2001 BUDGET

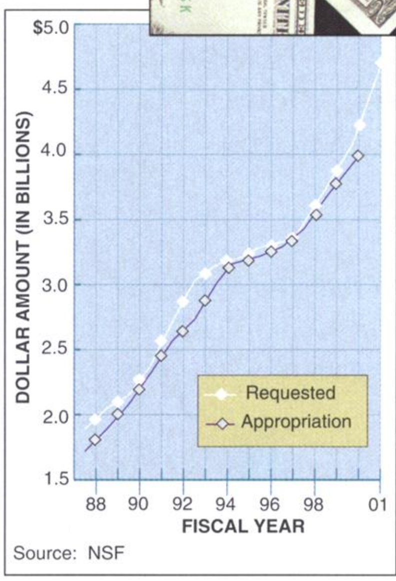
How NSF Came Up With the Biggest Boost in Its History

Bill Clinton got the scientific community's attention last month when he said that he aims to give the National Science Foundation (NSF) a record-breaking increase in 2001 (*Science*, 28 January, p. 558). The numbers, to be released officially on 7 February, sound remarkable—a proposed 17% boost that would be the largest in percentage terms since the Bush presidency and, at $675 million, the biggest dollar increase in the foundation's 50-year history.

But the numbers don't tell the whole story. The overall request for $4.6 billion would actually provide a bit more money than NSF officials had sought under the most likely of three budget scenarios. At the same time, it shifts funds from what NSF had labeled as priorities into other areas of research. Ironically, the 2001 budget now tackles head-on a problem—the need to sustain "core" disciplines—that NSF officials have argued is important but did not address directly in their request. In the end, to paraphrase Mick Jagger, you might say that even if NSF didn't get what it wanted, at least it got what it needed.

The budget deliberations for 2001 officially began last fall, when NSF director Rita Colwell and other agency chiefs submitted their requests to the Office of Management and Budget (OMB). Like the three bears, Colwell actually set out several servings for OMB to choose from—a big dish that would immediately double NSF's $3.9 billion budget, a small one that would freeze current spending (as OMB was required to consider), and a midsize or "investment" increase of 15% that NSF hoped the president might actually support. The last included generous helpings of research in nanotechnology, information technology, and biocomplexity, as well as new efforts to improve the scientific workforce. Except for biocomplexity (*Science*, 10 December 1999, p. 2068), they are all cross-disciplinary initiatives in hot areas that echo Clinton Administration priorities. It's an approach that NSF and other agencies have used successfully in the past to squeeze research money from a cost-conscious OMB.

But this year, a new concern about the distribution of research funds across all fields came into play. Colwell and others—including Neal Lane, her NSF predecessor, who is now serving as the president's science adviser—had been hammering home the idea that the federal government's $80 billion research portfolio is out of whack. The causes, they noted, were recent double-digit increases for the National Institutes of Health (NIH) combined with cuts in the defense and energy research budgets. That imbalance, they argued, needs to be corrected quickly to assure progress in all areas. At the same time, Colwell has also campaigned for larger, longer grants, noting that NIH awards, on average, are roughly four times the $70,000 median at NSF. The change, she says, would allow researchers to do better science by giving them more time between applications and more resources. It would also reduce paper shuffling and allow NSF to be more efficient.



Staying close. NSF hopes its 2001 budget comes close to the president's request for a 17% increase.

Those arguments apparently won over the president and became part of a $2.8 billion science and technology initiative that Clinton unveiled last month in a speech at the California Institute of Technology in Pasadena. For NSF, it translated into a $320 million boost for such fields as chemistry and mathematics, whose growth has lagged behind those areas addressed by the new initiatives. "We have not been effective advocates for our discipline," says Philippe Tondeur, head of NSF's division of mathematics, where the median grant size is a minuscule $29,000. Mathematicians made a conscious decision many years ago to hold down the size of grants so that more researchers could be funded, he says, but at great cost—halving the normal 2 months' summer salary and stripping out support for most undergraduates, graduate students, and postdoctoral fellows. "It has not been a good strategy," he admits. "When you look at the pipeline, you see a disaster looming."

But while NSF program managers welcome the boost for core disciplines, the increase also revives the perennial debate about how to balance bigger grants with a desire to fund as many people as possible. "The message is, 'Support the core,' " says Mary Clutter, head of the biology directorate, where the average grant has risen from $80,000 to nearly $100,000 in the past few years. "We're committed to increasing grant size, and hopefully our success rate [about 27%] won't suffer too much." But she admits that it's not easy to sell the idea to the community: "They figure that some money is better than no money." She says she's "thrilled" that the choices may not be so stark in this budget.

A 17% budget increase may allow NSF to do both. But there are still limits. The boost for the core disciplines required small cuts in NSF's request for its special initiatives, although all have emerged with healthy increases. Spending on nanotechnology, to be managed by the engineering directorate, is scheduled to rise from $97 million to $217 million. Information technology, run by the computer sciences directorate, would jump from $517 million to $740 million, and biocomplexity in the environment, now managed by biology, would be boosted from $50 million to $138 million. (These numbers contain some double counting that cannot be sorted out until the

SOURCE: NSF DATA

budget details are released.) The White House also rejected attempts to divert some of the core money into new facilities not already in the budget. Thus, OMB blocked a last-minute NSF push to shoehorn in a $30 million downpayment for an Integrated Ocean Observing System—a $100-million-a-year network of data-gathering and communications instruments—although NSF won $6 million to continue planning it as part of an interagency initiative in the 2002 budget.

