objects. The uncertainty has allowed some theorists to suggest that BL Lacs are not AGNs at all but a subset of quasars, which are far brighter and more distant. At the Berkeley conference, however, Arieh Königl of the University of Chicago reported finding an absorption line in EUVE data on the BL Lac object PKS 2155-304. He and his colleagues think that ions of magnesium, iron, and neon in clouds floating near the jet are absorbing radiation to produce the feature.

Its redshift, Königl and his colleagues say, implies a distance of "only" 1.5 billion light-years for PKS 2155-304, laying to rest the possibility that the object is actually a much more distant quasar. Says Bowyer, "EUV is telling us things about AGNs that you couldn't see in any other wavelength band."

It is doing the same for less exotic galaxies. Training EUVE's detectors on the elliptical galaxy M87, Richard Lieu of the CEA and his colleagues in Germany, the United Kingdom, and the United States saw a trillion-solar-mass halo of gas at up to a million degrees, enveloping the entire visible galaxy. X-ray observations of M87 had revealed an even more massive cloud at still higher temperatures, so the new EUVE data imply that two gas halos somehow coexist in the same space. Because million-degree gas has a wealth of emission lines that cool it efficiently, Lieu speculates that the EUV halo survives only because it is continuously replenished by supernova explosions that drive "stellar winds" of hot gas out of the galaxy.

But the discoveries, and the puzzles they bring, are only just beginning. By comparing EUVE and ROSAT data, for example, Jürgen Schmitt of the CEA and the Max Planck Institute for Extraterrestrial Physics in Garching has found scores of sources detected by one satellite but not the other. Because the probes made their surveys at different times, the explanation for at least some of the sources may be that they dim and brighten—but what they are, and why they should vary, no one knows.

All of which leaves EUV astronomers anxious to keep looking out their new window. A Japanese Mars probe scheduled for launch in 1998 should help keep that window open. Stripped of every nonessential gram, the craft will carry only one astronomical instrument to profit from the clear view of the stars available from interplanetary space: a miniature EUV detector.

**–Donald Goldsmith**

*Donald Goldsmith is an astronomy writer in Berkeley. His next book,* Einstein's Greatest Blunder? The Cosmological Constant and Other Fudge Factors in the Physics of the Universe, *will be published in August by Harvard University Press.*

ASTRONOMY

# Found: Ash From the First Stars?

For most of us, an occasional hike in Colorado or Maine satisfies the hankering to see nature in its pristine form. For astronomers, though, the search for primordial nature means a much longer journey.

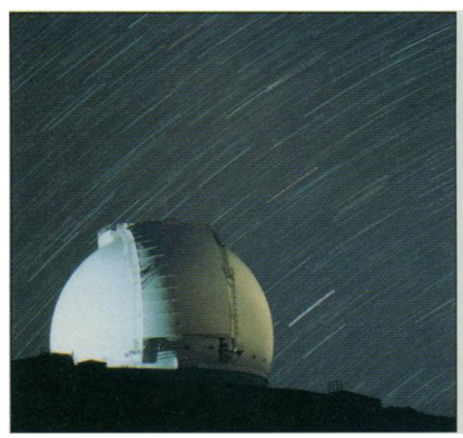
To see what the cosmos looked like before the first stars began to alter the pristine hydrogen and helium made in the big bang, observers peer billions of light-years away from Earth and billions of years back in time, to the vast clouds of hydrogen known as Lyman-α forest clouds because of the thicket of dark lines in their spectra. These clouds, thought to be the precursors of galaxies, have seemed free of the heavy elements that are the product of stellar burning. But now, like a hiker who finds a candy wrapper in a remote forest, astronomers are realizing that Lyman-α clouds may not be as pristine as they had thought.

Scrutinizing distant hydrogen clouds with the 10-meter Keck Telescope at Mauna Kea, Hawaii, the world's largest, groups from the University of Hawaii and the University of California, San Diego (UCSD), have shown that the clouds are "clearly contaminated with the products of stars," says Michael Shull, a researcher at the Joint Institute for Laboratory Astrophysics (JILA) of the University of Colorado, Boulder. The discovery of these products—atoms of carbon, an element that can only be made in stars—is as surprising as "getting to a Pacific island and finding elephants," says Jeremiah Ostriker of Princeton University. It may call for major revisions in the standard view of the early universe, in which the first stars winked on during the process of galaxy formation. At the same time, says Ostriker, an unseen first generation of stars could help clear up long-standing mysteries such as how present-day galaxies grew so large and how gas in the early universe became ionized.

