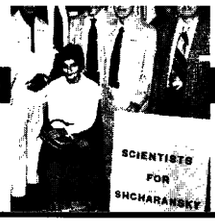


Speaker Newt Gingrich (R–GA), among others, raising doubts about whether Congress would back the plan. "Everyone except the White House appears to have woken to the reality that it is time to change the program," claims one Republican staffer.

Indeed, one NASA official wonders if the new agreement marks the end of Russia's major role in the space station project. "It certainly sends the signal that, rather than a partner, they are more like a hired hand," he says. But Russian Space Agency spokesperson Sergey Gorbunov says that's not the case. "NASA is just renting some space [from us]," he says. **–DAVID MALAKOFF**

With reporting by Elena Savelyeva in Russia.

PHOTONICS

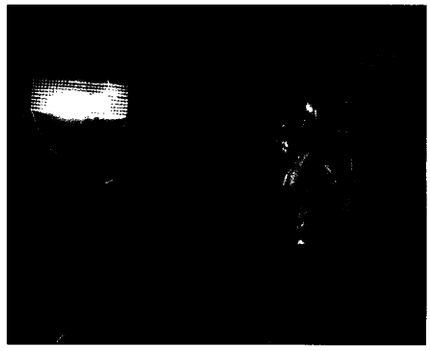
Optical Circuits Turn a Corner

The ultimate aim of today's telecommunications researchers is to quit dealing with electricity. Communication systems already zip messages across the globe via satellite as microwaves or through optical fibers as infrared light, but at either end of such transmissions the messages must be converted into electrical signals and passed through electronic circuits—a process that slows them down considerably. The solution is to develop circuits that can process the infrared or microwave signals directly. On page 274 of this issue of *Science*, a team of researchers from Sandia National Laboratories in Albuquerque, New Mexico, and the Massachusetts Institute of Technology (MIT) describe a crucial element of such optical circuits: an artificial structure called a photonic crystal that can transmit light with minimal loss and make it turn a corner.

Photonic crystals manipulate light in much the same way as semiconductor chips manipulate electricity. But the tiny components of a photonic circuit need to be wired together, and existing technology, such as fiber optics, is too crude, worse than joining the rooms of your house with a 12-lane freeway. "This experiment models the future wiring" of tomorrow's optical microcircuits, says photonic crystal pioneer Eli Yablonovitch of the University of California, Los Angeles. "I think it could really revolutionize the way that we are making optical circuits," says Katie Hall of Lincoln Laboratory in Lexington, Massachusetts.

The key feature of photonic crystals, which were first demonstrated by Yablonovitch in 1991, is a repeating pattern of reflective elements, spaced at roughly the wavelength of the light or other electromagnetic waves to be manipulated. The Sandia experimenters, led by Shawn-Yu Lin, made a photonic crystal from columns of alumina, or aluminum oxide, each a half-millimeter in diameter, set in a grid. Their spacing, about a millimeter apart, enabled the array to manipulate electromagnetic waves of millimeter wavelength, somewhere between the microwave and infrared parts of the spectrum.

At the surface of each column, part of each wave is reflected and part passes through. "The multiple reflections create a range of frequencies for which the propagation of electromagnetic waves is not allowed inside the crystal," says team member Pierre Villeneuve of MIT. The photonic crystal's repeating pattern causes the reflected waves to superimpose out of step, so that peak meets trough and they cancel out. "There's destructive interference between all the different waves that bounce back and forth," says Villeneuve. Exactly which waves have the correct frequency to re-



Guiding light. Sandia's Shawn-Yu Lin holds a photonic crystal.

bound around the crystal and cancel out is determined by the diameter of the rods and the spacing between them.

Although they work beautifully as filters, photonic crystals get really interesting when you add defects—in the case of the Sandia-MIT work, a missing row of alumina columns—which can support a wave otherwise banned from the crystal interior. This offers the prospect of micromanaging light within the body of the crystal. "If you open up a channel in that photonic crystal ... the light's going to follow the small channel you've carved out," says Villeneuve. Lin and fellow Sandia experimenters Edmund Chow and Vince Hietala found that they could pass millimeter waves along the missing row of alumina columns with virtually no loss.

