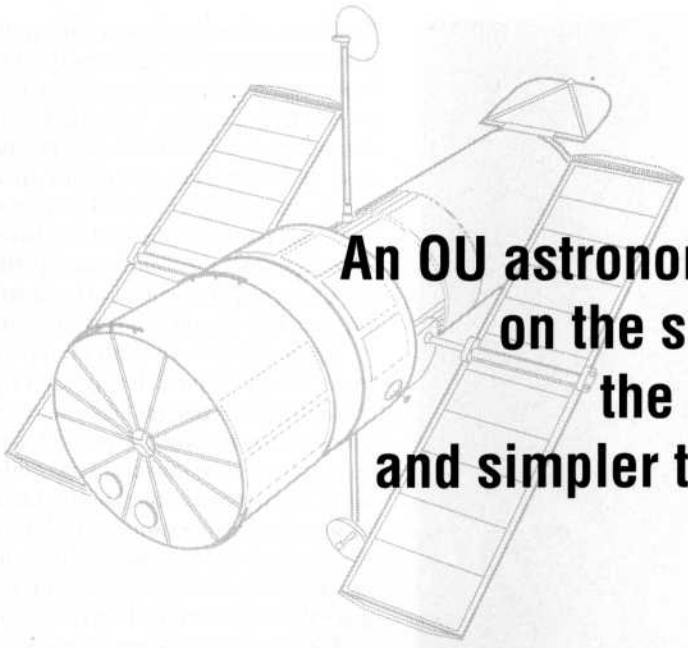


An OU astronomer enters a controversy on the side of scientists who see the universe as older, larger and simpler than previously believed.

A dispute that has factionalized astronomers for more than 50 years may be entering its final confrontation, with a University of Oklahoma astronomer firing the latest volley.

Seldom since the days of Copernicus, when stargazers were battling over whether the sun or the earth was the center of the universe, have astronomers been so divided.

An Astronomical Debate

by JUDITH WALL
OU News Services

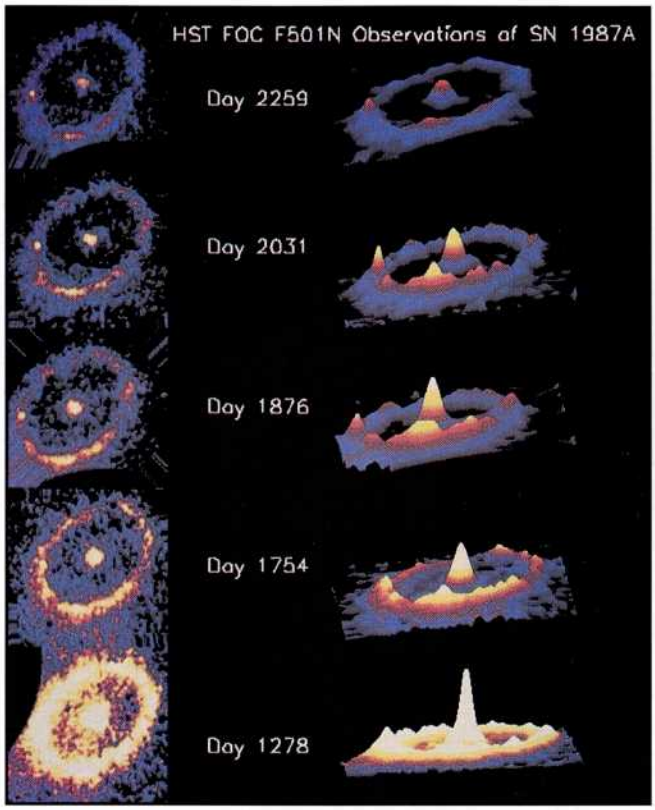
The modern-day controversy concerns the age and expansion rate of the universe, with OU's David Branch and his allies believing that the universe is expanding at an older, slower rate than forces on the side of a faster, younger expansion—with as much as a 70 percent discrepancy between the two camps.

