son with the discovery of a new drug and, therefore, requires a higher standard. As Gary Ellis, who oversees human subject protection for the National Institutes of Health, put it, "The importance of knowledge to whom? Those interested in better growing of cotton in west Texas?" Considerations such as these caused at least one committee member to suggest that EPA reject any data involving human experiments.

The committee had hoped to prepare a recommendation during the meeting itself. But the 16 members decided instead to submit comments for a draft advisory report that would be sent to EPA by 1 January. The EPA plans to use the report in preparing a draft policy on human testing. Given the range of opinions already expressed, however, EPA officials can expect a lively debate during the comment period that follows its release.

–JOCELYN KAISER

EUROPEAN SPACE AGENCY

Flat Budget Keeps Space Science on Edge

Europe's space powers have postponed until spring a decision on the long-term science budget for the European Space Agency (ESA), although they have temporarily approved level funding and kept alive a planned Mars mission. The delay angers scientists who have been lobbying for an increase in the agency's new 5-year budget, which begins today. But some officials said they were heartened that agency officials didn't make further cuts in a budget that, since 1996, has lagged behind inflation.

Looking up. ESA's Bonnet sees budget as a "positive sign."

"I am disappointed," says Hans Balsiger, chairman of ESA's science program advisory committee. "I told the council that they can't keep patting us on the head, telling us how well we are doing and, at the same time, taking money out of our pockets." But Roger Bonnet, head of space science at ESA, is pleased with the decision to approve $3.5 million for Mars Express, a mission to orbit the planet that's planned for launch in 2003. "It is the first positive sign from council since Toulouse [an October 1995 meeting at which funding was capped for 3 years] that they are concerned about science. It does at least reverse the trend [of budget cuts]."

On 16 December, ESA's ruling council met in Paris to approve a 1999 space science budget of $408 million, including the earmark for Mars Express. Last year's budget was $407 million. But they deferred discussion of longer-term spending plans until a May meeting in Brussels of science ministers from the 14 member states.

CREDITS: ESA

On its way. ESA provides first increment for Mars Express orbital mission.

The delay is feeding anxiety among European space scientists, who have drawn up an ambitious agenda of exploration. Those missions—including an x-ray multimirror telescope and a cluster of instruments to study the Earth's magnetosphere to be launched in 2000, a gamma-ray laboratory in 2001, the Rosetta comet mission in 2003, and a far-infrared telescope in 2007—had counted on steadily rising expenditures. "If we get funding at the mid-1998 level and this [year's] increase is in line with inflation, we can just about do all of these missions," says Balsiger, looking ahead to the spring meeting. "If it is less, then we will have to cancel Mars Express."

The delay highlights the precarious level of support for space science throughout Europe. "We see problems in both the short term, 5 years, and the long term, 10 years," says Paul Merton, director of space science at the British National Space Center. Britain supports a budget that would keep pace with inflation, Merton says, but would like ESA to save money on its large missions to make room for the rest of the science program. In Germany, the new government is carefully reviewing its current level of expenditures on science. "The Social Democrats spoke favorably of basic research prior to the election but said nothing specific about space science," notes Manfred Ottobein, who oversees space and microgravity science at the German Space Agency. And French scientists don't want ESA programs to be hurt by their country's agreement with NASA to share the cost—still uncertain—of a sample return mission to Mars, says Phillippe Masson, a former science adviser to the government.

While scientists look to the spring ministerial meeting for salvation, some observers warn that even a modest increase may not solve the long-term problems facing European space science. "People are scrabbling for the last million Euros," says Roy Gibson, a former ESA director-general. "No program is worth doing if it is eroded every year by inflation." –HELEN GAVAGHAN

Helen Gavaghan writes from Hebden Bridge, U.K.

ASTROPHYSICS

Galaxies Seen at the Universe's Dawn

Astronomers from the State University of New York, Stony Brook, have won a race to the edge of the universe. After 3 weeks of working around the clock on infrared data from the Hubble Space Telescope, they may have shattered previous records for the most distant stars and galaxies, pushing the frontier of the visible universe to distances so great that they are seen just a few hundred million years after the big bang. "We knew other groups were working on the same data," says one of the astronomers, Ken Lanzetta, "so there was a lot of hurry."