MIT theorists led by team member John Joannopoulos had predicted that under the right circumstances, waves would turn a corner from one such corridor into a second. When the researchers added a second corridor at right angles to the first, they found that they could get waves to do just that, cornering in a distance roughly equal to their wavelength. Reproduced at higher frequencies, this bending would mean that infrared waves—of interest to the telecommunications world—could turn through 90 degrees in about a micrometer, 1000 times tighter than anything possible using optical fibers.

The team's eventual aim is to integrate numerous components, such as waveguides, filters, light sources, and modulators, onto a single photonic crystal. The challenge, however, is manufacturing such chips, because the pillars of an infrared photonic crystal have to be fashioned accurately on a scale of micrometers. The necessary size reduction is "pretty tricky," says Hall. But Villeneuve says light-bending photonic crystals are already in sight: "The first samples at 1.5 microns, which is the telecommunications wavelength, have been fabricated: They are waiting on Shawn's [Lin's] desk ready to be tested." **–ANDREW WATSON**

Andrew Watson is a free-lance science writer in Norwich, U.K.

SPAIN

R&D Budget Request Reverses Long Decline

MADRID—In an effort to invigorate its poorly funded science community, Spain's conservative Popular Party government this week announced plans to ask for a major increase in research funding in the 1999 budget. Currently, Spain spends just 0.8% of its gross domestic product (GDP) on research and development, placing it firmly in the bottom tier of European research spending. Observers expect parliament—in which the Popular Party has an overall majority—to approve the increase by the end of the year.

Excluding military programs, the research portfolio will go up about 8%, to $1.8 billion. The government has cited biotechnology and medical research as priority areas for a cash infusion, but it says

CREDIT: RANDY MONTOYA/SANDIA NATIONAL LABORATORIES

other fields—including marine biology, energy, and transportation—will also receive special treatment.

Huge increases in research spending during the 1980s under the former Socialist government pushed government funding for R&D to 0.9% of GDP in 1992. Since then, Spain's economy has faltered, and R&D funding has stagnated or slipped slightly each year. "We are quite behind other developed countries," says Jesús Avila, a researcher at the Center for Molecular Biology in Madrid. Researchers hope that the 1999 budget will reverse this trend and bring Spain nearer to the European Union average of 1.9% of GDP. "We must continue this trend," says Fernando Aldana, director of the Office of Science and Technology in Madrid, which oversees distribution of the government's science funds and authored the R&D request. "Spain can only achieve competitiveness through the sustainable growth of the investment in R&D."

The main concern among researchers is to find work for the large numbers of young scientists who were trained during the Socialist-led science boom in the 1980s and cannot now find permanent positions or get adequate funding (*Science*, 20 March, p. 1844). "The big groups have money, but the new ones—some of them very good—must be funded to avoid a disastrous situation in the future," says Avila.

–ALICIA RIVERA

Alicia Rivera is a science writer in Madrid.

U.S. R&D BUDGET

Three Spending Bills Bolster Research

Congress last week sent a mostly upbeat message to researchers that it is ready to give basic science a fresh infusion of cash for the 1999 fiscal year, which officially began on 1 October. It put the finishing touches on a trio of spending bills that would give the National Science Foundation (NSF) a 7% increase, science spending at the Department of Energy (DOE) a 10% boost, and basic research at the Department of Defense a 6% rise. "We're delighted," says DOE science chief Martha Krebs, echoing reaction from the research community to the new spending levels.

The numbers were hammered out by House-Senate conference committees that negotiated compromises between different versions of the bills passed by each chamber, and in some cases have already been approved by both bodies. Not all of the research agencies covered by the bills were lifted by the rising tide, however. NASA and the Environmental Protection Agency (EPA), for example, received essentially flat science budgets from House and Senate conferees. And as *Science* went to press, Congress had not yet decided what to do with three other key funding bills—including one that could give the National Institutes of Health a double-digit increase—that have become mired in election-year politicking.

