COBE: Seeking traces of the beginning

Scheduled for launch as early as Nov. 9, a satellite called the Cosmic Background Explorer (COBE) will search for whatever faint glimmer remains from the birth of the universe. Looking back billions of years before the appearance of Earth, COBE's planned year-long survey will focus on neither planets nor stars but on the Big Bang that cosmologists widely believe led to both.

The long-awaited Hubble Space Telescope, due to orbit Earth next March, will look at some of the oldest stars in the sky. But even they are latecomers by COBE's standards. "Hubble has to wait until the lights come on. COBE begins *before* the lights come on," says Lennard A. Fisk, NASA's associate administrator for space science and applications.

COBE carries three instruments. One, the Differential Microwave Radiometer, primarily seeks to determine whether the Big Bang was equally intense in all directions. If it finds the brightness of the cosmic background radiation patchy rather than smooth, scientists will face the task of identifying as-yet-unknown "seeds" around which formed galaxies, galactic clusters, and clusters of galactic clusters. If the device measures equal brightness in all directions, the question of how these systems could have condensed since the Big Bang will become even more difficult to answer.

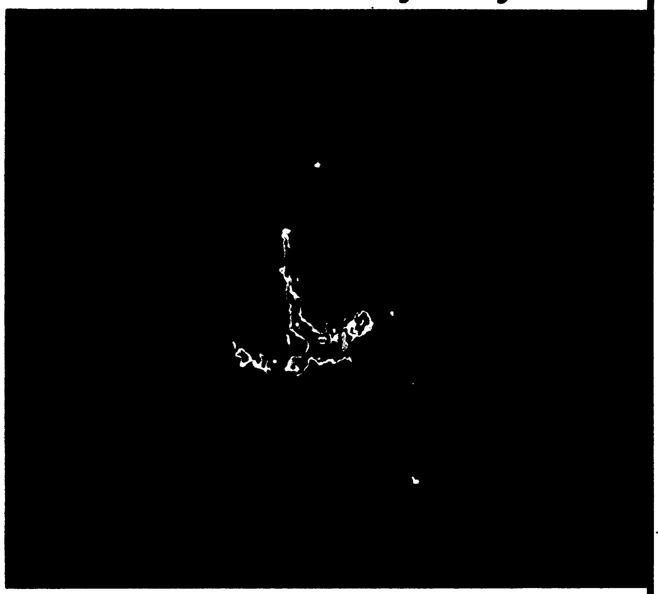
Liquid helium will cool COBE's two other instruments to only 1.6°C above absolute zero, making them sensitive to extremely faint heat emissions. The Far-Infrared Absolute Spectrophotometer, designed to determine the spectrum of the background radiation produced by the Big Bang, will survey the entire sky twice during the mission. Many astrophysicists reason that such a spectrum should be smooth and uniform, showing no significant releases of energy between the Big Bang and galaxy formation.

Variations from this spectrum could indicate the unexpected presence in the early universe of energy sources such as the annihilation of antimatter and explosions of supermassive objects that might have driven turbulence capable of triggering galactic formation. NASA officials rate the spectrophotometer's sensitivity as 100 times greater than that yet achieved by equivalent ground-based and balloon-borne infrared instruments. Researchers hope the data will essentially answer the question, "How bright was the Big Bang?"

Also supercooled is the Diffuse Infrared Background Experiment. This one is assigned to the "new" stuff. To survey distant primordial galaxies and other celestial objects that formed after the Big Bang, it will weed out the total glow of our own galaxy — the collective radiance of billions of stars and other celestial objects within the Milky Way — from the rest of the universe. This will be a matter of accounting for the many kinds of known objects whose emissions will get in the way, as well as for Earth's motion within the interplanetary dust permeating our own solar system.

After COBE has identified and subtracted all known sources and any newly discovered ones, a faint and uniform residual signal may remain. The COBE team hopes this will prove to be the long-sought light of primordial galaxies, produced by some of the young universe's first big beacons. *— J. Eberhart*

Swirls and threads at the Milky Way's core



Lo et al./NCSA

The Milky Way's center has a compact, powerful source of radio waves generated by the interaction of electrons and protons in clouds of ionized gas. Those clouds may mark the location of a massive, collapsed object, such as a black hole, at the galaxy's core. Astronomers now have the best view yet of this region, especially of the diffuse, filamentary structures surrounding the bright arms of the central radio source.

"It's a very impressive picture," says K.Y. Lo of the University of Illinois at Urbana-Champaign. Lo and his colleagues collected the data over a period of about four years at the Very Large Array radio telescope near Socorro, N.M. Using a supercomputer at the National Center for Supercomputing Applications in Urbana, they worked for nearly a year to process the data into a radio map of the region.

The map, representing the intensity of radio emissions at a wavelength of 6 centimeters, reveals a variety of structural features, including an array of streamers and threads that seem to follow magnetic-field lines. "I wish I understood exactly what it all means," Lo says. "We have some general ideas, but there are so many details in the picture that it baffles the mind." By comparing such images taken at different times, astronomers hope to detect movements, which would indicate whether ionized gas is flowing toward or away from the galactic center.

Oil wells cause earthquakes

In 1958, a geologist calculated that injecting fluid into the ground increases the chance of earthquakes. Thirty-one years later, another geologist has shown the reverse: pumping gas or oil *out* of the ground can also trigger earthquakes.

Pumping out underground crude contracts the rock in oil reservoirs and sets up large pressure changes over short distances, Paul Segall of the U.S. Geological Survey in Menlo Park, Calif., calculates in the October GEOLOGY. Vertical contraction makes the ground above the reservoir sink, while horizontal stresses pull surrounding rock inward. If the pull becomes strong enough to shear the rock, an earthquake results.

Although geologists have reported mild, shallow earthquakes near gas and oil fields since the 1920s and have long suspected the wells as the cause, Segall's mathematical analysis shows specifically how and where the ground slips, says geologist C. Barry Raleigh of the University of Hawaii in Honolulu. Segall's ground-breaking work, Raleigh adds, represents "a messy problem neatly tied up."

"This is the first time that anyone has shown in any kind of analytical way that withdrawing fluid causes earthquakes," confirms John D. Bredehoeft of the USGS.

Because such quakes seem limited in magnitude, petroleum engineers probably won't change their techniques, Raleigh says. But they may apply Segall's work to squeeze more fuel out of wells. Underground reservoirs often consist of fractured rock surrounded by fluid. Pumping the fluid can collapse the fractures, sealing off the remaining reservoir. Segall's analysis could be used to forestall this collapse, Raleigh says. *— A. McKenzie*