# Quasar Clumps Dim Cosmological Theory

A research satellite launched last June has allowed astronomers to peer deeper into space with X-ray eyes than ever before. And the distant vistas they've glimpsed show evidence of what appear to be giant clusters of quasars eight to 12 billion light-years from Earth — more than halfway to the edge of the observable universe. These clusters suggest the universe began getting lumpy earlier — and on a larger scale — than previous sky maps had indicated, researchers reported last week.

Combined with other recent observations of large-scale clumping (SN: 1/12/91, p.22), cosmologists say the perplexing new finding, if confirmed, may force them to abandon a standard theory — known as the cold-dark-matter model — of how the universe evolved. "This may be the start of the death knell for the cold-dark-matter theory," says physicist Paul Steinhardt, at the University of Pennsylvania in Philadelphia.

Scientists proposed the theory as a way of reconciling two snapshots of the universe — one representing the distant past and another of the present. Several measurements indicate that the ubiquitous background microwave radiation, believed a remnant from the Big Bang, has the same intensity everywhere in space. This suggests the universe began as an incredibly smooth and uniform soup of matter and energy (SN: 1/20/90, p.36). The conundrum is how it evolved into its current lumpy collection of stars and galaxies.

Because the *observed* mass in the cosmos is too small to gravitationally bind large objects, cosmologists at first suspected that the universe contains a large quantity of invisible, ordinary dark matter to supply the needed gravitational glue.

But the garden-variety dark matter — composed of protons, neutrons or other familiar building blocks — interacts strongly with light. During the early history of the universe, this interaction would have suppressed gravity's tug and prevented tiny lumps or fluctuations in the density of primordial matter from growing fast enough to account for the present large-scale structures.

To solve the problem, theorists turned to the concept of *cold* dark matter, which postulates a type of hidden material that interacts weakly with light and has more time to expand the size of primordial lumps. But the simplest form of this model — in which all hidden matter is cold — still cannot explain the picture of the universe emerging from recent observations, Steinhardt and others say.

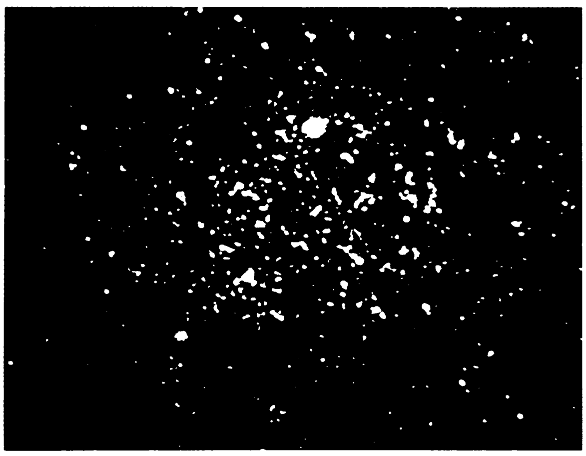
Next month, the U.S.-European Roentgen Satellite (ROSAT) will complete its first sky survey. Up to this point, it has resolved X-ray sources in greater detail and detected sources about 2.5 times fainter than other X-ray-probing satellites.

One of ROSAT's detectors imaged very dense, fuzzy patches of low-energy X-rays from dimmer sources about 8 to 12 billion light-years from Earth, Guenther Hasinger of the Max Planck Institute for Extraterrestrial Physics in Garching, Germany, reported last week at a meeting of the American Astronomical Society in Philadelphia. Based on this intensity, the rough shape of the fuzzy images and their proximity to individual quasars, he speculates that the X-ray emissions originate from clusters of quasars with a diameter of 15 to 75 million light-years.

Hasinger adds that further ROSAT observations with the same detector, expected to resume this August, may confirm the validity of the quasar-cluster interpretation. Stephen S. Holt of the NASA Goddard Space Flight Center in Greenbelt, Md., notes that ROSAT offers a prime tool to discern quasars, since many radiate 100 times more intensely in X-ray than in visible light. — *R. Cowen*

## Heavenly bodies make their UV film debut

When the space shuttle Columbia landed last month after a nine-day research mission called Astro, one anxious scientist still didn't know if his shuttle-borne experiment had worked. Theodore P. Stecher of NASA's Goddard Space Flight Center in Greenbelt, Md., had to retrieve and develop 900 frames of ultraviolet-sensitive film from the payload before he could assess the success of the Ultraviolet Imaging Telescope, the mission's sole picture-taking instrument.



NASA Goddard

*False-color ultraviolet image of the globular cluster Omega Centauri. The brightest areas denote regions of highest light intensity; the darkest areas denote the lowest intensity.*

Last week, at the American Astronomical Society meeting in Philadelphia, Stecher announced that the telescope had performed well indeed, and he presented several images to prove it.

The central region of the globular cluster Omega Centauri (pictured here) occupies a region of the Milky Way some 17,000 light-years from Earth and houses nearly a million stars. Until now, none of those stars had been photographed in the ultraviolet. Optical pictures of the cluster, taken by ground-based telescopes, detect mainly red giant stars and yellow main-sequence stars, whereas the ultraviolet image primarily spotlights hotter, less common stars that evolved from red giants by ejecting their outer atmosphere.

Stecher points out that the ultraviolet photograph, in contrast to optical images, does not show a strong concentration of stars at the very center of the cluster. Whether the apparent dark areas or "holes" in the core represent light-obscuring dust clouds, stars too dim to detect or an actual gap in the cluster remains unclear, says Goddard astronomer Susan G. Neff.

Neff notes another curious feature: an unusually large variation in stellar light intensity, indicated by the presence of several different hues in the false-color image. She says that Omega Centauri may have collided at some earlier time with another cluster to create the mix of ultraviolet intensities and the lower-than-expected core density apparent in the globular cluster today.

The Ultraviolet Imaging Telescope also captured on film the spiral galaxy M81, about 12 million light-years from Earth. Bright spots in the galaxy's curving arms reveal areas where starbirth concentrates. Some of these bright regions form a ring — barely visible in optical images of M81 — about 19,500 light-years from the galactic center. Neff suggests that gravitational pull from another galaxy that passed nearby, perhaps the irregular galaxy M82, could have helped form the ring-shaped feature. — *R. Cowen*