biotech melting pot to exploit its own genome center, it would consider a site near a different research powerhouse.

Ironically, Wellcome's tribulations at Hinxton come at a time when the U.K. government is promoting the biosciences as critical for the country's economic well-being and employment prospects. The Department of Trade and Industry, for example, is encouraging companies to gather together into biotech "clusters" similar to those in Maryland, North Carolina, and around the Massachusetts Institute of Technology. Urban geographer Alan Wilson of the University of Leeds says updating Britain's dusty planning regulations is crucial for biotech's development. Wilson is part of a team working with Science Minister David Sainsbury to identify ways in which government can help the biotech sector. "It is a shame that these issues are polarized as single planning questions, such as can the village stand an extra thousand houses," he says.

Dexter says he is still trying to arrange a meeting with the council. In the meantime, several cities—both in the United Kingdom and overseas—are eager to attract the prestige and money of the Wellcome Trust and have submitted proposals that the trust is evaluating. "Think about the major genome sequencing centers around the world," says Dexter. "There are some attractive overseas options."

–HELEN GAVAGHAN

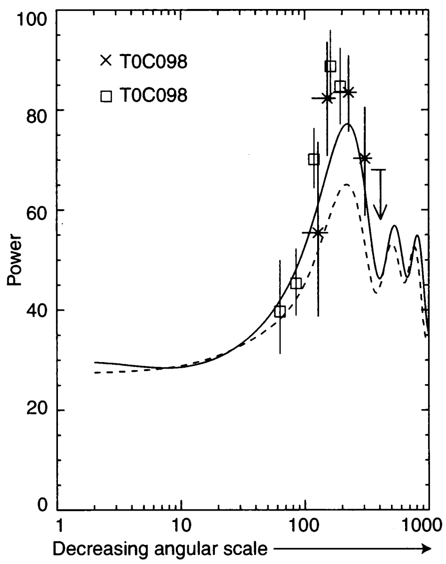
Helen Gavaghan writes from Hebden Bridge, U.K.

COSMOLOGY

Firming Up the Case For a Flat Cosmos

Doing research in modern cosmology is a bit like watching the game show *Wheel of Fortune*. At the beginning, the hidden phrase is impossible to guess, but as Vanna White turns over each letter the answer suddenly becomes blindingly obvious. A long-sought hump in measurements of the universe's faint background radiation, for example, was no more than a hint in earlier observations, but now a telescope high in the Chilean Andes has opened a clear view of it. The discovery, which will be reported in the 10 October *Astrophysical Journal Letters*, confirms a long-standing prediction about the universe's total mass and energy density and hints that a major part of the total may be a mysterious form of energy in empty space.

The "hump" actually measures the coarseness of the ripples imprinted on the cosmic microwave background (CMB) shortly after the big bang. In its first 100,000 years or so, the baby universe was so dense and hot that matter and light behaved like a single fluid, so that fluctuations in the density of the ionized gas created corresponding hot and cold spots in the radiation. But as the universe expanded and the gas cooled, light broke free, or decoupled, from matter. A fossil record of the fluctuations at the time of the decoupling can be seen even today, imprinted on the CMB.



Peak of interest. New measurements from Cerro Toco in Chile reveal the angular size at which cosmic-background fluctuations are most common.

SOURCE: MILLER *ET AL.*

Because cosmologists can calculate the actual size of the most common ripples, their apparent size in the sky reflects the overall shape of space, just as the apparent size of objects seen through a lens depends on the shape of the glass. By measuring the angle at which the fluctuations are most common—the "hump"—cosmologists can trace the geometry of the universe, which is determined by the total amount of energy and matter it contains. Theorists' favorite picture of the big bang implies that the universe contains just enough matter and energy to retain a flat geometry, in which parallel lines always remain parallel, rather than diverging or converging, as they would in "open" or "closed" universes. In a flat universe the hump would fall at an angular size of about 1 degree.

