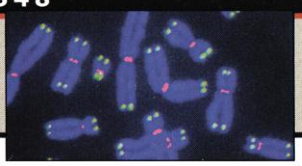
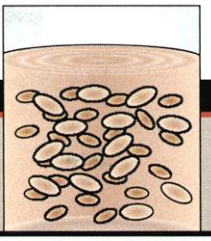


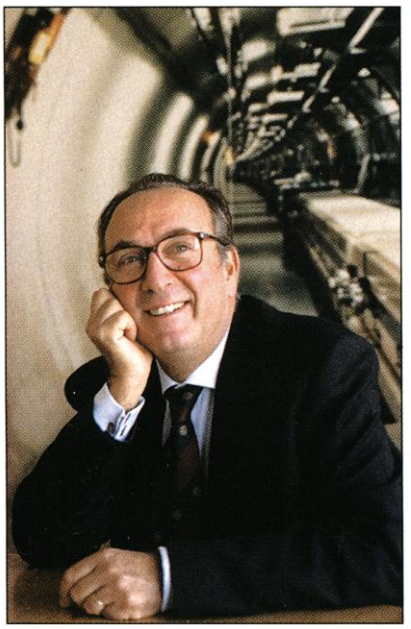


HIGH-ENERGY PHYSICS

Cost Overruns Will Hit Research at CERN

ALLSCHWIL, SWITZERLAND—Last June, CERN, the European particle physics laboratory near Geneva, issued a press release trumpeting "1754 days to the LHC and counting!" Make that at least 2000 days.

To cope with cost overruns on the Large Hadron Collider, CERN managers have drafted a preliminary plan that would delay start-up of the massive proton accelerator until sometime in 2007, slash spending on long-term research programs, and require belt-tightening across the lab. The embryo plan, outlined to CERN's governing council last week, would shift some $300 million from other operations into the LHC and stretch out payments for the facility until 2010.



Tunneling for funds. CERN director-general Luciano Maiani plans to focus the lab's resources on completing the LHC.

CREDIT: CERN

CERN's budget troubles came to light in September, when members of the facility's finance committee learned that the LHC—intended to hunt down an elusive particle called the Higgs boson—would cost about 30% more to build than the originally budgeted $1.6 billion (*Science*, 5 October 2001, p. 29). Excavations, industrial services, and LHC's 1236 "horribly complicated" superconducting magnets share the blame for the cost overruns.

CERN director-general Luciano Maiani had known about a budget shortfall for months but failed to disclose it, a move he has publicly regretted and one that "created an enormous amount of bad feelings," says Walter Hoogland, a scientific delegate to the governing council from the Netherlands. Seeking to reassure CERN's overseers, Maiani in December announced the formation of five internal task forces to look for efficiencies. An external review committee (ERC) was also set up to assess the LHC and CERN's other research programs in light of the LHC funding needs.

According to delegates present at last week's closed-door sessions, the good news from the ERC's early deliberations is that the committee sees no technical problems that would prevent delivery of the LHC. On the negative side, says Ian Halliday, chief executive of the United Kingdom's Particle Physics and Astronomy Research Council, the ERC is not yet persuaded that CERN is sufficiently focused. "CERN really needs to be seen to be finding credible solutions by June," when the governing council next meets and the ERC presents its final report, Halliday told *Science*. (Maiani was not available for comment last week.)

Even before the projected $510 million shortfall on the LHC came to light, CERN was coping with cutbacks required by member states when they approved the LHC in 1996. They include a substantial drop in member contributions and a staff reduction of one-third, from 3000 to 2000, a number that will be reached in 2006.

To help in the current crisis, the Swiss delegation has offered to advance $54 million over 3 years, to be deducted from later contributions. According to CERN spokesperson James Gillies, another $300 million can be saved by "cutting back very drastically on long-term research and development" as well as smaller research activities, and by slashing costs such as office overheads, support for visiting fellows and associates, and industrial services for infrastructure and installation. Maiani urged the council last week to increase CERN's budget to enable limited research and development to continue, and to speed financing of the LHC, but his plea is unlikely to be heeded.

On the research front, running time at the laboratory's existing proton accelerators will be cut 30% for the foreseeable future. In addition, the superproton synchrotron will be shut down for all of 2005, which in turn will put off the scheduled firing of a neutrino beam 780 kilometers to Gran Sasso, Italy, to 2006. Planning will also be curtailed, although high priority will be given to research and development on the compact linear collider, a "CERN invention," says Roger Cashmore, CERN's director of research, and the "only way to get to very high-energy electron-positron collisions."

Frans Verbeure, a scientific delegate to the council from Belgium, calls the emerging plan a "rather sound proposal." But Daniel Froidevaux, a physicist who has been at CERN for 25 years, says that the situation at the lab is "more difficult than I've ever seen it before." Cashmore is hopeful that the lab will emerge from the turmoil a better, leaner, more effective organization. And, he emphasizes, no one doubts that the LHC will be completed. **–GISELLE WEISS**

Giselle Weiss is a writer in Allschwil, Switzerland.

COSMOLOGY

Cosmic Ripples Confirm Universe Speeding Up

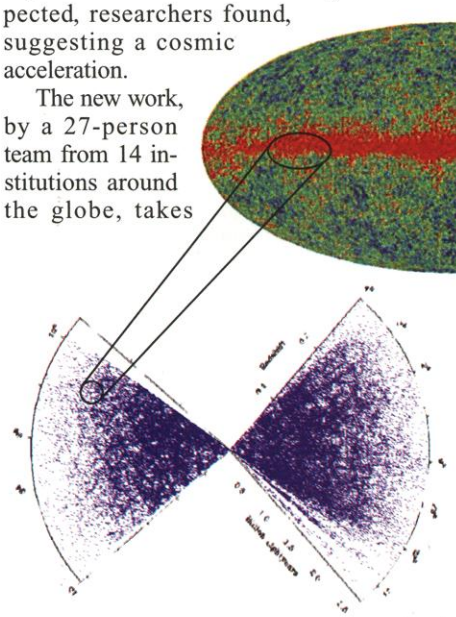
Four years ago, cosmologists astonished their colleagues by announcing that the universe appears to be expanding at ever-increasing speed—and that a mysterious antigravity force must be doing the pushing. Since then, other scientists have scanned space in vain for evidence that the unexpected acceleration might be an illusion. Now an international consortium of astronomers has confirmed the original finding by taking a completely different approach. "A compelling case has been made that the universe is accelerating," says Max Tegmark, a cosmologist at the University of Pennsylvania in Philadelphia.

"This is an important piece of work," says Neil Turok, a cosmologist at the University of Cambridge, U.K. In combination with earlier results, Turok says, the new research adds to the mounting evidence that ordinary matter alone cannot mold space into the geometry that cosmologists believe it has. Instead, many now believe, "dark energy" must be added to the mix—a repulsive force similar to one that Albert Einstein once considered and then forcefully rejected.

The original finding and the new study reflect the two different strategies that scientists use to map the structure and geometry of far-flung corners of the universe. One is to take a "standard candle"—an object of

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.

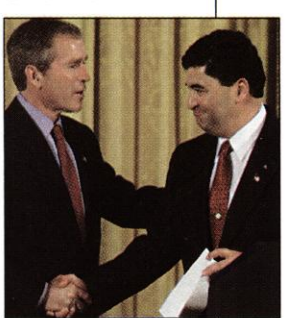
CREDITS: (TOP TO BOTTOM) MSFC/NASA AND 2DFGRS; RON EDMONDS/AP

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).