Astronomy

Ron Cowen reports from Phoenix at a meeting of the American Astronomical Society

Coloring the view of star formation

Do young galaxies form stars from the outside in or the inside out? Thirty-one years ago, astronomers Allan R. Sandage, Olin Eggen, and Donald Lynden-Bell published a paper suggesting that when a huge cloud of gas gravitationally collapses to create a galaxy, the first stars ignite at the outskirts of the galaxy. Over time, as more matter sinks toward the galaxy's center, star formation kicks in at the galactic core.

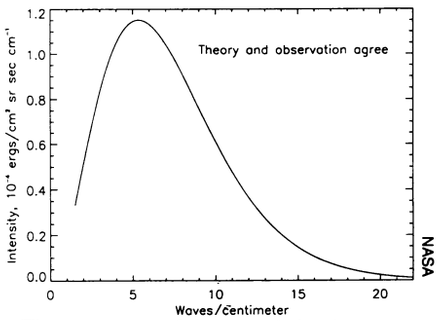
If starbirth follows this model, then younger, bluer stars should reside at a youthful galaxy's center and older, redder stars should reside farther out, closer to the galaxy's edge. (An older, more highly evolved galaxy would have a uniform distribution of stars of all ages throughout.) But researchers have been unable to test this model because they lacked telescopes sharp enough to examine the color of stars in different regions of a distant young galaxy.

Now, the Hubble Space Telescope — despite its flawed primary mirror — has provided the needed resolution. Viewing in visible and near-infrared light the distant radio galaxy 53W002, seen as it appeared some 10 billion years ago, Hubble's Wide-Field/Planetary Camera has found that the center of the galaxy is noticeably bluer than its outer edge. Rogier A. Windhorst of Arizona State University in Tempe says the finding is the first confirmation of the 1962 hypothesis that stars form first in the outer areas of a galaxy.

He and his colleagues, who include J.M. Gordon of Arizona State and William C. Keel of the University of Alabama in Tuscaloosa, plan to report further details of their work in an upcoming ASTROPHYSICAL JOURNAL.

COBE: A match made in heaven

Analyzing further data recorded by NASA's Cosmic Background Explorer (COBE) satellite, researchers say they have more evidence to support the Big Bang, the theory that the universe began with a giant explosion. The analysis, based on 10 months of data from COBE's Far Infrared Absolute Spectrophotometer, indicates that a single explosive event emitted 99.97 percent of the radiant energy in the universe and that the event took place some 15 to 20 billion years ago.



The spectrum of the cosmic background radiation seen by NASA's COBE satellite is virtually identical to that predicted by the Big Bang theory.

The new results show that at several different wavelengths, the radiation left over from the birth of the universe matches almost exactly the spectrum expected from a single blackbody — an object that absorbs all radiation falling on it. Soon after COBE's 1989 launch, researchers announced that the microwave background radiation detected by the satellite matched that of a blackbody to within 1 percent (SN: 1/20/90, p.36). The new data reduce the uncertainty to 0.03 percent.

The COBE findings also indicate that the background radiation, which has cooled dramatically since the hot Big Bang, has a temperature of 2.726 kelvins. COBE scientists say the temperature measurement is accurate to within 0.01 degree.

These results suggest that the youthful universe did not undergo a succession of "little bangs," as some theorists suggest. Black holes, exploding supermassive stars, or the decay of unstable elementary particles could not have released a significant amount of primordial radiation. Thus, tiny fluctuations in the radiation associated with the Big Bang — not other, smaller events — seem to have transformed the smooth primordial cosmos into today's lumpy universe.

"The Big Bang theory comes out a winner," says COBE scientist John C. Mather of NASA's Goddard Space Flight Center in Greenbelt, Md.

Stellar astronomy with resolve

Astronomers have for the first time resolved the size of a shell of gas hurled into space by a nova explosion just days after the eruption.

Aside from representing the first visible-light measurement of a recently ejected nova shell, the detection enables researchers to directly measure the distance of the nova from Earth — without making assumptions about the nova's luminosity or the amount of obscuring dust between Earth and the star system. Such measurements provide a better standard "ruler" for estimating the expansion rate of the universe.

Nova explosions occur in binary star systems, which consist of a puffed-up, low-density star called a red giant and a much smaller, compact companion called a white dwarf. Under the influence of gravity, mass in the outermost layers of the red giant falls onto an accretion disk surrounding the dwarf. When enough material is deposited, a thermonuclear explosion can result, boosting the brightness of the binary star and hurling a spherical, expanding shell of material into space.

In studying the aftermath of the explosion that created Nova Cygni 1992 (SN: 3/7/92, p.158), several researchers relied on a technique called optical interferometry. In this technique, telescopes separated by a known distance observe the same celestial source. Combining light from each telescope to produce an interference pattern of alternating dark and bright fringes, astronomers reconstruct the size of the source with a resolution far better than either telescope could attain alone.

Using the Mark III Optical Interferometer at the Mount Wilson Observatory near Pasadena, Calif., to study Nova Cygni just 10 days after first glimpsing the stellar outburst, researchers found it had an apparent angular diameter on the sky of 5.1 milliarcseconds. From this measurement they deduced that the nova then resided between 7,300 light-years and 9,500 light-years from Earth. Nicholas M. Elias II of the U.S. Naval Observatory, Andreas Quirrenbach of the Universities Space Research Association, and David Mozurkewich of the Naval Research Laboratory and their colleagues, all of Washington, D.C., collaborated on the study.

In other studies with the same interferometer, a team including Quirrenbach, Mozurkewich, and Richard S. Simon of the Naval Research Laboratory measured for the first time the width of the atmospheres of 10 giant and supergiant stars. One of the stars, Beta Pegasi, appears about 10 to 15 percent fatter when observed in the light emitted by titanium oxide than in broad-band visible light.

Studies with Mark III have also resolved the disks of hydrogen gas surrounding three rapidly spinning, massive stars known as Be stars. The disks don't seem to form perfectly symmetrical circles or ellipses around the stars. Intriguingly, interferometry of the Be star Gamma Cassiopeia reveals a sharply resolved, elliptical disk with an extra, fuzzy component orbiting it at a distance of about 1 astronomical unit (the distance between Earth and the sun).

This fuzzy blob, which might be an instrument artifact rather than a real object, suggests that visible-light interferometry may one day help scientists search for planets and other structures that may emerge from dusty disks like the one thought to have once encircled our sun.