Astronomers agree that the universe has been expanding since it came into existence with the Big Bang, carrying galaxies farther and farther apart. The age of the stars generally is accepted to be approximately 15 billion years. And astronomers have been able to calculate the speed at which galaxies are sailing outward into infinity.

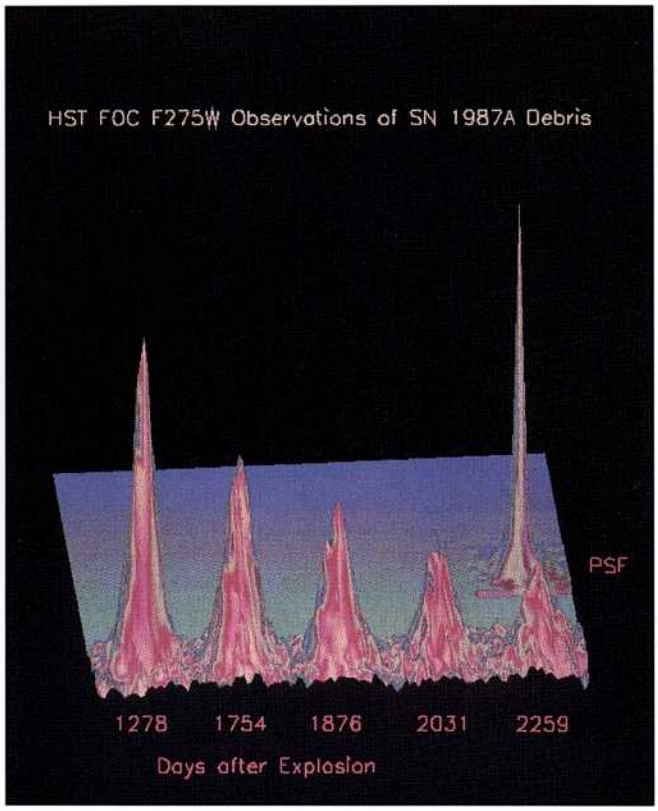
"The problem is figuring out how far away they are," says Branch, who is known internationally for his supernova research.

"If we can determine the distances to the galaxies and we know how fast they're going, we can estimate how long they've been going," he says.

The OU astronomer explains that the process is no different, in principle, from estimating how long it will take to drive from



Observations made by the Hubble Space Telescope, left photo, show supernova 1987A, which appeared in February 1987 in a "nearby" galaxy called the Large Magellanic Cloud (LMC). Because the LMC is at a distance of 170,000 light years from Earth, this catastrophic stellar explosion actually took place 170,000 years ago.



The Hubble Space Telescope photo reproduced above details images of the rapidly expanding supernova matter. The point spread function (PSF) shows how a non-extended source of radiation would appear. The supernova images show both the increasing extension and the fading of the supernova with time.

Oklahoma City to Tulsa, provided you know how far it is to Tulsa and how fast you will be driving.

At the center of this astronomical dispute is the value of the Hubble constant, which is the ratio of the speed of a receding galaxy to its distance from the earth. A high Hubble constant is used in the computations of those who favor a younger universe; Branch and his allies are proponents of a low constant.

Those who study the galaxies advocate a higher Hubble constant based on their estimate of the distances to the galaxies. Using that estimate with established velocities, they have calculated an age for the expanding universe that is lower than the 15-billion-year age of the stars.

"Now, that's a problem because it would mean that the universe is younger than its contents," Branch says. "And this would mean that the universe is mysterious and complicated."

To explain this astounding discrepancy, the galaxy forces have re-invoked something called the cosmological constant, which is a mathematical complication that Einstein tacked onto the theory of relativity to explain a static universe—but later retracted when Edwin Hubble demonstrated the universe was expanding.

Branch believes the most accurate and reliable "standard candles," or distance indicators, are Type 1a supernovae, which he has used to compute his entry into the Hubble-constant dispute.

