comparison with those Lingner had found, and one of those genes, *EST2*, turned out to be the very gene that Lingner had pulled out of the yeast database. "That was very exciting," says Cech, because of the Lundblad group's genetic evidence that *EST2* is needed for telomere maintenance. It was looking like p123 and Est2 could be the catalytic components of their respective telomerases.

The yeast connection was a lucky break for his lab, says Cech, because it enabled them to test that hypothesis genetically. "You can do genetics so easily in yeast," he notes, "and in *Euplotes* you can't do it at all." The teams collaborated to mutate sites in Est2 that correspond to the RT active site. They found that the telomeres of yeast cells containing the mutant enzyme shortened just as they did in cells missing the whole *EST2* gene.

Lingner subsequently showed that telomerase partially purified from those mutant yeast cells could no longer elongate telomeres. From that, "it was a reasonable conclusion," says Lundblad, "that [the proteins] were the catalytic subunits of their respective enzymes." Many in the field agree. "Looking at the whole package, I find it very convincing," says Jef Boeke, who studies reverse transcriptases at Johns Hopkins University. "They mutated the [key RT] residues, and they killed an in vitro activity. That evidence is very strong."

The evidence also suggests that Est2 and p123 represent a new class of RT that is most closely related not to RTs from retroviruses like HIV, but to RTs coded for by transposable elements (segments of DNA that can move around in the genome) found in many cells. In that case, drugs that inhibit the HIV enzyme may not work on telomerase, Boeke says, so researchers wanting to develop antitelomerase drugs for possible anticancer applications may have to start from scratch.

Despite the evidence that Est2 and p123 are telomerase catalysts, they still have rivals for that role: p95 and p80, telomerase-associated proteins purified and cloned 2 years ago from the ciliated protozoan *Tetrahymena thermophilia* by Greider, with Kathleen Collins and Lea Harrington, who were then postdocs in Greider's lab at Cold Spring Harbor Laboratory on Long Island. Collins proposed that p95 may be the catalytic component, based on resemblances it shows to enzymes that synthesize RNA or DNA. And in the past 3 months, Harrington's team at the University of Toronto and Fuyuki Ishikawa's at the Tokyo Institute of Technology have reported finding p80-like proteins in human, mouse, and rat telomerases.

But, so far, no one has shown either p95 or p80 to be essential for telomerase activity, and the current discovery casts more doubt on the role of those proteins. "The most straightforward scenario," says UCSF's Blackburn, is that the *Tetrahymena* and mammalian telomerases also have a p123-like protein as their catalytic unit, and it has somehow been missed. In that case, p80 and p95 may have an accessory role in the enzyme. "Given this [result], one should look very hard for RT motifs in all species of telomerases," Blackburn says.

Or it may be that either p80 or p95 will prove to be the catalytic part of *Tetrahymena* telomerase. But that would mean that the two ciliates, *Tetrahymena* and *Euplotes*, have evolved different enzymes to do the job—an idea that Gottschling describes as "sort of amazing, evolutionarily." Most researchers say they are reserving judgment about these possibilities until some of the remaining gaps in the story are filled. However, most also agree with telomere researcher David Shore of the University of Geneva that "the burden of proof is now on those with p80 and p95 in their hands" to show that those proteins are essential parts of telomerase.

Even if the new results do pinpoint the crucial actor in telomerase, the enzyme likely contains many other proteins, all with some role in its function, that vary from organism to organism. The picture looks confusing now, Greider says, because "we are interpolating between several different organisms. We need to solve the problem completely in each organism" before the true nature of telomerase is revealed.

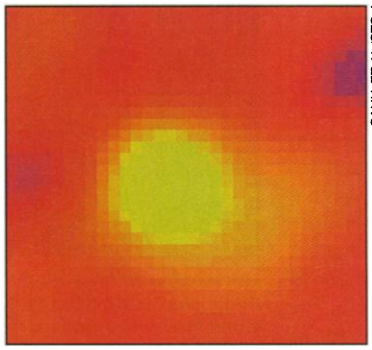
–Marcia Barinaga

GAMMA-RAY BURSTS

Visible 'Source' Teases Observers

Just when astronomers thought they might be solving one of their longest running mysteries, the story has taken another dizzying twist. The question is whether the flashes of gamma rays called gamma-ray bursts (GRBs) originate in or near our galaxy or billions of light-years away, at cosmological distances, which would make them the brightest outpourings in the universe.

