MEETING BRIEFS

Hubble Repair and More Wins Astronomers' Acclaim

The repaired Hubble SpaceTelescope overshadowed everything else at the American Astronomical Society (AAS) Meeting earlier this month in Alexandria, Virginia. The nearly 2000 astronomers who turned out for the society's largest meeting yet provided plenty of "oohs" and "aahs" for every new image. But, in between, some astronomers caught word of a new proposal about how to tell whether the universe is open or closed, more data about mysterious gamma ray bursts, and the crowning of the "Galaxy of the Year."

Gamma Rays Burst Out of the Galaxy

In the late 1960s, U.S. defense satellites circled the globe looking for flashes of gamma rays that would betray illegal nuclear tests by the Soviet Union. Yet when the satellite data were declassified in 1973, the findings stirred up astronomers, not politicians: The satellites had spotted brief bursts of high-energy gamma rays coming not from Earth, but from space. Ever since, astronomers have been arguing: Some insist that the flashes originate within our own Milky Way Galaxy, while others favor sources in the distant reaches of the universe. Now a new analysis of bursts seen by the Compton Gamma-Ray Observatory suggests that at least some of them have been stretched out in time by cosmic expansion, implying that their sources lie far out in the universe.

The latest news, reported at AAS by a team led by Jay Norris of NASA's Goddard Space Flight Center, "will strengthen the case [for a distant origin] for people like me and maybe make a few converts," says Princeton University's Bodhan Pacyzinski. Still, acknowledges Pacyzinski, "it's not conclusive enough to convert everyone." The University of Chicago's Don Lamb, who has developed theories and a line of evidence arguing for a galactic origin of the bursts, agrees. "I don't think it's a smoking gun [for a cosmological origin]."

The gamma ray debate has raged in a near-vacuum, because the bursts betray few clues about where they are or what causes them. The flashes are very brief, lasting anywhere from a few minutes to less than a second, and they never—or almost never—repeat. Nor have they been linked to any known astronomical objects. Most astronomers originally favored a galactic origin because if the flashes originated far out in the universe, the explosions would be unimaginably powerful.

But the case for a galactic origin was dealt a large blow when the Compton Observatory, with its sensitive gamma ray detectors, was launched in 1991. Since then, Compton's Burst and Transient Source Experiment (BATSE) has found that the bursts came from random directions in the sky—not the plane-like distribution expected if they originated in the Milky Way. That gave supporters of a cosmological origin the upper hand—a position now strengthened by the new statistical analysis of BATSE data.

The impetus for the study came from Pacyzinski and Harvard University's Tsvi Piran, who predicted that if the bursts come from the far reaches of the universe, they should show the time-dilation effects predicted by Einstein's theory of relativity. The theory predicts that in an expanding universe, signals from objects that are farther away should last longer because time is running more slowly there. Moreover, a "reddening" of the bursts' light would be expected as wavelengths get stretched in their travels across an expanding universe.

That's just what Norris and his colleagues found when they compared the 46 brightest bursts with the dimmest 60 detected by BATSE. If the bursts all had about the same brightness at their source, the dim bursts presumably came from more distant objects. Indeed, they showed both predicted signs of time dilation: They were "redder" than the bright bursts, consisting of more of the soft, less energetic, gamma rays and they typically lasted twice as long. The doubling of the dim bursts' duration suggests, Norris says, that they are halfway to the edge of the observed universe. This means that to be observable at such distances, gamma ray bursts must be the most powerful events ever seen, putting out the energy of a quintillion suns.

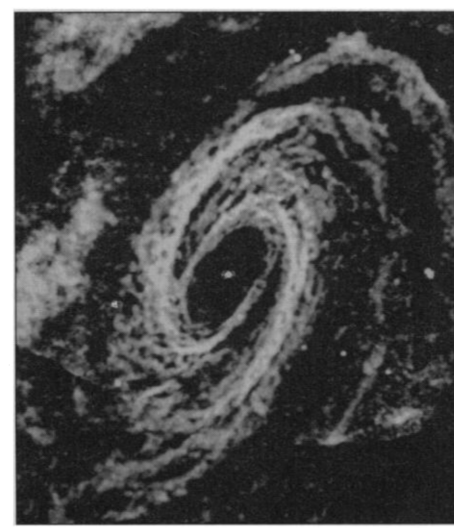
Lamb and others find that implication hard to stomach, especially since there's no consensus about how such explosions might be powered. They suggest it's more likely that Norris' assumptions are flawed: Not all bursts may be the same, and dimmer ones may naturally last longer and be less energetic. But Norris counters that time-dilation is the simplest explanation for his data. "The theory that accounts for this, without jerking around the numbers, is the cosmological," he says.