Finding the hump has proved difficult, however, because it requires extremely precise comparisons of the CMB's temperature at different points in the sky. A first glimpse came from two experiments done last year at the South Pole, Viper and Python. Viper showed that the abundance of ripples seemed to increase from 1/6 of a degree up to 1 degree; Python showed it falling on scales larger than 1 degree (*Science*, 1 January, p. 21). But no single experiment covered the entire hump, and cosmologists were concerned that they might be forcing mismatched pieces of the puzzle together. "There are always calibration issues" when the results of different experiments are combined, says Princeton University astrophysicist Amber Miller.

The new measurements by the Microwave Anisotropy Telescope (MAT) team, a collaboration led by Lyman Page of Princeton and Michael Devlin of the University of Pennsylvania, seem to have put that concern to rest. Observing from a dedicated 85-centimeter telescope perched high on the southern slopes of Cerro Toco in northern Chile, the MAT team compared the CMB at different spots in the sky for almost 1200 hours. They found that the abundance of ripples clearly "rises and then falls" near 1 degree, says Miller.

"All by itself it shows the existence" of the 1-degree hump, says University of Chicago cosmologist Michael Turner. He says it will take the Microwave Anisotropy Probe satellite, to be launched in fall 2000, to reveal the precise shape and position of the hump. But already, Turner says, "we can claim to have a complete accounting of the matter and energy in the universe."

If so, the universe that astronomers can see is seriously underweight. Simply counting up all of its stars, gas, and hidden "dark matter," astronomers have found only 30% of the critical density needed to flatten it. Theorists speculate that the rest takes the form of a cosmological constant first proposed by Einstein, an energy in empty space that pushes on the fabric of space-time. Its effects may already have been spotted in observations of distant exploding stars, or supernovae, which appear to show that the expansion of the universe is accelerating (*Science*, 18 December 1998, p. 2156), says Saul Perlmutter of Lawrence Berkeley National Laboratory in California.

Happily, the supernova observations point to a cosmological constant that accounts for nearly 70% of the critical density, just enough to make up the deficit. The consistency of the two results is "nudging us from having to believe [in the cosmological constant] to being able to measure it," says Harvard University astrophysicist Robert Kirshner.

–MARK SINCELL

Mark Sincell is a science writer in Houston.

LASER FUSION

A Less Powerful NIF Will Still Cost More

The managers of a giant laser project have proposed drastically shrinking the National Ignition Facility (NIF) to curb rising costs, a step that could reduce its chances of achieving an important scientific goal in fusion research. But the downsizing will not eliminate cost overruns at the facility, and scientists in laser fusion and other fields are also worried that the Department of Energy (DOE) might tax their programs to complete the world's largest laser project.

Earlier this month DOE officials revealed that the $1.2 billion NIF, slated for completion in 2003 at Lawrence Livermore National Laboratory in California, was a year behind schedule and at least $200 million over budget. Now DOE managers say that, because of problems building and housing the lasers, the full 192-laser configuration would cost about $350 million more than planned and would not be finished until 2005. To rein in the project, Livermore officials propose cutting the number of lasers in half and finishing initial construction in 2004, a plan that would limit the cost overrun to about $100 million. Additional lasers, they say, could be added by 2008 if funding became available.

"The bigger the hammer, the better the chance of success."

—Richard Petrasso

Researchers have been counting on NIF to blast a tiny capsule of deuterium-tritium fuel with high-powered lasers, triggering a tiny burst of fusion that could simulate nuclear weapons explosions without underground tests and test the feasibility of generating fusion energy. DOE officials say the weapon simulations, intended to help make stored bombs safer, would be relatively unaffected by the proposed redesign, one of several cost-saving options developed by Livermore researchers. But fusion researchers say that having fewer lasers could complicate efforts to ignite a self-sustaining fusion burn in the target, a controversial civilian goal that helped DOE convince Congress to fund the dual-use megaproject.

Some critics have argued that ignition, an essential step toward realizing inertial confinement fusion, would have been unlikely even with NIF's original design (*Science*, 18 July 1997, p. 304). Now, even some of NIF's supporters concede that having only 96 beams could make the job that much harder. "Getting ignition with half the beams is iffy," says one DOE manager. "The bigger the hammer, the better the chance of success," adds physicist Richard Petrasso of the Massachusetts Institute of Technology in Cambridge.

