Dating the cosmos from super stars . . .

The Hubble constant provides a measure of the expansion of the universe, indicating the age and size of the cosmos (SN: 10/8/94, p.232). Next week, astronomers using the repaired Hubble Space Telescope will make a long-awaited announcement — their estimated value for the constant. In the meantime, researchers using ground-based telescopes have reported a flurry of new measurements.

Obtaining a value for the Hubble constant requires astronomers to gauge accurately the distance to objects far from the Milky Way. Several teams use a succession of "standard candles," the celestial equivalent of lightbulbs of known wattage, to calibrate, step-by-step, distances in the universe. But Robert P. Kirshner of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., and an international team of colleagues use an approach that provides direct distances to objects several hundred million light-years from Earth.

He and his coworkers rely on observations of the brilliant remnants of type II supernovas, the rapidly expanding shells of hydrogen-rich gas hurled into space when the cores of massive stars collapse. By measuring the color and brightness of the expanding gas, the team deduces how big a patch of sky the exploded star occupies at different times. Comparing the size of the patches with the expansion velocity yields the distance to the supernova.

In the Sept. 1 ASTROPHYSICAL JOURNAL, Kirshner and his colleagues report the results of their recent observations of five type II supernovas. Combined with findings from their previous studies of 13 similar objects, these results show that the Hubble constant has a value ranging from 67 to 79 kilometers per second per megaparsec. This would make the cosmos no more than about 14 billion years old, younger than many theorists believe but perhaps old enough to allow for the evolution of the most ancient known groups of stars.

. . . and relic radiation

Many methods of measuring the Hubble constant are at least partly flawed because they don't peer deeply enough into the universe. John P. Huchra of Harvard University notes that just because the Hubble constant appears to have a certain value a few hundred million light-years from Earth, it doesn't mean that number can be applied to the rest of the cosmos.

Several new strategies enable astronomers to measure the Hubble constant directly at larger distances. Although the methods don't require calibration from a nearby galaxy, some of the techniques force astronomers to make unproved assumptions about the shape of galaxies and galaxy clusters.

One of these strategies relies on a phenomenon known as the Sunyaev-Zel'dovich effect. This effect involves the interaction between hot, X-ray emitting gas found in galaxy clusters and the cosmic microwave background, the relic radiation left over from the Big Bang.

Some of the microwave background photons passing through a cluster get kicked to a higher energy by electrons in the hot gas there. A radio telescope measuring the microwave background near a cluster would thus see a decrease in the number of microwave photons. This would make it appear that the glow from the radiation has a slightly lower temperature near a cluster than elsewhere in the universe.

Combining the perceived drop in the microwave background temperature with data on the intensity of X rays in the cluster, astronomers can calculate the length of the galaxy cluster along the line of sight to Earth. At this point, they typically make a simplifying assumption: They model the cluster as a sphere.

If a cluster takes the form of a sphere, its length is equal to its width. By comparing the cluster's true width with its diameter on the sky as observed from Earth, scientists can calculate how far away the cluster must lie. Armed with the distance to a far-off cluster, astronomers can then obtain a more accurate value for the Hubble constant.

Richard Saunders, Michael Jones, and their colleagues at the University of Cambridge in England used the Ryle telescope, a group of five 13-meter radio dishes in Cambridge, to observe the Sunyaev-Zel'dovich effect in the galaxy cluster Abell 2218. The team's latest results, reported in the most recent ASTROPHYSICAL LETTERS AND COMMUNICATIONS (vol. 29, no. 5), suggest the Hubble constant is low — between 25 and 55. This implies that the universe is 18 to 20 billion years old. Preliminary observations of another cluster, Abell 1413, give a similar value, Saunders says.

Saunders asserts that had he assumed these clusters were highly elongated — cigar-shaped rather than spherical — the Hubble constant his team inferred would only have been lower, indicating an even older age for the universe. However, other groups observing the Sunyaev-Zel'dovich effect find different values for the constant.

The supernova that wasn't?

Some 1,800 years ago, Chinese astronomers witnessed the sudden appearance of a brilliant "guest star." Scientists now widely regard this celestial event, carefully noted in an official history at the time, as the oldest supernova ever recorded. Indeed, researchers have suggested several candidates for the glowing stellar remnant cast off during this apparent supernova, the explosive death of a massive star.

But a new analysis of the historical record suggests the ancient Chinese didn't see a supernova explosion after all. Instead, two radioastronomers now argue, the Dec. 7, 185, discovery was in fact a comet.

Yi-Nan Chin of the University of Bonn in Germany and Yi-Long Huang of National Tsing Hua University in Hsinchu, Taiwan, base their assertion on a reinterpretation of a key passage in the *Houhanshu*, the official history of the Later Han dynasty. Their translation, detailed in the Sept. 29 NATURE, differs significantly from that of several other scientists.

Researchers who previously had studied the passage, written in 185 by astronomers at the imperial observatory of Lo-Yang in central China, interpreted the wording to mean that the guest star remained fixed in the sky and stayed visible for about 19 months. This description is consistent with a supernova. In contrast, a comet moves, and its orbit would cause it to fade from view more rapidly.

But Chin and Huang argue that key words had been translated according to their meaning in modern Mandarin Chinese rather than the original definitions used by ancient astronomers. A more accurate translation, they maintain, reveals that the bright object moved across the sky and lasted for only 7 months.

They note that an additional passage in the text forecasts civil war in China. This kind of astrological prediction is based on a bright body moving across the sky at the same position as the guest star, Chin and Huang note. They add that the supernova remnant RCW86, a favorite candidate for the guest star, looks too old to have appeared in the sky only 1,800 years ago. "It seems clear that the guest star was a comet and not a supernova," the radioastronomers conclude.

Astronomer Bradley E. Schaefer of Yale University finds the new report intriguing but says it's too early to settle the controversy. He maintains that the ancient Chinese discovered the object low in the sky just before sunrise. A comet at the reported position would have had to have been very bright to be seen at all. And a bright comet is either unusually large or passing very near Earth. In the latter scenario, the comet couldn't remain visible for as long as 7 months, Schaefer says.