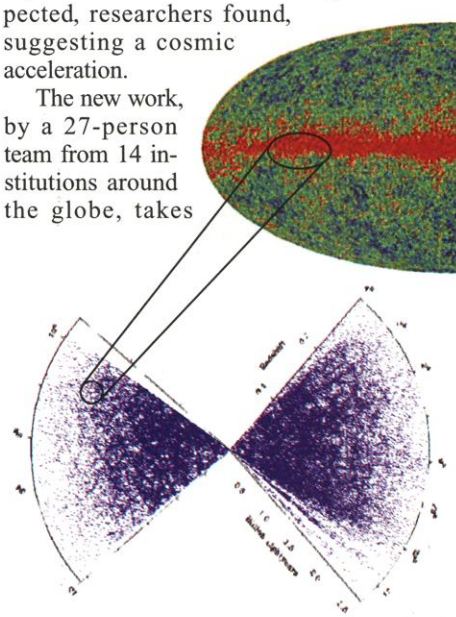
known brightness—and then calculate its velocity by measuring how much the redshift "stretches" its light as it traverses the universe. The 1998 announcements that the universe's expansion is speeding up (*Science*, 30 January 1998, p. 651) relied on this technique, using exploding stars dubbed type IA supernovae as standard candles. Distant supernovae recede more slowly than expected, researchers found, suggesting a cosmic acceleration.

The new work, by a 27-person team from 14 institutions around the globe, takes the alternative route. "We have used a 'standard ruler' test," says George Efstathiou of the Institute of Astronomy in Cambridge, who led the study. By starting with something of known size, he explains, cosmologists can calculate how much matter the universe must contain to make it appear the way astronomers see it from Earth.



Cosmic recipe. Linking microwave ripples (*top*) to galaxy clusters revealed "dark energy."

The researchers used an esoteric ruler: the size of the lumpiness of the universe. They started relatively close to home, by calculating the variations in clustering within a huge swarm of galaxies surveyed by the Anglo-Australian Observatory in Siding Spring, Australia—the so-called Two Degree Field Galaxy Redshift Survey (2dFGRS). This lumpiness, says Efstathiou, can be traced all the way back to the ripples in the afterglow of the big bang, the cosmic microwave radiation. In recent years, balloon-borne and ground-based detectors have given scientists a good look at those ripples in patches of the sky (*Science*, 28 April 2000, p. 595; 22 June 2001, p. 2236).

"The cosmic microwave background gives us a picture on the sky of the fluctuations as they were when the universe was 400,000 years old," says Efstathiou. "So the test is, we have a three-dimensional picture of the present day, and we can compare it with the angular picture at 400,000 years." Working from that information, the team calculated how much matter must be sprinkled through the cosmos to transform the primordial ripples into multigalactic clumps as the universe aged.

The results, published in the *Monthly Notices of the Royal Astronomical Society*, confirm earlier findings that the universe is geometrically flat, or subject to the rules of Euclid on a large scale. More important, there is not enough matter to create that flatness. Taken together, the ordinary matter that astronomers can observe and the so-called dark matter that they infer from the pull of its gravity provide just a third of the energy required for a flat universe. It's the Enron problem, says Tegmark: "Most of the budget is missing." The budget deficit, the remaining two-thirds, is what cosmologists call dark energy.

"What we are measuring is the energy associated with empty space," says Efstathiou. And some features of that energy, Tegmark says, are "really weird." For example, whereas ordinary matter pulls on other matter and attempts to reign in the expansion of the universe, "dark energy has this strange property that it's essentially repulsive, so that it pushes everything away and makes the universe accelerate faster and faster."

The new study gives a valuable boost to the earlier results based on supernovae, says Paul Steinhardt, a cosmologist at Princeton University in New Jersey. "We are uncertain how reliable type IA supernovae are as standard candles when you talk about supernovae that exploded a long, long time ago," he says. The strategy used by Efstathiou and his colleagues "is much more secure since we have many cross-checks, [although] it is more indirect and less intuitive," says Steinhardt. Crucially, Tegmark says, the new study "finds the same amount of dark energy as the supernova analysis did, but in a completely independent way." In an online paper (xxx.lanl.gov/abs/astro-ph/0105091) scheduled to appear in *Physical Review D*, Tegmark and two colleagues provide further backing with a similar study based on a different, smaller galaxy survey.