One of the few things that Norris and Lamb do seem to share is a belief that the flow of data from BATSE will eventually resolve the puzzle of gamma ray bursts. "BATSE has produced a whole series of incredible clues to this mystery. We're on the verge of cracking this case," says Lamb.

M81 Steps Into the Spotlight

A lot of galaxies get their picture taken by eager astronomer paparazzi, but few have soared to celebrity status as fast as M81, a celestial superstar—excuse us, supergalaxy—proclaimed "Galaxy of the Year" by the AAS at this year's meeting. Explained a bemused David Adler of the National Radio Astronomy Observatory in Socorro, New Mexico, "It's a novel way to point out the fact that there was a lot of work on the galaxy. It was a very well-studied galaxy last year."

Unfortunately, M81 was unable to gratify its starstruck fans by picking up its award in person; maybe it was just too busy. After all, in 1993 M81 unveiled a supernova that still had scientists at AAS buzzing and also 30 new Cepheid variables, pulsating stars being used in the search for the Hubble constant, the expansion rate of the universe.


D. ADLER, D. WESTPFAHL, NRAO/AUI, PALOMAR OBSERVATORY

Star quality. M81 is Galaxy of the Year.

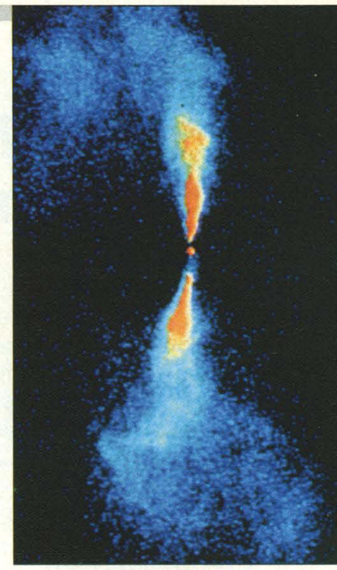
Adler's own fascination with M81 stems from his detailed examination of the distribution of neutral hydrogen gas inside the galaxy's spiral arms, which showed the arms to be much less smooth than was thought. "We had known that most of the gas was restricted to the spiral arms, but we did not know its structure," explains Adler, who along with David Westpfahl of the New Mexico Institute of Mining and Technology spent more than 60 hours observing M81 with the Very Large Array (VLA) in New Mexico. The VLA, which consists of 27 radio antennas grouped in the shape of a "Y," found that the hydrogen is distributed in a complex mixture of knots, kinks, and holes. These perturbations have probably been caused by local events like star formation and supernovae and should show up in other galaxies as well, explains Adler.

The VLA study also yielded a provocative finding from a study of how M81 rotates. Observations of almost all spiral galaxies have shown that rotational velocities do not fall off in their outer regions, as one would expect if most of their mass was concentrated near the center, where most visible stars are found. In fact, the velocities remain remarkably constant or, in astronomical parlance, galactic rotation curves stay "flat," implying the presence of more matter than can be seen in the galaxies' outer reaches. The findings have led scientists to propose that perhaps 90% of a galaxy's mass consists of mysterious "dark matter" sitting in a galactic halo.

But M81, like only a few other known spiral galaxies, breaks the mold. By measuring the Doppler shift of specific hydrogen emission lines, Adler and Westpfahl found that the galaxy's rotational velocity gradually declines with distance from the center, consistent with very little dark matter, says Westpfahl. That result, he believes, should help put to rest the idea that the universe has placed exactly enough dark matter in every galaxy to keep its rotation curve flat. Based on these new observations of M81 and the presence of a handful of similar galaxies, Westpfahl asserts, "Given the existence of dark matter, its distribution varies from galaxy to galaxy." And that's something cosmologists will have to factor in as they attempt to model how the universe evolved. With results like that on M81's resume, it's clear that contestants for the 1994 "Galaxy of the Year" title will be hard pressed to surpass this year's winner.