If one knows the luminosity of a light source, whether candles or exploding stars, it is possible to compute the distance to that light source by comparing the true luminosity to the apparent luminosity, Branch explains.

"Type 1a supernovae are a very homogeneous class of exploding stars," he says. "An explosion of one supernova is very much like the explosion of another."

By computing the distance to a Type 1a supernova, Branch then knows the distance to the galaxy in which it is found, or more correctly, was found, since these thermonuclear explosions took place in the distant past with the light they generated taking many millions of years to reach earth.

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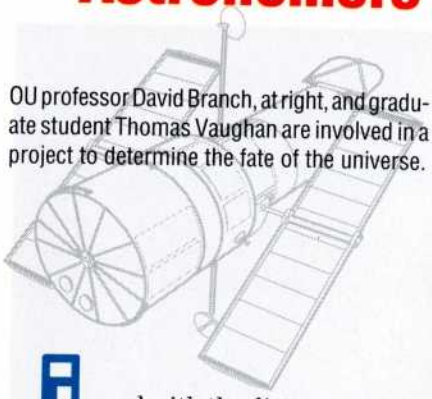
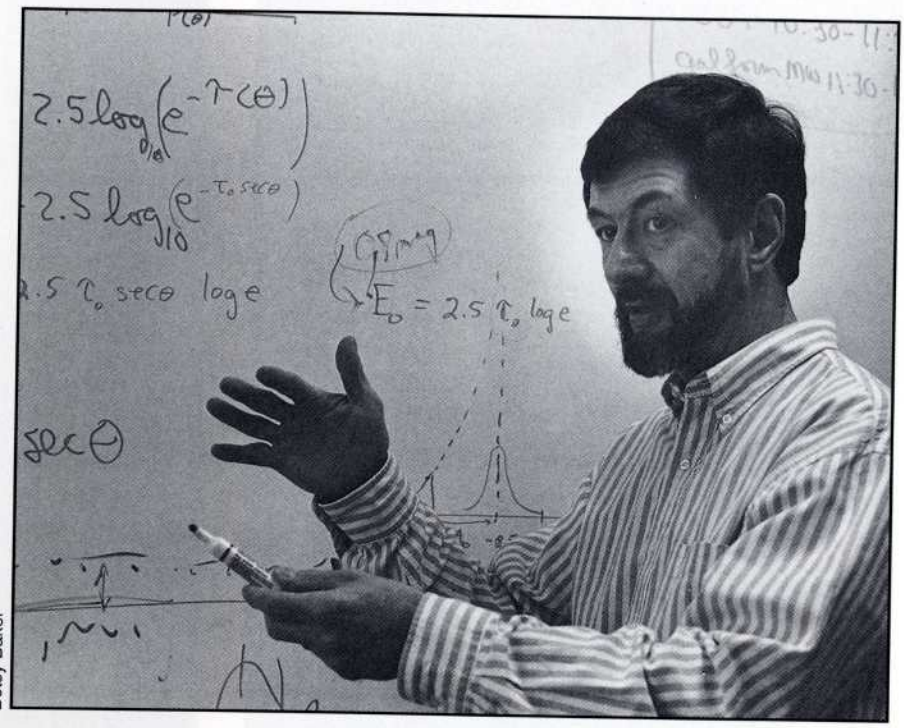


OU professor David Branch, at right, and graduate student Thomas Vaughan are involved in a project to determine the fate of the universe.

Armed with the distances to the galaxies, Branch has determined how long the galaxies have been receding and, therefore, how long the universe has been expanding.

The age that he calculates is consistent with the age of the stars, meaning there would be no need to complicate the universe with the cosmological constant.

"If the supernova distances are correct, the universe is older and bigger than many people think," he says.



Betsy Baker

Perpetual Expansion or Great Collapse?

Will the universe expand forever, or will it gradually slow down, turn around and fall back on itself in a great collapse?