Astronomers thought they were on the verge of an answer when the Italian-Dutch satellite Beppo-SAX saw a fading source of x-rays that seemed to be the afterglow of a GRB the satellite had detected on 28 February. Because x-ray detectors have much better spatial resolution than those for gamma rays, that helped pin down the burst's position for further observation. Hopes shot even higher when ground-based telescopes aimed at the spot then fished out both a point of light and a faint fuzzy patch next to it—possibly the GRB source and its host galaxy in the distant universe (*Science*, 21 March, p. 1738). The cosmological alternative seemed poised to carry the day. But then the orbiting Hubble Space Telescope (HST) got into the act.


SAHU ET AL./STScI

Near or far? Hubble view of the point source and adjacent fuzzy patch.

The latest results of its scrutiny of the proposed source, reported on the Internet last week in International Astronomical Union (IAU) circulars, have thrown the debate wide open again. One group claimed that the pointlike burst source, if that's what it is, is moving noticeably across the sky and might be a nearby object. Another group—looking at the same data—saw nothing of the kind. Says Chryssa Kouveliotou of NASA's Marshall Space Flight Center in Huntsville, Alabama: "I'm more confused than anything."

This new chapter in what Princeton University's Bohdan Paczyński calls "the wonderful story of [gamma-ray burst] 970228" opened earlier this month when Kailash Sahu, Mario Livio, Larry Petro, and F. Duccio Macchetto of the Space Telescope Science Institute (STScI) in Baltimore, along with several collaborators including Kouveliotou, published a circular reporting HST observations of the optical counterpart 26 and 38 days after the burst. The observations confirmed the fading point source and the adjacent fuzzy patch. By prior agreement, the group immediately released its raw HST data to the entire astronomical community.

Then, on 17 April, a separate group, including Patrizia Caraveo at the Istituto di Fisica Cosmica (IFC) in Milan, Italy, and several collaborators, posted another circular reporting their own analysis of the data. They had found something startling: The point source was moving across the sky. The angular motion was so quick, says one of the collaborators, Marco Tavani of IFC and Columbia University, that the object might have to be within a few hundred light-years of Earth, much closer than even the proponents of a galactic origin for GRBs have been suggesting recently. The fuzzy object could then be anything from a transient cloud of gas associated with the burst to a background galaxy, aligned by chance with the pointlike object.

But the Sahu team's own analysis, completed after their first circular, shows that to within the error bars, the point source is stationary. "We cannot reproduce what Caraveo says in the IAU circular in spite of our best efforts," Sahu told *Science*. Tavani suggests that the discrepancy is due to his own team's superior software for extracting apparent motion from the data, but the issue remains unresolved. So does the nature of the fuzzy patch. As *Science* went to press, several astronomers reported in an IAU circular that a so-far-uncorroborated measurement at the Keck 10-meter telescope indicated that the "host galaxy" might have faded, which would indicate that it isn't a galaxy at all.

Resolving these issues, says Paczyński, is likely to require a third HST observation when the point source, now drawing close to the sun, reemerges from its glow in a few months. If the object is still visible, the next glimpse of it should settle the question of whether it is moving. And finding and studying optical counterparts for several more GRBs could finally solve the mystery—providing they yield their secrets more readily than this one has. In the meantime, says Peter Mészáros, a theorist at Pennsylvania State University, "It has been a bit of a roller coaster."

–James Glanz

PHYSICS

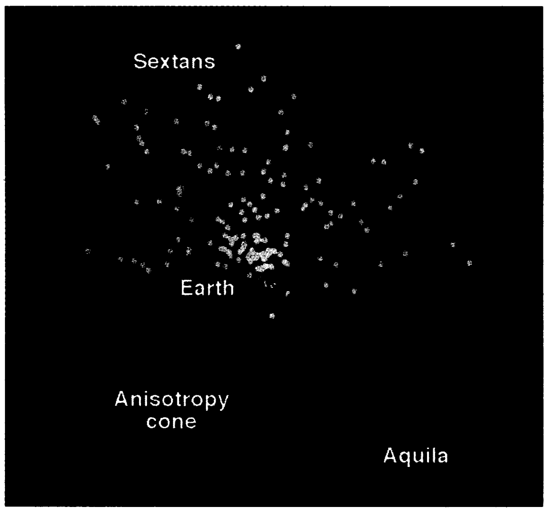
Doubts Greet Claim of Cosmic Axis

Interesting—but probably wrong. That distills the reaction of most physicists and radio astronomers to an extraordinary claim that space itself might have an overall orientation. Aired last week amid a barrage of university press releases that culminated in front-page newspaper headlines, the claim was based on unaccountable differences in the way radio waves seem to propagate to Earth from galaxies at different spots in the sky. But other researchers say that the evidence behind the claim has serious shortcomings.

