs, but these changes are expensive, time-consuming, and labor-intensive; eliminating some of these shifts could lead to significant cost savings. For similar reasons, the McCray panel may call for some of Kitt Peak's telescopes to become dedicated single-instrument telescopes.

The panel is also expected to encourage more collaborations between NOAO and universities. The model they'll point to is a new 4-meter WIYN telescope now producing images on Kitt Peak. A joint effort between the University of Wisconsin, Indiana University, Yale University, and NOAO, the WIYN telescope was built largely with money raised by the universities, but it will be operated by NOAO in exchange for 40% of its observing time.

Will all these ideas free up enough money to instrument and operate the new glass? Though many in the field publicly praise the efforts of the McCray panel and express optimism, a few leading astronomers are privately skeptical that quid pro quo and the other recommendations will do much to solve the looming financial crunch. "I'm concerned that the McCray committee is becoming a bit too fancy" and not sufficiently facing fiscal realities, one told *Science*. If those sentiments are true, NOAO's budget may become an increasingly tempting target, guaranteeing that astronomy's civil war between the haves and have-nots is likely to continue.

–John Travis