University of Oklahoma astronomer David Branch and OU graduate student Thomas Vaughan are working on a project to determine the fate of the universe that was instigated by astronomers at the Lawrence Livermore Laboratory at Berkeley, California.

The key to the future lies in the past, says Branch, who is known internationally for his supernova research.

Using the distances to Type 1a supernovae, Branch has calculated the expansion rate of the relatively nearby universe.

"That's the recent past," he says. "In fact, in astronomical terms, it's almost now."

What Branch and the Berkeley group want to do is look far back in time by using an orbiting dedicated telescope capable of discovering supernovae at very large distances in any direction.

"If we discover a good sample of Type 1a supernovae in very remote galaxies, we can use them to determine the expansion rate of the universe back then," he says.

Using their "two snapshots in time," the astronomers can compare the expansion rates of the nearby universe with that of the more distant universe and, thereby, determine to what extent it is decelerating.

"If it's decelerating a lot, then we can calculate that it is destined in the future to reverse and come back," Branch says. "If it hasn't changed very much, we can conclude that it is decelerating very little and is destined for perpetual expansion."

Branch admits that the proposed research is a "monstrous task."

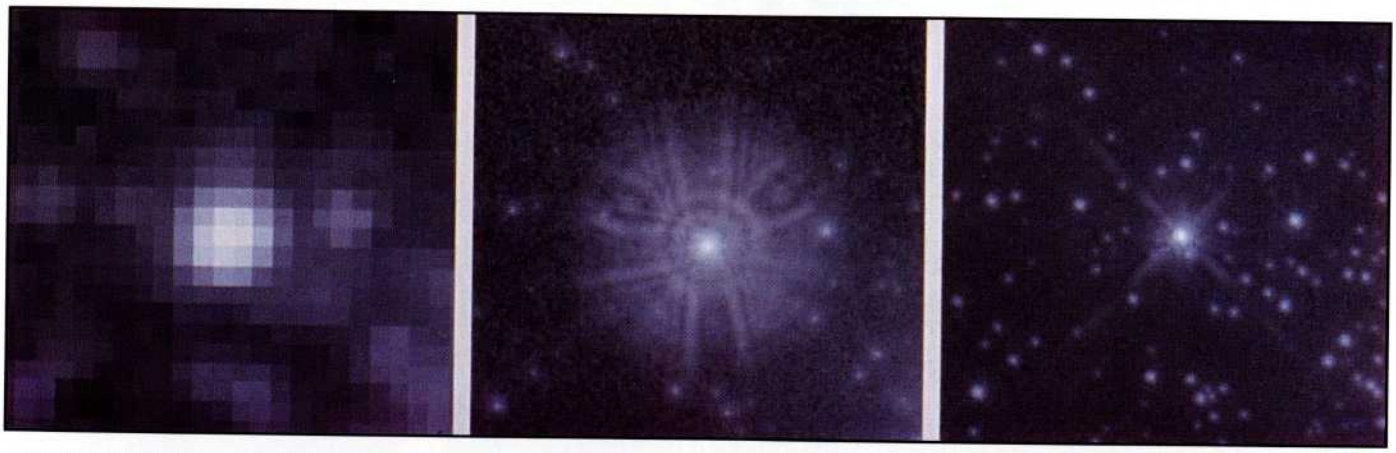
Since the Hubble Space Telescope has too small a field of view, the research group proposed to NASA the launch of an orbiting telescope dedicated to discovering the fate of the universe—and were turned down.

"We have to do a more thorough job of demonstrating feasibility," he says. "We'll keep on making proposals, but a lot depends on the fortunes of NASA."