Opening Up the Universe

Much of cosmology has been said to rest on two simple letters, *H* and *q*. *H* is short for the celebrated Hubble constant, a number that tells cosmologists about the age and size of the universe. Less well known to the general public is *q*, the so-called deceleration parameter, which marks the rate at which gravity is slowing expanding. It thus speaks to the amount of matter in the universe and determines whether the universe will go on expanding infinitely or will actually reverse itself and collapse in a "Big Crunch."



Open or shut case? Radio sources may reveal the fate of the universe.

The fate and mass of the universe remain uncertain, however, because finding *q* has proved to be no less a challenge than determining the Hubble constant. Most attempts had relied on "standard candles," objects presumed to shine at the same brightness wherever they are. The problem is that there are few trustworthy standard candles observable in the distant universe. At this year's AAS meeting, however, Princeton University theoretical physicist Ruth Daly unveiled a new approach that reveals *q* without the need for standard candles. Her preliminary conclusion: Anyone alarmed by the prospect of a Big Crunch can rest easy. "The results strongly favor an open universe," says Daly, also pointing out her low value for *q* matches the amount of observationally deduced mass in the universe.

Daly's approach gauges whether the universe is open or closed by looking at the pairs of radio-emitting "lobes" seen near some elliptical galaxies. Known as powerful extended radio sources, these lobes typically span 500,000 light-years. They are apparently formed when the galaxy's central energy source, perhaps a massive black hole, fires out two oppositely directed beams of relativistic particles that impact on the surrounding medium, triggering shockwaves that produce powerful radiowaves.

Daly had been studying the physical processes that govern how these lobes expand and found that she could mathematically model their growth with the use of observable quantities like how much energy the galaxy's center was putting out and the density of the surrounding medium. More important, claims Daly, all dependence on the distance to the source cancels out in her equations. That means that she can calculate the actual lobe separation of these sources without knowing their distances from Earth.

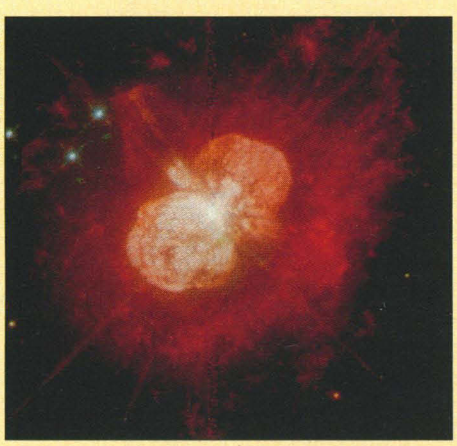
And that is where *q* comes back into the story. Cosmologists have written equations that relate an object's actual size to its observed size and distance away, but those relations depend on *q*. Daly then used her model to calculate the actual spans of 10 extended radio sources, whose distances from Earth, as well as their observed spans, are known. That gave her everything she needed to constrain *q* to certain values. Those values are quite low, says Daly, and are consistent with an open universe, one in which there is not as much dark matter as many believe.

Daly's search for *q* is already winning cautious praise. Calling her new method "clever," Princeton University cosmologist Jeremiah Ostriker told *Science*, "One has to applaud any new independent way of doing *q*." Still, he points out that since each method for determining *q* requires many assumptions, the "only way to tell if you're right is when three or four independent methods give the same result." No other uncontested value for *q* has weighed in yet and Daly's approach will doubtless be debated. And until further observations of other extended radio sources are completed, even Daly remains cautious. "I hesitate to talk about the fate of the universe with only 10 sources," she jokes.

–**John Travis**

Hubble Photo Stars at AAS

In 1841, normally faint Eta Carinae briefly became the second brightest star in the night sky when light from a violent outburst on the star, 10,000 light-years away, finally reached Earth. At the AAS meeting, scientists working with the Hubble Telescope's new Wide Field Planetary Camera 2 (WFPC-2), which corrects for the telescope's faulty mirror, released the sharpest image yet of the aftermath of the outburst. New details of the starburst leap out in the image, notes Arizona State University astronomer John Hester. Earlier pictures made by the unrepaired Hubble showed, for example, that two lobes of ejected material are moving away from Eta Carinae at high velocity but the area close to the star itself couldn't be readily seen. Astronomers had speculated that the two lobes shot out from the poles of a presumed dense disk of dust and gas surrounding the star. But the new pictures reveal instead that the lobes travel along the plane of this disk. The new Hubble image "completely turned our picture of the object by 90 degrees," says Hester.



J. HESTER/ASU NASA