White House officials say President Clinton is likely to sign the bills that emerged last week, once Congress has completed its work. Here are some highlights:

• **NSF:** Officials are very happy with the conferees' 7% solution to their $3.67 billion budget and the relatively free hand it gives them. The 8.8% increase in the research account, to $2.77 billion, is less than the Administration's 12% request, but it allows for healthy growth in programs ranging from human-computer interactions to life in extreme environments. Legislators agreed to drop proposed Senate earmarks for several research centers, although they directed NSF to spend $22 million more than it requested to support Arctic research and added $10 million to the $40 million plant genome initiative begun last year by congressional directive. They also added $10 million to a $38 million program to help 18 "have-not" states as part of a broader concern for schools outside the top 100 grant recipients.

Congress was more specific about how it would like NSF's $663 million education and training directorate to grow. It boosted the directorate's budget by $30 million, but told NSF to spend $13.5 million of the increase on two programs to increase minority participation in science and $10 million on informal science education. On major facilities, legislators once again ignored NSF's request for $21 million for a Polar Cap Observatory in Canada, although they tacked $17 million onto NSF's request for $22 million to nearly complete financing of its $145 million renovation of the South Pole station.

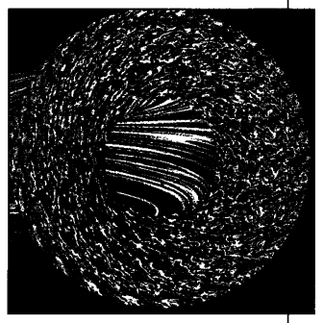
• **DOE:** Legislators not only gave DOE's science programs a $217 million boost, to $2.7 billion, but also moved fusion energy from its politically exposed position as a separate budget item into a new four-division Office of Science covering existing energy research programs. Krebs says the change, which also added $1.6 million to the Administration's request for fusion, reflects DOE's success in retooling the $223 million fusion program to emphasize university research rather than technology demonstration. The new office's $809 million Basic Energy Sciences account includes a $130 million boost to begin construction of the Spallation Neutron Source, a $1.3 billion facility scheduled to open in 2005 at Oak Ridge National Laboratory in

ScienceScope

TURN OUT THE LIGHTS, THE ITER'S OVER

The U.S. Department of Energy is recalling its fusion scientists from their posts in Germany and Japan, where they have spent the last 3 years working on the moribund International Thermonuclear Experimental Reactor (ITER). Congress ended U.S. contributions to the $10 billion project last week (see p. 210), prompting DOE to order more than a dozen scientists back to their home institutions by 16 November. The recall completes a withdrawal begun in July, when it became clear that Congress wouldn't provide enough money to support the 36 U.S. researchers assigned to the project.

The retreat "has created a pretty depressed mood here," says physicist Ron Parker, who will be leaving his post at the ITER site in Garching, Germany, to return to the Massachusetts Institute of Technology. He calls Congress' decision to pull out "completely destructive. But at some point you have to put disappointment behind you and move on to new challenges."



ITER won't get the chance to test this simulation of tokamak turbulence.

CHEMIST TAPPED TO HEAD GENOMICS INSTITUTE

The Swiss life sciences giant Novartis is expected to name University of California, Berkeley, chemist Peter Schultz as the director of its new Novartis Institute for Functional Genomics. Last spring, the company announced that its philanthropic arm—the Novartis Research Foundation—would spend $250 million over 10 years to bankroll the San Diego–based institute. The center is expected to hire some 100 researchers to sort out the function of newly discovered genes as a basis for new drugs.

Schultz has pioneered the use of techniques such as combinatorial chemistry and DNA chips for drug development. His appointment is "a good hire for Novartis and a tough break for Berkeley," says Harvard University biologist Tim Mitchison. "He's not someone to let anything stand in his way."

CREDIT: R. E. WALTZ AND G. D. KERBEL/NUMERICAL TOKAMAK PROJECT