NSF has won support for other new starts, however, including the first three of a planned 10 or so high-tech ecological field stations, and the first portion of an ambitious network of instruments to monitor seismic activity across the country. Colwell is also touting a proposed major expansion of an effort to create a dozen or more Centers for Teaching and Learning; by last week, NSF had received 115 letters of interest for the pilot phase. The centers aim to train better math and science teachers and improve the skills of those already in the classroom by involving discipline-based faculty in kindergarten through grade 12 education.

Now that the Administration has spoken, the next steps are up to Congress. NSF supporters take heart from the bipartisan applause by legislators that greeted Clinton's announcement of a science initiative in his State of the Union address last week. But they know that the devil is in the details, and that a lot of political decisions have to fall into place before NSF can get what it needs.

–JEFFREY MERVIS

ASTRONOMY

Signs of MACHOs in a Far-Off Galaxy

For the past 20 years, astronomers have been using a technique called gravitational lensing to study exotic objects from the universe's infancy, such as superluminous quasars many billions of light-years from Earth. A gravitational lens is a massive object, such as a normal galaxy or galaxy cluster, that happens to lie directly in the line of sight between the object of study and Earth, bending and amplifying its light. But in a recent study carried out by Dutch astronomers, the lens itself turned out to be more interesting than the quasar under examination.

The radio signal focused by the lens—a normal spiral galaxy like our own Milky Way but 3.5 billion light-years from Earth—appeared to flicker. This odd behavior, the astronomers believe, is caused by compact, dark objects in a halo surrounding the lensing galaxy. The objects themselves appear to be acting as microlenses, focusing the radio signals as they pass through the line of sight. "To explain our observations, you probably need massive objects like neutron stars or black holes," says Léon Koopmans of the Kapteyn Astronomical Institute in Groningen. If so, it would be the first time that microlensing has spotted such objects—called massive compact halo objects, or MACHOs—in a very distant galaxy.

Koopmans and Ger de Bruyn of the Netherlands Foundation for Research in Astronomy used the Very Large Array radio telescope in Socorro, New Mexico, and the Westerbork Synthesis Radio Telescope in the Netherlands to study radio waves from a distant quasar known as B1600+434. It is located some 6 billion light-years from Earth in the constellation Hercules. The normal galaxy sitting in front of B1600+434 gives the quasar a "split personality": Its gravitational pull bends the radio signals passing through it to produce two images of the quasar.

"The lensing galaxy is a spiral galaxy like our Milky Way, seen exactly edge-on," says Koopmans. The faintest of the two quasar images is produced by radio signals that pass through the star-studded central bulge and disk of the galaxy, while the brighter image is formed by signals that miss the main galaxy altogether and only pass through its outer dark halo. Surprisingly, the image seen through the galaxy's halo displays extremely fast variations in its brightness. "The radio brightness varies wildly, by as much as 10% in a few weeks," says Koopmans. The other image remains relatively quiet, however.

Double vision. A normal spiral galaxy (upper right) focuses two images of quasar B1600+434 behind it.

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In a paper submitted to *Astronomy & Astrophysics*, Koopmans and De Bruyn attribute the flickerings to additional lensing by isolated dark objects in the galaxy's halo: The gravity of a compact object passing between the distant radio source and Earth produces short-lived brightness variations. The second image shows no sign of such flickering, they argue, because there are so many microlensing stars in the galaxy's bulge that the sharp peaks are smoothed out.

If they are right, these observations strengthen the idea that MACHOs account for some of the universe's unseen "missing mass." Our own Milky Way galaxy is endowed with a similar dark halo, which, according to gravitational studies, must contain a lot of dark matter, but no one is quite sure what form it takes. Microlensing studies at optical wavelengths have turned up tantalizing evidence for MACHOs in the Milky Way's halo (*Science*, 7 January, pp. 67 and 74); now Koopmans and De Bruyn may have spotted them in a similar spiral galaxy.

"This sounds very interesting," says gravitational lens pioneer Anthony Tyson of Bell Laboratories, operated by Lucent Technologies in Murray Hill, New Jersey. "It could certainly give information on the compact forms of dark matter in galaxy halos." However, he says, some theorists have proposed that a major part of the dark matter in the universe might consist of a diffuse gas of exotic elementary particles, which the microlensing technique would not be able to detect. Since they submitted their paper, Koopmans and De Bruyn have observed even stronger flickerings in B1600+434, up to 30% in less than a month. These results will be presented later this month at a microlens conference in Cape Town, South Africa. "Originally, we derived a lower limit for the mass of the microlensing objects of about half a solar mass," says Koopmans, "but this may be too conservative. To explain variations of 30%, you probably need objects that are much more massive, like stellar black holes."

–GOVERT SCHILLING

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