Together with his Stony Brook colleague Amos Yahil, postdocs Alberto Fernandez-Soto and Sam Pascarelle, and students Hsiao-Wen Chen and Noriaki Yahata, Lanzetta analyzed data from a very small patch of sky in the southern constellation Tucana, where the Hubble gathered light for 10 straight days last October (*Science*, 27 November 1998, p. 1621). NASA released data from this observation, called Hubble Deep Field South, on 23 November. By 18 December, the team had published its results on the Internet (sbast4.ess.sunysb.edu /hdfs/home.html): a catalogue of 323 distant galaxy candidates, along with their redshifts—a measure of distance, and hence age. The farthest galaxy spotted previously has a redshift of 5.64, meaning that the expansion of the universe has stretched its light by a factor of 6.64. Lanzetta and Yahil now claim to have found 14 galaxies with redshifts of between 5 and 10, and another five candidates with redshifts larger than 10.

At a redshift of 10, galaxies are seen when the universe was only 9% of its current size and probably just a few hundred million years old. "We are getting back to a significant fraction of the age of the universe," says Yahil. "These are the last few percent to the big bang." If he and Lanzetta are right, galaxies and stars formed much earlier in cosmic history than most theorists had imagined.

There is a catch, however. Because the galaxies are extremely faint, Lanzetta and Yahil did not measure their redshifts from a spectrum—the usual procedure. Instead, they deduced redshifts by comparing each galaxy's brightness in measurements at different color

Far frontier. Data from the Hubble Deep Field South observation may have revealed the most galaxies yet.

ranges. In very distant galaxies, for example, interstellar hydrogen gas blots out a part of the ultraviolet spectrum. By comparing observations at different colors, astronomers can estimate where this drop-off falls in the spectrum of a distant galaxy, and thus how much its light has been red-shifted. Because even ultraviolet light is shifted all the way into the infrared for very distant galaxies, Lanzetta and Yahil's analysis relied heavily on observations by Hubble's NICMOS infrared camera.

Such "photometric" redshift measurements are considered less reliable than measurements based on a spectrum. Yahil notes, for example, that some of the candidate high-redshift galaxies could be old elliptical galaxies—whose light is very red—at smaller distances. Charles Steidel of the California Institute of Technology in Pasadena, who pioneered the photometric redshift technique a few years ago, sees "no reason to doubt the results," but says, "You have to have a lot of faith at these high redshifts." And theorist Jim Peebles of Princeton University says, "Lanzetta and Yahil have demonstrated a good track record for redshift estimates in the [Hubble Deep Field North], so I expect people will take the observations in the south seriously, but not [consider them] definitive."

Confirming the results could take the Next Generation Space Telescope, an orbiting infrared telescope to be launched in 2007, although Lanzetta and Yahil have floated plans to build an array of cut-rate telescopes, with giant mirrors made of spinning mercury, to gather the light needed to make spectra of distant galaxy candidates. But if the findings do hold up, they will add to mounting evidence that the early universe was a far more active place than astronomers had thought.

When the Hubble Space Telescope observed Deep Field North, just over 3 years ago, the NICMOS camera wasn't installed yet, and the most remote objects remained invisible because all of their light is shifted into the infrared. Based on Deep Field North, astronomers concluded that few stars had formed at redshifts larger than 3. "That notion is beginning to crumble," says Yahil. Steidel, for example, has found evidence of rapid star formation at redshifts greater than 4 (*Science*, 4 December 1998, p. 1806). And Yahil now says, "At the moment, it's even not clear if we see a drop in the star formation rate between redshifts of 5 and 10."

How the new data will affect theorists' picture of cosmic structure formation isn't clear yet. "I think the conclusions are not a problem for the usual ideas if the galaxies at a redshift of 10 are quite rare," says Peebles. But as astronomers push farther out and back in time, the usual ideas may come under more and more pressure.