Critics have not identified a single fatal error that could explain away the result, which Borge Nodland of the University of Rochester in New York and John Ralston of the University of Kansas published in the 21 April issue of *Physical Review Letters*. But astronomers say the two physicists relied on old and incomplete data, omitting perhaps 99% of recent observations of radio galaxies. Their analysis also depends on outdated ideas about the nature of the signals from those galaxies, says Kenneth Chambers of the University of Hawaii. Add the likelihood that the conclusions would—just for starters—overturn Einstein's theory of relativity, and other researchers are deeply skeptical. Michael Turner, a physicist at the University of Chicago, had one of the kinder assessments. "Extraordinary claims demand extraordinary evidence," he said. "The evidence presented does not yet meet this standard."

Ralston says he is not surprised by the criticism: "It's always going to be there as long as somebody tries something new." He and Nodland analyzed published observations of 160 radio-emitting galaxies scattered around the sky. The electric field in radiation from such galaxies often arrives at Earth with a distinct polarization, or orientation, like the silhouette of a baton held against the night sky. Nodland says he and Ralston thought data on these polarizations could provide a test of whether "certain [arrival] directions are special compared to other directions."

Like a baton hurled into the air, the polarization of radio waves rotates as they travel through space. Part of the rotation can be explained by the so-called Faraday effect, which results when the waves interact with charged particles and magnetic fields in space. Because the effect varies with frequency, Nodland and Ralston tried to estimate the Faraday rotation between Earth and any given radio galaxy by comparing the polarization of the signals at different frequencies.



BORGE NODLAND

Universe with an attitude? A new analysis suggests that the polarization of radio waves rotates the most when they arrive from particular directions.

They then tried to estimate the signals' original polarization by assuming that each galaxy emits radio waves polarized at a specific angle relative to observed structures, like the energetic jets of plasma seen emanating from many radio galaxies. They subtracted the Faraday rotation from the polarization observed at Earth, then compared the result with their estimate of the original angle. The procedure revealed a residual twist—one that varied with the distance of the galaxy and its direction. The twist was greatest for galaxies lying near a single axis in the sky, running roughly in the direction of the constellation Sextans.

That conclusion ended up making headlines last week after unrelenting promotion by the two universities' press offices. Its consequences would indeed be momentous. A preferred axis in space would violate physicists' cherished assumption that physical laws are the same everywhere in the universe, and it could revise cosmologists' picture of the big bang.

But it also conflicts with the best evidence cosmologists have that the universe really is isotropic, or identical in all directions: the homogeneity across the sky of the microwave background radiation generated in the big bang. And the conclusion is weakened by problems in the selection and treatment of data, say other researchers. For one thing, the bulk of Nodland and Ralston's data set consists of observations from before about 1980, when the Very Large Array (VLA) near Socorro, New Mexico, came on line and began making far better observations of radio galaxies.

For another, the assumption that each galaxy emits radio signals at a single, predictable polarization is decades out of date, says Chambers. Measurements at the VLA and elsewhere have shown that the emitted polarization varies widely over a single galaxy. Also, large and incalculable amounts of Faraday rotation often occur in the plasmas and magnetic fields near the galaxies themselves.

Responds Ralston, "People have sent me e-mail saying there are newer data. Of course, there are newer data on radio galaxies in general," but he says he didn't find any other observations that had all the features needed for his analysis. And he says the very fact that the analysis reveals a systematic variation in the twist shows the signals could not have been completely scrambled at the source.

But most researchers think the effect would simply vanish in a larger, more modern data set. "I wouldn't look at this and say there's no chance it could be right," says Ruth Daly, a physicist at Princeton University. "But it's not clear whether [the analysis is] telling us something interesting about the universe or about problems in the data."

–James Glanz