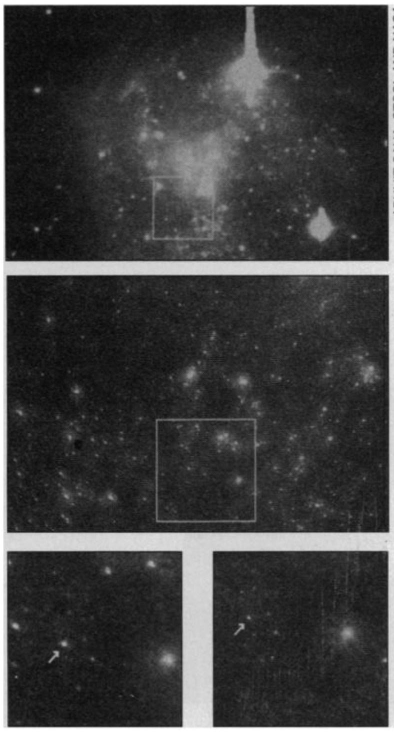
ASTRONOMY

The Hubble Constant Takes The Low Road Again

Like a careening roller coaster, values for the Hubble constant have soared and plunged for decades as cosmologists sought the one number that could tell how fast the universe is expanding and thus how old it is. Now researchers have tried to freeze-frame it with another of Edwin Hubble's namesakes, the Hubble Space Telescope. Combining the pulsating stars known as Cepheid variables with an old supernova, astronomers F. Duccio Macchetto, Nino Panagia, and Abhijit Saha of the Space Telescope Institute in Baltimore, along with Allan Sandage of the Carnegie Institute of Washington and Gustav Tammann of the University of Basel in Switzerland, have produced a new and unfashionably low estimate of this crucial constant. If correct, this newest number would peg the universe as substantially older—15 billion years plus—than a slew of other recent estimates suggest.

But views about this latest result's significance depend, as usual in this rancorous field, on which camp is talking. The beleaguered low-constant, old universe crowd, which yearns for a value of around 50 kilometers per second per megaparsec, hopes that the Space Telescope team's figure of about 45 may turn the tide back toward their view. But the preponderance of cosmologists, who see a Hubble constant of around 85—and therefore a sprightly universe perhaps 10 billion years old—voice skepticism based, in part, on the fact that Sandage and Tammann are leading lights of the low-constant crowd. One cynical researcher told *Science* that the pair's motto should be "Ignore the facts, this is the answer." A more neutral observation came from Harvard University's John Huchra, who notes that the new value "by no means ends the controversy. It's another piece of ammunition in the battle."

At the heart of the conflict is the seemingly unending debate over how to calculate the distances of far-off galaxies. Cosmologists need these numbers and one other set —the one telling how fast the galaxies are speeding away from Earth—to calculate the Hubble constant. It's easy to determine speed from the galaxies' spectra, but to get distances researchers have had to climb a rickety cosmological distance ladder based mostly on so-called standard candles. These are stars and other objects with uniform intrinsic brightnesses, which allows their distance to be estimated based on how bright they appear in a telescope.



ABHIJIT SAHA, STSCI, AND NASA

Distant beacon. A Cepheid variable brightens and dims *(above left and right)* in a galaxy *(top and center)* that hosted a 1937 supernova.

Climbing the ladder, researchers first find distances to nearby galaxies or stars in order to calibrate a short-range standard candle. They then use the first candle to calibrate a second one that can be seen in more distant galaxies and so on out into the cosmos. But each step up the ladder adds errors to the final measurement, so astronomers prefer to leapfrog as many rungs as possible—and that's just what the Space Telescope researchers have tried to do.

Cepheid variable stars, an excellent standard candle that often serves as the first rung of the distance ladder (*Science*, 24 January, p. 404), provided the starting point for this recent effort. These stars pulse like clockwork, at a rate that depends on their brightness. By timing a Cepheid, researchers can learn its intrinsic brightness and hence its distance from Earth. But Cepheids are usually too faint to be seen except in nearby galaxies, so that by themselves they can't give a good reading of the Hubble constant.

Several rungs up are the exploding stars called type Ia supernovas, which can be seen at much greater distances than Cepheids. These stellar blasts result when a companion star dumps extra material onto a white dwarf, turning it into an outsize thermonuclear bomb; theory predicts that all type Ia supernovas should peak at the same brightness. "These type Ia's are remarkably homogeneous. If you've seen one, you've almost seen them all," says David Branch, a supernova expert at the University of Oklahoma. That's just what is needed in a standard candle—except that because of the uncertainties in calibration, no one knew exactly how bright these standard candles were.

With the aid of the wounded but working Space Telescope, the researchers tied these two rungs together. In a faint spiral galaxy called IC 4182, the group was able to identify 27 Cepheid stars (they reported this accomplishment this week at a workshop in Sardinia, Italy). Only once before had Cepheids been seen at a comparable distance and then not in such numbers, says Macchetto.

Then came the tie in: IC 4182 is also the home of a type Ia supernova that exploded in 1937. Using the Cepheids, the observers were able to calculate a distance to the galaxy—16 million light years. Combining that figure with old observational data from the 1937 explosion, they then established an absolute brightness for the supernova. And having calibrated the supernova, they were on their way to a new estimate for the Hubble constant.

Assuming that the type Ia supernovas that have been spotted in other, more remote galaxies all reached peak brightnesses similar to that of the 1937 event, the researchers calculated the galaxies' distances. Combining these distances with the recessional velocities of the galaxies, the team emerged with a Hubble constant between 30 and 60, with 45 being the most probable value.

Not surprisingly, that figure is tough to accept for some, who point out that the Cepheid-based result is at odds with other distance measurements to the crucial galaxy. Just recently, a team led by Michael Pierce of Kitt Peak National Observatory looked at extremely bright stars called red giants and concluded that IC 4182 is only around 8.5 million light years away, putting the Hubble constant nearer to 86. Pierce says he isn't about to retreat before the Space Telescope results, although he admits that Cepheids are potentially a better gauge of distances than red giants. "Cepheids will definitely be superior. There's no question about that—if they're done properly," he says, reserving judgment until he sees a published paper.

Even Macchetto isn't prepared to say the latest result is the last word on the Hubble constant. "I'm uncomfortable with doing just one supernova," he says, explaining that his group will try to look for Cepheids in other galaxies, even more remote, where type Ia supernovas have been observed. In that way, they can be assured that the 1937 blast was not an unusual one. "This is not the end of the story. It's only the beginning," he says. But if the story unfolds as planned, the Hubble Space Telescope may yet write the final chapter on the controversial constant of the same name.

–John Travis