–GOVERT SCHILLING

Govert Schilling is an astronomy writer in Utrecht, the Netherlands.

CREDITS: (TOP) K. M. LANZETTA, SPACE TELESCOPE SCIENCE INSTITUTE; (BOTTOM) PYTHON/VIPER

ASTROPHYSICS

Microwave Hump Reveals Flat Universe

PARIS—The physicist Richard Feynman once said that even if a camel's tail appeared under the flap of a tent, he wouldn't believe in the camel until he could see the hump. Now, astrophysicists may be seeing the full dimensions of a hump in measurements of the cosmic microwave background (CMB), a faint microwave glow on the sky that is the afterglow of the big bang. The observations, made by two microwave telescopes at the South Pole and announced here in mid-December at the Texas Symposium on Relativistic Astrophysics and Cosmology, are likely to be far more welcome than a camel in a tent. The hump appears to be a long-sought sign that the cosmos contains the full complement of matter and energy that theorists have long postulated.

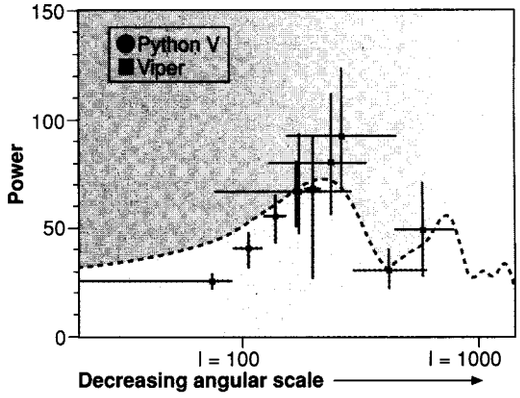
The hump is actually a measure of ripples in the CMB, which record slight irregularities in the matter and energy of the early universe. The apparent size of the irregularities indicates the shape of the universe, just as the apparent size of an object viewed through a magnifying glass says something about the shape of the glass. In a plot of "power," or abundance, of ripples of various sizes, a peak at a size of about 1 degree on the sky would indicate a universe that is spatially "flat."

A flat universe—a universe with a "critical density" of matter and energy—is a key prediction of the best-accepted theory of how the big bang got started, called inflation. In a universe consisting entirely of matter, the critical density of matter would be just enough for gravity to slow its expansion to a stop after infinite time. But if a major ingredient of the universe is a hypothetical energy in empty space, it could be flat with much less matter, and its expansion could even be speeding up, as recent measurements of distant exploding stars suggest it is (see *Science*, 18 December 1998, p. 2156).

At least two earlier sets of measurements had hinted at the 1-degree hump. One set, made from a telescope in Saskatoon, Canada, showed points on the power plot rising from large angular scales to a possible peak at 1 degree; another, made by the Cambridge Anisotropy Telescope in the United Kingdom, seemed to show a drop on the far side of the peak at smaller scales. But astrophysicists wanted more details of the hump before believing it—details that the South Pole experiments, Python and Viper, now appear to have provided.

The two experiments, part of the Center for Astrophysical Research in Antarctica, take advantage of the thin, dry air at the South Pole for a clear view of the CMB. They surveyed opposite sides of the peak, Viper looking for ripples on scales from 1/6 degree up to a degree, and Python for ripples measuring from one degree up to several degrees. Their findings dovetail, too. "We definitely see rising power up to this [1-degree] scale," said Python's Kimberly Coble of the University of Chicago. "We see a decrease" at large scales, said Viper's Jeff Peterson, of Carnegie Mellon University.

Both results are preliminary, although Python members say they are preparing a paper on the results. But Neta Bahcall of Princeton University, who is not involved in the work, said, "It's a very nice observation. They do see a rise; they do see something falling down. It's very suggestive." **–JAMES GLANZ**



Telltale peak. The Python and Viper experiments show that fluctuations in the cosmic background radiation are concentrated at the size predicted (dashed line) for a "flat" universe.