Fomalont and Kenneth I. Kellermann of the National Radio Astronomy Observatory in Charlottesville, Va., who worked with the Very Large Array (VLA) of radiotelescopes near Socorro, N.M.; Bruce Partridge of Haverford (Pa.) College, who also worked with the VLA; and Rod Davies of the Nuffield Radio Astronomy Laboratories in Jodrell Bank, England, and Anthony Lasonby of Cambridge University, both working with an antenna in the Canary Islands.

Typical of what these groups find is a temperature variation of 5 parts in 100,000 over an area of 8° in the sky. Mapped with false colors to indicate temperature differences, such a pattern looks like acne, and so some of the scientists involved call this the ZIT model.

The ZITs refer to an interesting time, as cosmologists describe it, back at a redshift of 1,000. (For comparison, the most distant and oldest quasars we can see have redshifts around 4.) Wilkinson translates a redshift of 1,000 as when the universe was 100,000 years old (compared with a present age between 10 billion and 20 billion years). The ZITs thus refer to fluctuations in the famous cold, dark matter that seems to pervade the universe and may be enough to close it. They also refer to regions that in earlier times had developed out of contact with each other and were then beginning to overlap each other.

In the earliest days of the universe, two different expansions were concurrently going on. These were the expansion of space — that is, of the universe itself — and the expansion of our (or any observer's) horizon. Astrophysicist David Schramm of the University of Chicago says that people may deceive themselves if they imagine the Big Bang as a kind of explosion. He prefers to use the analogy of raisin-bread dough. As the dough rises, it expands everywhere fairly evenly. As a result, the raisins are carried farther and farther from each other, even though they do not move with respect to the dough right around them. Galaxies, like the raisins, are carried farther and farther from each other as the space between them (like the dough) expands, but they do not necessarily move with respect to the space right around them.

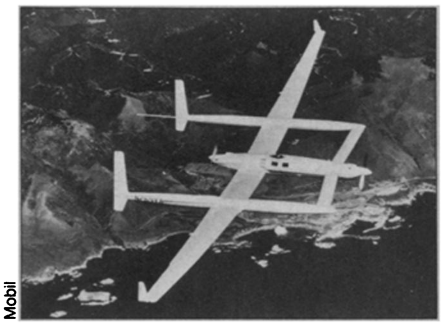
Meanwhile our horizon is expanding, too. At any time we can see only the objects from which light has had time to get to us since the beginning of the universe. If we could have been around when the cosmos was 1 second old, we would have seen only objects less than 1 light-second away, not as far as the moon now is. As time goes on, each observer sees objects farther and farther away. Horizons expand at the speed of light; space expands presumably at a different speed. Expanding horizons may gradually gain on the expansion of space, or they may not.

It is not clear how big the universe was at time zero, though it seems to have been extremely smaller than it is now. However, in the earliest moments, a number of regions could have developed independently of one another, because their horizons did not overlap and they could not communicate and so could not affect events in each other. Eventually horizons began to overlap. Each observer began to see regions that had developed independently of his or her own immediate surroundings. The differences between them should show up as minute variations in the equilibrium temperature of the cosmic microwave background, on the order of 1 part in 1,000 or less. Such phenomena should produce the ZITs.

Are the reported observations really ZITs? Wilkinson cautions that they could be galactic bremsstrahlung, radiation produced by galaxies moving through the intergalactic gas. Spectra will tell the difference: True ZITs will have the blackbody spectrum characteristic of the cosmic microwave background. The present observations are all at single frequencies, because radiotelescopes observe one frequency at a time. Astronomers are now planning to look at other frequencies to see whether they can fill in the proper spectra. *— D. E. Thomsen*

Around the world on a tank of gas

Early on the morning of Dec. 14, a spindly, ungainly, plastic-and-paper aircraft, dragging its fuel-laden wings, took off from Edwards Air Force Base, Calif. Nine days later, the airplane, *Voyager*, landed on the same field after completing the first nonstop flight around the world without refueling.


Mobil

The experimental aircraft Voyager *as it appeared during a test flight earlier last year.*

"It was a good, solid engineering feat," says Joseph W. Stickle, chief of the low-speed aeronautics division at NASA's Langley Research Center in Hampton, Va. Although the flight represents no single, major technological breakthrough, he says, it's the culmination of recent advances in composite materials, in airfoil design and in weather observation and navigation.

The experimental plane's designers put together several state-of-the-art technologies to create a unique, featherweight aircraft specifically designed to accomplish its one mission. The plane's self-supporting skin consists of a honeycombed paper core sandwiched between layers of carbon-fiber tape impregnated with an epoxy resin. Firewalls of special lightweight ceramics able to withstand temperatures greater than 2,000°F separate the aircraft's two engines from the fuel tanks. The only metal components are the two engines and a few nuts and bolts. Although its 111-foot wingspan is longer than that of a Boeing 727, the empty, no-frills aircraft weighs only 1,858 pounds.

Its smooth skin and novel airfoil shape also help reduce drag. The absence of joints and protruding rivets typically found in wings fabricated from metal allows air to flow smoothly in even layers over the two wings. This couldn't have been done without the use of composite materials, says Stickle. However, this flight was too short to address concerns about the long-term durability of composite materials — their resistance to fatigue, ultraviolet light and lightning.

When *Voyager* took off, it carried about 1,200 gallons of fuel. After its nine-day westward circuit covering more than 25,000 miles, fewer than 10 gallons of usable fuel were left. At an average speed close to 115 miles per hour (including tail winds), the aircraft's miles-per-gallon performance rated higher than that of many automobiles.

Satellite-based weather observations and navigational aids enabled the pilots to avoid thunderstorms and dodge tropical typhoons in a flight that occurred mainly over water. Five or 10 years ago, when such aids were unavailable, the flight would have been much more hazardous, says Stickle.

In terms of human endurance, the *Voyager* flight was probably more demanding than any previous airplane flight. The pilots, Dick Rutan and Jeana Yeager (no relation to test pilot Chuck Yeager), had to cope with being cooped up in a cabin that's barely the size of a phone booth. Turbulence repeatedly knocked the pilots around. In Rutan's words, the aircraft was a "beast" to fly, often rolling, heaving and lurching through the air. The flapping of its wings, which could flex as much as 30 feet, didn't help. Because there was no soundproofing, Rutan and Yeager also had to put up with a constant, deafening roar from the plane's engines.

As he approached Edwards Air Force Base at the end of the flight, Rutan radioed, "I must admit there [were] times during the flight when I didn't think it was possible." *— I. Peterson*