Still, Petrasso and others say that other technical improvements, such as target designs that absorb more of the available laser energy, could make up for much of the shortfall. Indeed, a Livermore official predicted last week that the smaller system could produce almost as much energy as the original arrangement. A pared-down NIF would also be able to contribute to a next-generation laser fusion effort. "A 96-beam version would still give us most of what we need," says Robert Goldston, chief of DOE's Princeton Plasma Physics Laboratory in New Jersey. DOE officials, however, say they won't decide how to cope with NIF's troubles until they hear from an independent scientific panel they are still assembling (*Science*, 10 September, p. 1647).

An even greater worry for many scientists is that DOE may rob other defense science programs to pay for the NIF overruns. "I'm concerned about where they are going to find the money" to complete NIF, says Anne Davies, chief of DOE's fusion program, which includes defense and civilian elements. Energy Secretary Bill Richardson has already said he will not ask Congress for more money, meaning that DOE and Livermore will have to work within existing budgets. And Livermore officials have already informed several researchers that planned funds for detectors and other equipment won't be available anytime soon, indefinitely delaying some science projects. "This is beginning to look like the space station," says one DOE scientist, alluding to NASA's delay-plagued project.

The House Science Committee this week asked the General Accounting Office to investigate the causes of the overruns and delays. Ironically, the revelations came as more than 150 researchers were preparing for a 3-day conference to draw up a research portfolio for NIF.* Although anxiety may be high at the summit, organizer Petrasso is upbeat. "We're concerned, but this is just the beginning of the beginning," he says. "There will be lots of science to do."

–DAVID MALAKOFF AND ANDREW LAWLER

* Frontier Science at the National Ignition Facility: Episode I, Pleasanton, California, 4 to 6 October.

INTERNATIONAL EXCHANGES

Iranian Delegation Makes Rare U.S. Visit

In what could be a prelude to warmer scientific relations between the United States and Iran, a delegation of five high-ranking Iranian scientists spent 5 days in Washington last week meeting with several nongovernmental scientific organizations. It was the first such visit since the 1979 Islamic revolution that toppled the shah. The U.S. National Academies of Sciences and Engineering and the Institute of Medicine, which co-hosted the visit, are hoping to send a delegation to Iran next spring to flesh out some of the ideas raised during a daylong session at the academy.

The trip was arranged by Jeremy Stone, president of the Federation of American Scientists, who led a three-person FAS delegation to Iran last December. He says it took 8 months of "tortuous negotiations" with the Iranian bureaucracy to arrange a visit for his hosts, who were eager to discuss possible collaboration with their U.S. counterparts in fields such as renewable energy, environmental cleanup, earthquake hazard mitigation, agriculture, education, and health. Abolhassan Vafai, president of Iran's civil engineering society and founding editor of the fledgling journal *Scientia Iranica*, says, "There have been no ties for a long time. So any contact would be welcome." The delegation's liaison, Ali Mansoori, a chemical engineering professor at the University of Illinois, Chicago, and a foreign member of the Iranian Academy of Sciences, adds, "We are interested in exchanges by students and faculty members and in joint research."

The meetings were mostly show-and-tell exercises for groups such as the American Physical Society (APS), the American Chemical Society, and the American Association for the Advancement of Science (publisher of *Science*), combined with window-shopping by the Iranians. According to Mehdi Bahadori, a mechanical engineer and academy vice president, Iran is particularly interested in beefing up its educational system in an effort to train a larger proportion of a growing population: "We are also increasing our graduate programs, so that more [Iranian scientists] can be trained in Iran." Still, the lure of the United States remains strong. After meeting with the delegates, APS's Irving Lerch notes that "they suggested that a majority of students would prefer to study in the U.S. After all, four of the five visitors were trained here."

A major obstacle to closer links, however, is restrictions on travel. Because there is no U.S. consulate in Iran, Iranians must go to a third country to submit a visa application and then make a second trip, often several months later, to pick up the visa if it has been approved. This month's visit was made possible by what Stone calls "the full cooperation of the State Department," which arranged for one-stop shopping in Bern, Switzerland. Full diplomatic relations would be a boon to increased cooperation, says Lerch, who noted that both Iranian President Khatami and President Clinton have expressed a desire for closer cultural ties between the two countries.

–JEFFREY MERVIS