Even so, Tegmark says, the case for acceleration fueled by dark energy "certainly hasn't been established beyond any reasonable doubt." Turok agrees. Data from the forthcoming MAP and Planck satellites and the million-galaxy Sloan Digital Sky Survey should help firm up the case and enable cosmologists to check out some of the assumptions underlying these tests.

–ANDREW WATSON

Andrew Watson is a writer in Norwich, U.K.

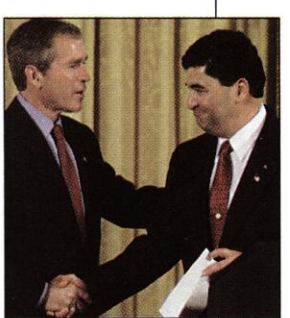
CREDITS: (TOP TO BOTTOM) MSFC/NASA AND 2DFGRS; RON EDMONDS/AP

ScienceScope

Making It Official In a packed East Room ceremony, President George W. Bush this week formally introduced his pick to head the National Institutes of Health (NIH). As expected, it is radiologist Elias Zerhouni (below, right). Executive Vice dean for research at Johns Hopkins University School of Medicine in Baltimore, where he has spent most of the past 27 years, Zerhouni is also known for his entrepreneurial bent, having invented a new MRI technique and co-founded a company to develop it (*Science*, 15 March, p. 1988).

Bush said that Zerhouni is "well prepared" to manage NIH as it completes a 5-year doubling of its budget to $27.3 billion and takes on "urgent" biodefense efforts. The president also indirectly raised the stem cell debate, saying that Zerhouni "shares my view that human life is precious and should not be exploited or destroyed for the benefits of others ... [and] that the promise of ethically conducted medical research is limitless."

Zerhouni made no reference to the stem cell controversy, saying only that as an Algerian immigrant 27 years ago, he "could never have dreamed of" the nomination, and that "I will do my very best to advance the noble mission of the NIH."



Bush also announced his pick for U.S. Surgeon General: Richard Carmona, a trauma surgeon and professor at the University of Arizona in Tucson. Both nominations are now subject to Senate confirmation.

Stem Cells United Stem cell researchers are organizing in a bid to influence political and ethical debates over their hot new field. Last week, they announced the creation of the International Society of Stem Cell Research at a symposium in Keystone, Colorado.

Leonard Zon of Children's Hospital Boston will lead the new society. Board members include Irving Weissman of Stanford University in Palo Alto, California, and Douglas Melton of Harvard University. Zon says the group will offer advice on clinical trials of new stem cell therapies and weigh in on hot topics such as human therapeutic cloning, which is expected to be the subject of a Senate vote next month. The society plans to hold its first annual meeting late next year (see www.isscr.org).

in a deterministic way."

It's too early to tell what effect the slow earthquakes might have on the risk of a blockbuster shakeup. Each slow event reduces strain locally but not in the locked zone, which is where the big ones break out. The slow earthquakes do have a menacing potential, Dragert warns. "Just as a taut violin string is more likely to snap during sudden rapid tightening," Dragert says, the locked zone—if close to critical threshold—might rupture when loaded with stress from a slow earthquake. This suggests that the likelihood of a major event may increase during slow-earthquake season.

But the CWU team points out that a large number of slow temblors may take place between each 500-year great quake. This makes it unlikely that any single slow earthquake is going to be a meaningful precursor. "I'm not convinced that they're a harbinger of disaster," Miller says. All agree, however, that slow earthquakes are likely to reveal more about how plate boundaries work.

Miller's team believes the regularity implies that slow earthquakes are a basic way that strain is relieved in this subduction zone. Continuous GPS observations are revealing similar, individual events at other subduction zones, such as Japan and Peru, Miller notes. (Other experts say they'd like to see more examples of periodicity from around the world before calling the mechanism fundamental.)

To learn more, Miller's team is exploring collaborations that would set down denser arrays of GPS stations with seismometers, strainmeters, and other instruments before a slow earthquake is scheduled to begin. And as continuous GPS networks become more common and more accurate in other parts of the world, the pace will be anything but slow.

–ERIK STOKSTAD

ENVIRONMENTAL FELLOWSHIPS

Will Congress Catch EPA's Falling STAR?

