Astronomy

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

Quasars without clothes

Are quasars born naked and only later in life cloaked in a starlit galaxy? New images taken with the Hubble Space Telescope suggest that some of the most brilliant of these light beacons may indeed emerge in isolation — an idea that appears to defy conventional wisdom about how a quasar forms.

According to a widely accepted model, massive black holes power quasars. As gas or stars venture close to a hole, the material heats up and radiates tremendous energy in a narrow beam of light — a quasar. But if infalling stars and gas provide the fuel for quasars, it would seem necessary that a "host" galaxy harboring this fuel surround each such beacon. Moreover, ground-based observations hint that the brightest quasars lie at the center of the brightest galaxies.

But when John N. Bahcall of the Institute for Advanced Study in Princeton, N.J., and his colleagues recently used a Hubble camera to search for galaxies around some particularly bright quasars, they came away nearly empty-handed. Among 15 bright, relatively nearby quasars in their survey, only four showed some evidence of a host galaxy. The host galaxies around the other 11 quasars are either too faint to be seen in the Hubble survey or simply don't exist.

"This is a giant leap *backwards* in our understanding of quasars," says Bahcall, who collaborated with Sofia Kirhakos of the Institute for Advanced Study and Donald P. Schneider of Pennsylvania State University in University Park.

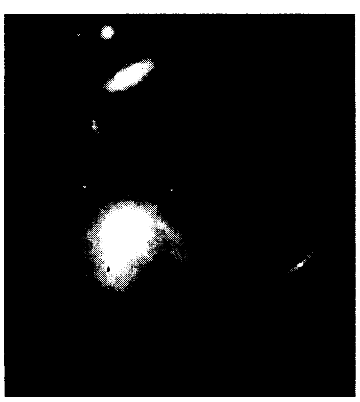
"This is one of the most surprising results ever obtained with the Hubble Space Telescope," says cosmologist Jeremiah P. Ostriker of Princeton University.

The bright, seemingly naked quasars may in fact signal the birth pangs of galaxies. Bahcall speculates that at least some quasars form at the heart of budding galaxies that are initially too faint to observe. A quasar glows brightly because of the gas pulled into the region by gravity, he suggests. Later, as less material falls in and the quasar dims, the surrounding galaxy accumulates enough material to trigger star formation and shine. This model fits with ground-based observations that less luminous quasars do have host galaxies.

"This is purely conjecture . . . but the story hangs together if you assume that it's the beginning of quasar-galaxy evolution," Bahcall notes. The team, he adds, may simply have missed the host galaxies by not looking for faint enough objects. "We all expected the [galactic] environment to be [readily] visible."

Bahcall's team often found galaxies or remnants of galaxies in the same patch of sky as the quasars. Until researchers obtain spectra of these faint bodies, they won't know whether the galaxies actually reside at roughly the same distance as the quasars or just happen to lie along the same line of sight.

Though he regards the latter possibility as unlikely, Bahcall notes that if the galaxies and quasars don't reside at the same distance, it would have an enormous impact on cosmology. In that case, he says, redshift — the lengthening, or reddening, of light emitted by faraway objects — may not indicate an object's distance. The notion of redshift as a measure of distance is central to Big Bang cosmology and the concept of an expanding universe.



Bahcall/NASA

Bright central object in this Hubble image is the quasar PKS 2349-01. Two wisps at quasar's left are remnants of a galaxy believed to have been torn apart by the quasar. Whether they once formed part of a host galaxy remains unknown.

Earth Science

Top 10 uses for Super Collider tunnel

When Congress killed the Superconducting Super Collider (SSC) in October 1993, comedians had no trouble thinking up uses for the $2 billion section of tunnel already drilled. For example: world headquarters for the Cold Fusion Research Institute; an oxygen storage tank for Biosphere 2.

Geophysicists are now coming forward with some ideas of their own. They have proposed a suite of potential experiments and hope to forestall closure of the 22.5-kilometer-long, 45-meter-deep tunnel. In the Nov. 29 EOS, Herbert F. Wang of the University of Wisconsin–Madison and his colleagues contend that the SSC site has value as a research tool because it offers scientists superb access to rocks underground.

"It's an ideal opportunity to test new methods. It's actually a rare opportunity. In the earth sciences, we usually do not have the chance to get underground access to the tests we do. And that always leads to ambiguity in drawing conclusions about whether you have really done what you have thought you have done from the surface," says one of the study's coauthors, Larry R. Myer of the Lawrence Berkeley (Calif.) Laboratory.

Because the tunnel runs through fractured beds of chalk and shale, scientists could use it to test how fractures help and hinder fluid flow underground. "There are many environmental problems in which chemicals and toxic substances have gotten into the groundwater system, and the groundwater travels primarily through fractures. These are difficult to map out and characterize," Myer says.

Engineers could use part of the tunnel to learn more about the properties of shale, a type of rock that presents problems for construction projects. But according to Wang, geophysicists interested in the SSC site must find funding quickly in order to take advantage of the opportunity. Under an agreement with the state of Texas, the U.S. Department of Energy plans to fill the entrance shafts to the tunnel soon.

Century-old fossil mystery put to rest

The fossil *Hallopus* made quite a splash in 1877 when famed paleontologist Othniel Charles Marsh described it as a tiny, birdlike dinosaur. But the fiercely competitive Marsh went to his grave without revealing where collectors had unearthed this unique specimen. By combining modern analytical techniques with some old-fashioned detective work, two paleontologists and a geologist have now resolved the *Hallopus* enigma.

Marsh himself described the fossil as coming from the lower Jurassic rock formations (about 200 million years old) in Colorado, getting no more specific than that. But he considered the rocks important enough to coin the name *Hallopus* beds after the sandstone in which it was found.

The site remained a mystery until 1991, when Kenneth Carpenter of the Denver Museum of Natural History began studying century-old quarries near Garden Park, Colo. Using a one-sentence description in archival records from Yale University (where Marsh had worked), Carpenter located a layer of rock beneath a distinctive cone-shaped hill. He sent a sample of the rock to Yale's John H. Ostrom and Jay J. Ague.

By comparing the abundances of various elements and minerals in the rock, Ague and Ostrom determined that Carpenter's sample matched the *Hallopus* rock exactly. They later found confirming evidence in a letter, written to Marsh in 1877, describing in detail where collectors had found the fossil.

In the January AMERICAN JOURNAL OF SCIENCE, the three researchers report that *Hallopus* actually came from the upper Jurassic, about 40 to 50 million years later than Marsh had suggested. That's not the only error he made about *Hallopus*. Work in 1970 revealed the animal's true identity as a long-legged crocodile, not a dinosaur at all.

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