several millimeters' length available from circular accelerators. Linacs can also produce narrower beams because the electrons are not following a curved path, where the emission of photons causes the beam to widen. "The beam size decreases linearly with energy in a linac," says Rossbach, "while it increases quadratically with the energy in a storage ring."

Dedicated linacs for the x-ray community will become available in some 15 years, predicts David Moncton, director of the Advanced Photon Source at Argonne (Illinois) National Laboratory, which started test runs last year (*Science*, 31 March 1995, p. 1904). Moncton foresees superconducting linacs that will "fan out the beam through a switchyard" to as many as 50 free-electron lasers running in parallel (see drawing).

The FELs, which would convert the electrons' energy into x-rays, also play an important role. Like present-day wigglers and undulators, FELs send an electron beam through a series of hundreds of magnets with alternating polarities. But their brilliance is expected to be several orders of magnitude higher because of the amplifying effect of stimulated emission, in which each x-ray photon triggers the emission of the next, resulting in a burst of coherent radiation.

FELs, however, are also the big holdup in this effort to straighten out storage rings. Current designs have mirrors at both ends to increase the radiation intensity in the device so that stimulated emission becomes possible. But x-ray scientists would like to dispense with the mirrors. "At these wavelengths, mirrors reflect badly and cannot deal with the intensity of the radiation," explains Luijckx.

To solve that problem, researchers hope to obtain stimulated emission during one pass by bunching the electrons sufficiently through a principle known as SASE (Self-Amplified Spontaneous Emission). "[SASE] would solve a lot of problems," says Luijckx. But the SASE has not yet been demonstrated experimentally at short wavelengths, although two test linacs are now under construction at DESY to test the principle. "In general the theorists agree that it will work," says DESY's Gerhard Materlik. "Now we have to test it."

Because of these barriers, Moncton believes circular machines "will be the x-ray servers for the next 20 years. We have to do 5 years of R&D on linacs and FELs to see how happy we are with their performance before we make any decisions." But users are already preparing for the day when they can go straight. "We are running workshops to find out what really will happen at these huge peak brilliances and femtosecond pulses," says Materlik. "This is opening up a completely new horizon."

–Alexander Hellemans

Alexander Hellemans is a writer in Amsterdam.

MEETING BRIEFS

Heavy Hitters Anchor the AAAS Lineup at Annual Meeting

BALTIMORE—Within a few short blocks of this city's baseball stadium, U.S. Vice President Al Gore came out swinging in his speech at the Annual Meeting and Science Innovation Exposition of the American Association for the Advancement of Science (AAAS, the publisher of *Science*). At the gathering, held from 8 to 13 February, Gore had choice words about political opponents and their support of science; we cover that and other notable presentations here. An additional story, on biological clock research presented at the meeting, starts on page 905. Coverage of later sessions will appear next week.

Gore Courts and Exhorts

While Republican presidential hopefuls made last-minute pitches to Iowa voters as that state kicked off the 1996 U.S. primary season, U.S. Vice President Al Gore was busy wooing the scientific community. In a 12 February speech at the AAAS meeting—the first of three talks this week on science and technology—Gore derided the Republican Congress for opposing research and pleaded to see more "white lab coats of American scientists" on Capitol Hill.

AP/WIDE WORLD PHOTOS

Rallying cry. U.S. Vice President Al Gore called for scientists to get more involved in politics.

Gore also challenged researchers to build better bridges among disciplines and with society (see accompanying story). But he saved his strongest language for House Republicans who oppose Administration policies on environmental research and applied technology programs. With the exception of boosting funding for the National Institutes of Health, Gore said House members "were approaching science with the wisdom of a potted plant" and supporting "a science policy straight out of science fiction."

The audience seemed pleased with the message, laughing at Gore's references to Republican statements criticizing atmospheric research, and gave him a standing ovation. "A lot of people here are worried about what's going on" in Washington, says Al Teich, who directs policy at the AAAS. "This adds to the chorus of people" calling for the community to take a more activist approach in defending research budgets. Republicans, however, told *Science* after the speech that Gore was merely trying to score political points. Representative Robert Walker (R–PA), who chairs the House Science Committee, dismissed the talk, saying that "scientists are smart enough to recognize when they are being used in a game of politics."

Gore maintains that scientists can play a larger role in educating politicians. "Walk through the halls and you will see the Gucci loafers of corporate lobbyists," but few people clothed in scientific garb, Gore said. "Page through a directory of members of Congress and you will find over 150 lawyers, but only six scientists, two engineers, and one science teacher among the 535 people in the House and Senate."

That is not wholly a partisan view. Thomas Weimer, Republican staff director of the House Science Committee's basic research panel, told a weekend session on the current Congress that "we must be aware that there is a real education problem with" newer House members, few of whom have a scientific or technical background. But Weimer notes that the House moderated its stance on R&D cuts over the past year, and he rejects the Administration's contention that Republicans intend to gut government R&D. The biggest difference in the long-term budget plans of the two parties, he says, is the pace of the reductions: The Republican plan would do it gradually over 7 years, while the Administration has delayed most of its cuts until early in the next century.

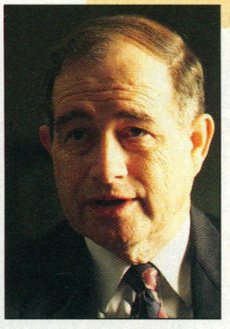
Gore, however, insists there are major differences between the White House and Congress on science and technology issues, and he used his speech to drive home the point. He cited a host of legislative accomplishments that demonstrate the Administration's commitment to science, from stronger patent protection for inventors to higher funding for some research agencies. And he exhorted scientists to "enlist in the army of persuasion whose battle cry says knowledge is important for knowledge's own sake." But

that battle cry has been sounded before, and despite enthusiastic murmurings among the ranks, the white coats have yet to storm Capitol Hill.