The U.S. Environmental Protection Agency (EPA) has pulled the plug on a popular, one-of-a-kind graduate fellowship program in the environmental sciences. This year, the program drew applications from about 1400 environmental science and engineering students, who now must scramble to find other support.

Agency officials say the move, announced recently on the agency's Web site (es.epa.gov/ncer), responds to a presidential proposal to end the $10-million-a-year program this fall. An EPA official familiar with the fellowship program, called Science to Achieve Results (STAR), says the agency is "being a good soldier" in assuming that Congress would concur with the president's 2003 budget request and zero out the program.

Supporting role. Granger Morgan says fellowships bolster EPA's "science-based" rules.

Awards for the 2002–03 academic year were due to be announced next month. But rather than making a commitment it might not be able to honor, the official said, EPA will instead send back reviewers' comments and suggest that students look for other sources of funding. The money saved in the 2002 budget will be doled out as needed to complete the multiyear awards for 211 current fellows.

Environmental groups are beginning to rally support for the program, pointing out that last year EPA director Christine Todd Whitman told Congress it "continues to successfully engage the best academic environmental scientists and engineers." The program is also important for the field, says David Blockstein, head of the National Council for Science and the Environment. "If the STAR fellowships end, there will be no dedicated funds for graduate fellowships in the environmental sciences." The demand greatly exceeds the supply, he adds: "Based on my experience as a reviewer, EPA could double the number of awards without diluting the quality."

Terminating the STAR graduate fellowships would undermine EPA's efforts to improve the scientific basis of its regulations, says Granger Morgan, head of the department of engineering and public policy at Carnegie Mellon University (CMU) in Pittsburgh, Pennsylvania, which has had several fellows. "It's been very important in funding top-flight students," he says, adding that the fellows also develop a relationship with EPA and a better understanding of its mission. "If you want science-based regulation, then you need to invest in the people to do it," Morgan says.

In addition to tuition support, the fellowships provide students with an annual stipend of $17,000 and research funding of $5000.

CREDIT: (TOP TO BOTTOM) CARNEGIE MELLON UNIVERSITY; P. BAGLA

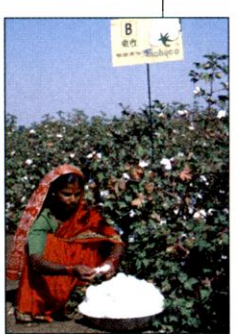
ScienceScope

Pondering Quality A new rule aimed at improving the quality of technical information released by the government could do both good and harm, experts concluded last week at a Washington, D.C., workshop. The data quality rule, issued by the White House Office of Management and Budget on 22 February, requires agencies to rigorously vet data in reports and regulations. It also allows citizens to challenge information that they think is inaccurate (*Science*, 13 July 2001, p. 189).

Legal experts at the National Academy of Sciences (NAS) workshop predicted that the rule's loosely defined call for "objective" review of "influential" information will trigger lawsuits. A business group has already cited the rule in challenging U.S. climate projections, but environmental activists could also use it to question industry data, suggested David Hawkins of the Natural Resources Defense Council.

Academic scientists, meanwhile, worry that they could become entangled by provisions that "third-party" data cited by the government be subject to review. That could be used to harass scientists, marking "the dark side of an otherwise positive development," says Washington, D.C., attorney Fred Anderson, a member of an NAS task force on data quality. Agency proposals for implementing the rule are due 1 April.

India OKs GM Cotton Indian agriculture reached a milestone this week as the government approved the first commercial release of genetically modified (GM) cotton. Farmers have been given a 3-year pass to plant three Bt cotton varieties developed by the Maharashtra Hybrid Seeds Co. (MAHYCO) in Mumbai. Under the new rules, farmers must plant at least 20% of any GM field with non-Bt varieties and surround them with five rows of non-Bt plants. MAHYCO must also report insect resistance and track annual GM seed sales. Monsanto, which imported the *Bt* gene, owns a minority stake in the company.



Some farmers like the promised higher yields, but environmentalists say the government's decision is premature. Pests are "bound to develop resistance," says Devinder Sharma, a food policy analyst with the Forum for Biotechnology and Food Security.

Contributors: Jocelyn Kaiser, Constance Holden, Pallava Bagla