Opening the Door to the Early Cosmos

The universe seems to have grown up in a hurry.

When the cosmos was less than a billion years old—about 7 percent of its current age—some massive galaxies had already assembled, and an entire generation of stars had lived and died. So report two groups of astronomers who have independently found a huge amount of carbon monoxide gas around a distant quasar.

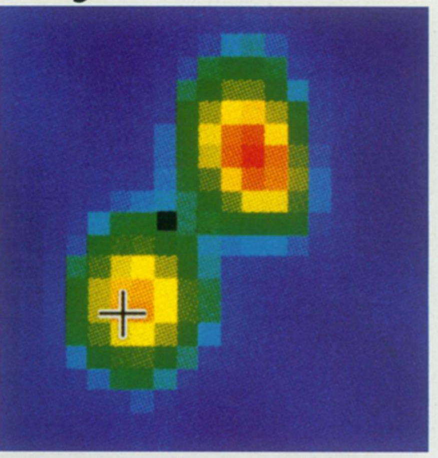
Carbon and oxygen weren't forged in the Big Bang and are known to be produced only by nuclear burning at the cores of stars.

To examine the vicinity of the quasar, dubbed BR 1202-0725, researchers used telescopes operating at millimeter wavelengths to peer deep into space and far back in time. The quasar's redshift of 4.69—a measure of distance—indicates that the light now reaching Earth left this brilliant powerhouse when the cosmos was only about a billion years old.

In this regard, the carbon monoxide detections, reported in the Aug. 1 NATURE, set a new record. Other astronomers had observed this gas in the vicinity of two slightly nearer objects—a quasar at a redshift of 2.5 and a gas cloud at a redshift of 3.1.

To obtain the new data, Alain Omont of the Institute of Astrophysics in Paris and his colleagues used a quartet of millimeter-wave antennas built by the Institute of Millimeter Radio Astronomy on the Plateau de Bure in France. A second team, which includes Toru Yamada of Japan's Institute of Physical and Chemical Research in Saitama, relied on the Nobeyama Millimeter Array in Nagano.

Astronomers had previously found an enormous amount of dust, possibly heated or produced by stars, around the quasar (SN: 9/17/94, p. 188). The observations of carbon monoxide bolster the case for a previous generation of stars. They also confirm that distant quasars don't exist in solitary confinement but lie at the center of star-forming galaxies, notes cosmologist Martin J. Rees of the University of Cambridge in England. "Until recently, the only objects at [large distances] have been quasars. . . . This is fairly direct evidence that large galaxies had already assembled."



Stéphane Guilloteau/NATURE

Map shows a carbon monoxide emission surrounding the quasar BR 1202-0725 (in crosshair). The second blob may be an emission from an unseen galaxy.

Can theories of galaxy formation explain such rapid assembly?

Observations of a single, distant quasar aren't enough to spell trouble for any theory. Many astronomers think of quasars and the galaxies that house them as rare beasts that may not represent conditions typical in the cosmos. If researchers continue to spy normal galaxies—those not associated with quasars—further and further back in time, however, some models may fall by the wayside (SN: 6/29/96, p. 406). "Obviously, the earlier galaxies formed, the more constraints on theories," Rees notes.

Omont's team found two blobs of carbon monoxide emission. One blob is centered on the quasar's visible-light image; the other lies a few hundred thousand light-years away and has no known optical counterpart. This second blob might represent a cosmic mirage, in which the gravity of a foreground galaxy splits the quasar light into several images, but it could also be a bona fide galaxy, hidden by dust, that shows up only at far-infrared or millimeter wavelengths.

If the object is real, says Richard Barvainis of the Massachusetts Institute of Technology's Haystack Observatory in Westford, Mass., it could herald a new era in astronomy. A slew of even more primitive quasars and galaxies may lie cloaked in dust, waiting to be unveiled by the next generation of millimeter-wave and radio telescopes, he notes.

— *R. Cowen*

Geologists ponder the depth of earthquakes

When a section of the Pacific plate scrapes North America, seismologists expect to see a whole lot of shakin' goin' on. In Southern California, where this clash is ongoing, experts puzzle over the limited size and number of quakes over the past century.

Geologists Harold Magistrale of San Diego State University and Hua-wei Zhou of the University of Houston help resolve the mystery in the Aug. 2 SCIENCE. They report that a hidden layer of soft schist rock helps to buffer Southern California from the most violent shaking.

They also say their data can improve predictions of the biggest quake likely to strike specific sites.

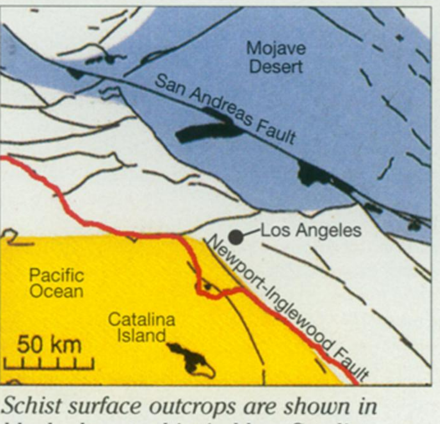
Zhou used earthquake data from 1981 through 1994 to determine hypocenters—the location and depth—of 37,000 Southern California earthquakes. They found differences of 4 to 10 kilometers in depth between some quakes that were geographically close together, indicating that Earth's brittle, quake-prone outer layer has well-defined "steps" where its thickness changes dramatically. Where composed of schist, the layer is thinner.

An earthquake's magnitude is proportional to the length and depth of the rupture created by slipping plates. Because schist softens under less temperature and pressure than other rock in the outer layer, it does not rupture as far down, thus limiting a quake's magnitude.

While schist outcrops on the surface are widely scattered in Southern California, the new data show that a broad region on either side of the San Andreas fault rests on schist, as does the area west and offshore of the Newport-Inglewood fault, which runs under densely populated zones.

Rock distribution can explain much, but improved predictions of quake magnitude will have to await a more thorough grasp of heat flow under the region, says Hiroo Kanamori, a geophysicist at the California Institute of Technology. Temperatures deep underground can vary 50°C or more at sites less than 150 km apart, he notes, regardless of rock distribution.

— *E. Skindrud*



Magistrale/SCIENCE

Schist surface outcrops are shown in black, desert schist in blue, Catalina schist in yellow. Red line indicates Southern California coast.