–Andrew Lawler

Wanted: Citizen-Scientists

Neal Lane, the director of the National Science Foundation (NSF), is looking for "civic scientists" who will get out of the lab and build upon the public's fascination with the natural world, putting research higher on society's agenda. Representative Robert Walker (R–PA), the chair of the House Science Committee, would settle for a few scientists blunt enough to tell Congress that some research projects are more valuable than others. Speaking on consecutive nights at this week's annual meeting, the two men called for a shift in the culture of science that could help the community cope with hard times. But the discussion that followed suggested that they may be asking for a lot.



CATHALEEN CURTISS

The current squeeze on federal research dollars is an unwise "experiment," Lane said, but scientists can't blame it entirely on politicians. "The public likes science, but do scientists like the public?" he wondered, suggesting that scientists have failed to convey the value of their work to the voters who choose those politicians. And while the current U.S. university system rewards excellence in the lab, he said, it doesn't show the same appreciation for efforts to improve scientific literacy. Public outreach, for example, rarely figures in tenure decisions, and it takes time away from the research activities that count most heavily. But "scientists are the only genuinely credible people to deliver the message," Lane said. "At the very least, providing support to your colleagues who do take on this noble challenge would be an important contribution in itself."

Judging from audience responses, that support may be hard to rally. One scientist asked if Lane would defend her civic work when she came up for tenure, while another wondered if NSF had any programs to fund individuals engaged in such activities. Responding to the first question, Lane urged faculty senates to put the issue on their agendas. And he told the second questioner that NSF's $35 million a year budget for informal public education—museums, television, and the like—is only a small part of what is needed. Scientists, he said, must not expect the government to finance their outreach efforts.

Researchers must also change their attitude toward setting spending priorities, said Walker. Speaking on a panel about congressional science policy, he noted that scientists now offer little help to Congress in this area, yet complain when Congress is forced to make its own judgments. "We are considered unqualified to set priorities, so we urge scientists to help us," Walker said. "But their answer is usually a well-worded, 'They're all good and they all should be funded.' That's not good enough." This year, he said, Congress stepped into the advice vacuum by drawing up its own priorities, only to be roundly criticized for cutting such initiatives as the Advanced Technology Program even as it tried to protect basic research.

"The public likes science, but do scientists like the public?"

—Neal Lane

Another panel member, presidential science adviser John Gibbons, took a more optimistic view of the community's ability to set priorities, noting a "remarkable" shift in attitude over the past 3 years "from an assumption of steady growth to a steady state. ... I'm not discouraged." After all, he noted, you have to recognize the problem before you can do something about it.

–Jeffrey Mervis

Probing Primate Morality

Humans have been called "the moral animal," but where did that morality come from? If primatologist Frans de Waal of Emory University is right, it could have come from our nonhuman primate past. At the AAAS meeting, de Waal presented data on chimpanzees and macaques indicating that these primates develop a sense of what is "right" and "wrong" in their community, particularly about sharing resources such as food. They also punish rule breakers and learn to mediate social conflicts. These behaviors, he says, are rudimentary forms of our own ethical and moral reasoning.

Others feel the work is provocative, but speculative. "Interesting!" says primatologist Richard Byrne of St. Andrews University, in Scotland. "To my mind, ethics and morality can only begin when one can conceive how other individuals feel, what they might want, what they (perhaps falsely) believe." Apes do seem to have empathy for the feelings of others, Byrne says, but demonstrating how this evolved into abstract morality is a hard task.

Indeed, de Waal, who studies animals at the Yerkes Primate Center in Atlanta, agrees that human morality is more abstract than anything chimps produce, involving "a value system that makes us decide what we accept and what we don't accept." But, he maintains, primate social rule-keeping resembles human conduct in other ways. Many of these rules involve reciprocity over food-sharing; this, he suggests, may have laid the foundation for other forms of social cooperation, including the human sense of social equity.

Researchers at Yerkes run experiments in which they gather leaves, tie them into bundles, and turn them over to a group of hungry chimps. Rather than fight, the chimps share the food in an intricate pattern of behavior. The individuals who share generously are repaid with easily obtained shares of food at other times, while some tentative new data show that those who are stingy are more likely to be "aggressively rebuffed" when they seek food during later meals. This reciprocity has multiple currencies, de Waal notes—grooming and sex are other forms that can be exchanged. The principle: If I groom you in the morning, you share food with me in the afternoon.

Not all rules enforced by chimps are devised by them, de Waal pointed out. At Yerkes, for example, the human keepers decided to minimize chaos and competition by feeding the chimps only after the entire group gathered together. One day, two adolescent females were slow to come in from a play island, delaying dinner for the entire group. That evening, the community gave the two laggards a beating. At dinner time the next day, de Waal said, those adolescents were the first chimps to come off the island. Such examples of reciprocity and punishment for breaking the group code, de Waal says, are more prevalent among primates with more complex social organizations. It's rarely seen among rhesus monkeys, for example, but much more common among the chimps.

If reciprocity is one pillar in this system of community order, the other pillar is a pattern that de Waal labels "consolation behavior." It is "very common," he said, to see a young member of the chimpanzee group rush up to an older member who has been defeated in a fight and put an arm around the unhappy elder's shoulder. Consolation behavior, de Waal said, has only been observed among chimps, gorillas, and orangutans; it hasn't been seen among monkeys. He added: "I think that this kind of behavior may only be possible in species that have reached a certain level of development." Reciprocity, in contrast, seems to fall along a gradation. In de Waal's scheme, evolution has created a spectrum of social behaviors from rudimentary forms (as in the rhesus) to the complex. Proving the reality of that spectrum, however, will be complicated as well.

–Eliot Marshall