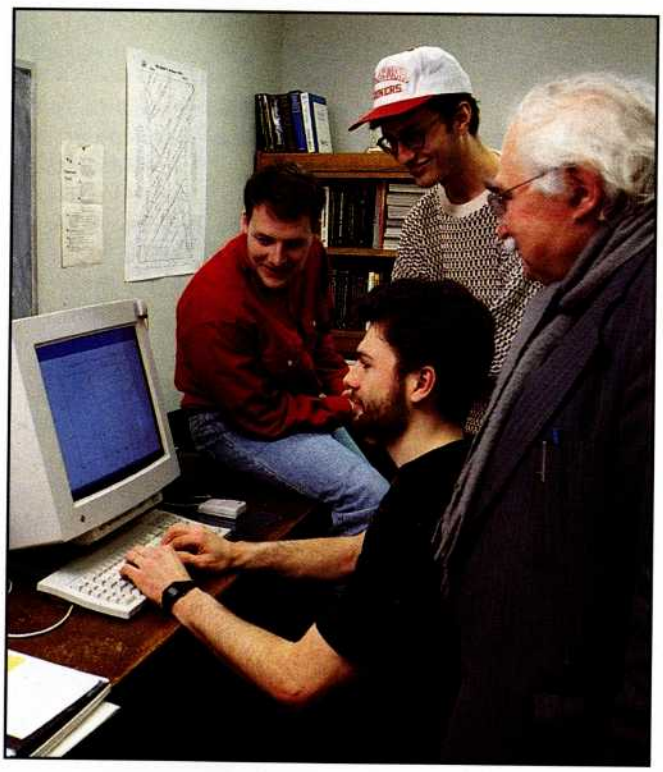
With or without a dedicated orbiting telescope, the determined astronomers will do whatever needs to be done to complete their research, Branch says, even if it means completing it a piece at a time with ground-based telescopes. Using such an approach, the answer may take a decade or more to discover instead of just a few years.

—Judith Wall

nding since it came into existence with the Big Bang



STAR LIGHT, STAR BRIGHT - Proving that the historic NASA mission to repair the Hubble Space Telescope was well worth the trip, the photo at left was taken without the HST, the one in the center by the HST before repair and the one on the right after repair.



Gil Jain

Branch's faculty colleague Tibor Herczeg, right, and graduate students Peter Nugent, left; Thomas Vaughan, seated; and Adam Fisher are part of the OU team suppporting a low Hubble constant as indicative of an older universe.

"And it also means the universe may be simple.

"If the galaxy people are right, the universe is somehow complicated, and the cosmological constant—or something even worse—is needed to determine how old and large it is."

Branch contemplates a more simple universe. "Of course, it can't be too simple, or we wouldn't be here at all," he admits. "But we still have the possibility that it's as simple as it can be. And that seems rather profound to me."

In a paper published December 1993 in *The Astronomical Journal*, Branch and graduate students Adam Fisher and Peter Nugent classify numerous Type 1a supernovae as "normal," and therefore acceptable as distance indicators, and only a few as "peculiar" and unsuitable.

And in a paper accepted for publication in early 1994 in *The Astrophysical Journal*, Branch, OU astronomy professor Tibor J. Herczeg and graduate students Fisher, Nugent and Douglas L. Miller support the estimate of a low Hubble constant by demonstrating the reliability of two normal Type 1a supernovae as distance indicators.

Branch has a prestigious ally in astronomer Allan Sandage of the Carnegie Institute of Washington in Pasadena, California. Sandage, who studied under Hubble, also believes that supernovae are reliable standard candles. With the aid of the Hubble Space Telescope—even in its original damaged state—Sandage has used Cepheid variable stars to check on reliability of the three nearest Type 1a supernovae as distance indicators.

Branch, whose research is funded by NASA and the National Science Foundation, expects that a soon-to-be-published paper by Sandage documenting additional work done with the Hubble Space Telescope will further confirm the validity of his own research.

The OU astronomer admits that validation is sweet. The clash between him and the "galaxy people" has been a long one. And it's not over, he points out. Those in favor of a higher Hubble constant and a younger universe are not ready to surrender.

But the tide of this astronomical battle does seem to be turning. And an older, larger and simpler universe eventually may prevail.