Astronomers can study these clouds, which lie roughly 10 billion light-years away, only with the help of even more distant and enigmatic objects that shine with the intensity of hundreds of billions of suns: quasars. By lighting up the clouds from behind, the quasars serve as convenient probes. Most of the quasars' light streams unimpeded through the clouds, but a sprinkle of neutral, or unionized, hydrogen in the clouds absorbs photons at characteristic wavelengths, the most prominent being the Lyman-α line. When a quasar's light is collected in a telescope and sorted in a spectrograph according to wavelength, a forest of Lyman-α lines reveals clouds wafting between Earth and the quasar.

The spectra of rarer, denser clouds thought to be associated with young galaxies do show traces of carbon and other heavy elements. But in the more tenuous clouds scattered across the sky, "heroic efforts" have failed to reveal anything but isotopes of hydrogen, says Steven Vogt of the Lick Observatory at the University of California, Santa Cruz. Most researchers, he says, have concluded that these clouds consist of "primordial stuff left over from the big bang," just beginning to coalesce into the structures seen today. The clouds, in this view, collapsed to form small groups of stars, which then merged to make galaxies.

But Keck may now have muddied this picture. Keck combines its light-gathering ability with the world's largest and most sensitive spectrograph, designed by Vogt. The result was enough observing power for teams led by Lennox Cowie and Antoinette Songaila at the University of Hawaii and David Tytler and Xiao-Ming Fan at UCSD to detect not just hydrogen but also faint carbon lines in about half of the clouds they studied. (The results were announced by the Hawaii group in this month's *Astronomical Journal* and by the UCSD researchers at a recent workshop.) To Cowie, the finding implies that the clouds are "a pool of stuff



RUSS UNDERWOOD

**Where there's smoke ...** The 10-meter Keck Telescope saw carbon in distant gas clouds.

that has been ejected from previous stars," which came and went so long ago that not even their embers can be seen.

By placing the birth and death of the earliest generation of stars before the development of galaxies, the results may call for a revision of standard cosmology. But, by creating one puzzle, they would also solve another: how the intergalactic medium in the early universe became ionized—as it must have been, or else it would absorb so much light that it would blot out our view of quasars.

Some researchers have suggested that the quasars themselves, or the turbulence generated as gas clouds collapsed to form the first galaxies, could have done the job, but the numbers have never quite added up. "Now we can breathe a sigh of relief," says JILA's Shull. The amount of carbon the Keck researchers found, he says, implies a large enough population of early stars to make the numbers come out right. By bathing the early universe in ultraviolet light during their lifetimes and jolting it with energy from supernova explosions at their demise, these stars could have heated and ionized the primordial gas, as well as laced it with carbon.

That heating could also help explain why the galaxies seen today are so large, according to computer simulations by Princeton's Ostriker and his colleagues. If the only source of heat in the very early universe was the afterglow of the big bang, as standard theories suggest, the thermal pressure of the primordial gas would have been low enough for it to collapse on relatively small scales, forming much smaller galaxies than those we see. Perhaps, says Ostriker, this first round of small-scale collapse did take place, forming the first generation of stars, which then "heated up the universe." Once those stars burned out or blew up, a new stage of galaxy formation began on much larger scales.

Still, it may be too soon to embrace a new, stars-first picture of the early universe, says Tytler. He cautions that young galaxies, too faint to see, might be responsible for the carbon in the contaminated clouds; the pristine ones could still be patches of primordial universe. To find out, Lick's Michael Keane plans to check whether the contamination becomes rarer in more distant—and hence earlier—clouds, existing at times when galaxies would be less likely to have formed. If the carbon does persist, astronomers may have to reckon with an unseen first generation of stars after all. And that means observers will have to press still deeper into the Lyman-α forests for their glimpse of unsullied nature.

**–James Glanz**

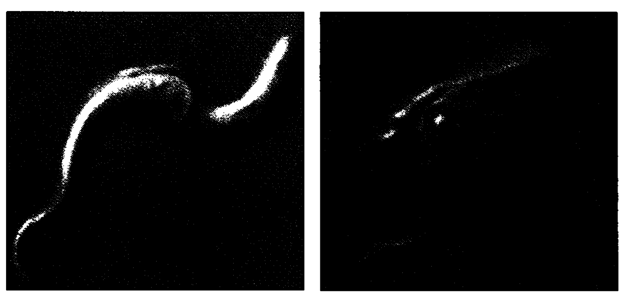
*James Glanz is a science writer in Chicago.*

PARASITOLOGY

# Trypanosome Mystery Solved?

A parasite can be defined as "one frequenting the tables of the rich." But not all parasites find humans to be a rich feast. Take the tiny flagellated protozoan called *Trypanosoma brucei brucei*. In cattle, it causes a disease closely resembling African sleeping sickness in humans. Indeed, the prevalence of this veterinary disease makes it impossible to raise livestock in much of Africa. But even though the parasite can infect humans, it doesn't make them sick because it rapidly disintegrates in the blood.

Exactly what in human blood kills the protozoan is a mystery that traces back nearly a century. But now, molecular biologist Stephen Hajduk and his colleagues at the University of Alabama, Birmingham, may have provided the answer. On page 284, they report purifying a protein that destroys the parasite in lab culture. "What they appear to have done is solved one of the major puzzles in African trypanosomiasis," says George Cross, a molecular parasitologist at Rockefeller University in New York City. If subsequent work verifies that, it may be possible to use the gene encoding the protein to create productive, trypanosome-resistant strains of cattle for Africa.



PHOTOS BY STEPHEN HAJDUK

**Blowout. The trypanosome on the right has been exposed to a lethal dose of human HDL and is dissolving.**

In spite of its obvious significance, for decades, parasitologists had no idea what the human trypanosome killing factor could be. The first clue came only in 1978, when cell biologist Mary Rifkin, now at Mount Sinai Medical School in New York City, found that the killing component resides in the high density lipoprotein (HDL) fraction of blood serum, best known for its role in removing cholesterol from the blood. "This was a very strange finding," recalls Rifkin. "No one had a clue as to how this could be."

Rifkin moved on to other projects, and Hajduk's group decided to take on the tedious task of purifying the killing factor. The Alabama group narrowed the search to a small HDL subfraction, which they called trypanosome lytic factor, or TLF. It was from this material that the researchers eventually pulled out what they think is the killing factor—a protein closely related to the blood protein called haptoglobin, which binds hemoglobin released from dying red blood cells and helps prevent loss of iron from the body. One indication that they have the right protein is that an antibody to haptoglobin blocks trypanosome killing by TLF.

This result is surprising, says Linda Curtiss, a lipoprotein biochemist at Scripps Research Institute in La Jolla, California, because haptoglobins have not previously been known to associate with the HDLs, nor have these proteins been implicated in defenses against infectious diseases. The result suggests that HDLs may play "an important role" in the body's defenses, Curtiss notes.

After identifying the TLF, the Alabama group went on to sketch out a possible mechanism by which the protein kills the trypanosomes. Their previous work suggested that TLF is taken up by the parasite, where it gets into the lysosomes: small membranous sacs filled with digestive enzymes. The researchers now believe that before TLF is taken up, the haptoglobin-related protein binds hemoglobin, and once this complex is in the lysosomes, the low pH there stimulates an enzymatic activity that haptoglobin and hemoglobin have when together. This in turn generates free radicals that damage the lysosome's membrane, causing the potent lysosomal enzymes to spill out and digest the parasite from the inside. "Hajduk and his colleagues make a convincing case that the haptoglobin-related protein is the key element in the killing of *T. b. brucei*," says Rockefeller's Cross.

Cross adds, however, that some important questions remain to be answered before this medical mystery is put to rest. For one thing, two trypanosomes that are otherwise identical to *T. b. brucei*—*T. b. rhodesiense* and *T. b. gambiense*—do cause sleeping sickness in humans, and researchers wonder how those strains survive in human blood. Another issue is raised by the observation that the haptoglobin-related factor is not the only substance in human blood that may protect against *T. b. brucei*. Rifkin and Stephen Tomlinson of New York University report in the March issue of *Molecular Biochemical Parasitology* that serum from two patients who have a hereditary disease in which the HDLs are missing still shows some ability to lyse the trypanosome. "It certainly confuses the issue," says Rifkin.

The final proof of the importance of the haptoglobin-related protein will only come, Cross says, if researchers can introduce the human gene into mice and show that the animals gain protection against *T. b. brucei* as a result. That experiment is next on the Alabama group's list of things to do. And if that experiment works, it will not only solve the mystery of human resistance to the protozoan but could also open the door to trypanosome-resistant cattle.

**–Karen Schmidt**

*Karen Schmidt is a free-lance writer in Chapel Hill, North Carolina.*