Waves from a Parallel Universe

Preparing a stunningly detailed map of the radio sky

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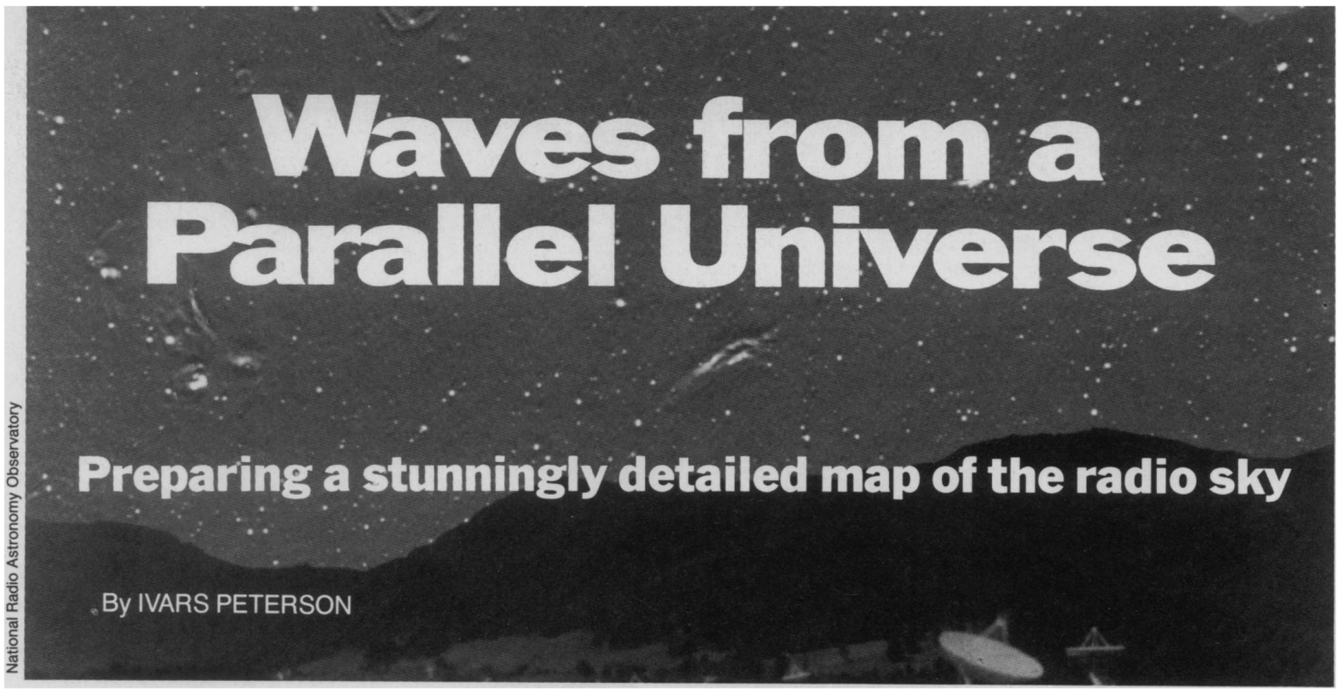

National Radio Astronomy Observatory

The radio sky bears little resemblance to the sky we see at night. This composite photograph, based on old data, shows the radio sky over the National Radio Astronomy Observatory site in Green Bank, W. Va. The bright splotches concentrated in a band running from the lower left to the upper right of the image represent radio emissions from the remnants of hot, dust-enshrouded stars at the fringes of the Milky Way. The bright spots scattered across the image reveal not stars, but extremely distant radio galaxies and quasars. The new VLA survey will produce sky maps containing considerably greater detail.

Stretched across the Plains of San Agustin in New Mexico, the composite ear known as the Very Large Array (VLA) radio telescope listens to the sky. The whispers overheard by this gargantuan radio receiver reveal a universe quite unlike the one visible to the human eye.

Absent are the familiar constellations of the heavens. Gone is the faintly glowing band of the Milky Way. Instead, the entire sky appears thickly speckled with sources of radio waves in locations that rarely match the positions of visible stars.

"The radio sky and the visible sky are quite different," says James J. Condon of the National Radio Astronomy Observatory in Charlottesville, Va. In a sense, they represent parallel universes.

Most visible stars reside within our own galactic neighborhood, often at distances of less than 1,000 light-years. In stark contrast, radio sources typically represent tremendous outpourings of energy from objects 5 billion or more light-years away.

Because it takes radio waves from these sources so long to reach Earth, they broadcast information about galaxies and their environs in the distant past — before the solar system had even formed and when the universe itself was younger and more active than it is now. "These radio sources are very powerful beacons for doing cosmology," Condon says.

Last September, Condon and his colleagues started an ambitious survey of the sky using the VLA radio telescope. This instrument consists of 27 individual radio telescopes, each 25 meters in diameter. When connected together electronically, they act as a single antenna more than 1,000 meters across.

By the time the astronomers complete their project in 1996, they will have made 200,000 "snapshot" observations — at a radio frequency of 1,400 megahertz — of the heavens visible from New Mexico. "This survey will give astronomers a uniquely sensitive and detailed picture of the radio sky," Condon says.

Condon and his coworkers presented the first set of images from the VLA survey at an American Astronomical Society meeting held last January in Arlington, Va. Other images and data will be released to astronomers as they become available.

Astronomers expect that the VLA survey will add about 2 million new entries to the catalog of known emitters of radio waves in the universe. In fact, just a week of observations in the current program establishes the positions and intensities of more sources than have been recognized in the entire previous history of radio astronomy.

With access to such a large sample, researchers will be able for the first time to study significant numbers of weak radio sources inside dust-cloaked "starburst" galaxies, where new stars are forming at prodigious rates. They will also get a chance to take a closer look at radio signals resulting from the explosion of massive, short-lived stars in nearby galaxies.

Most of the emitters identified in the survey, however, will be far more distant. These waves come from radio galaxies or quasars, in which tremendous concentrations of mass — the equivalent of millions of our suns — have created supermassive black holes.

"We also hope to see some galaxies as they began forming stars from interstellar gas over 10 billion years ago," Condon says.

The large ratio of distant to nearby radio sources appears to indicate a much greater abundance of radio galaxies and quasars in the early universe than in recent epochs. "The conditions for the formation of radio galaxies and quasars were much more favorable in the far distant past than they are now," Condon says. "This means that the universe is changing with time."

These distant sources also appear uniformly scattered across the sky, suggesting that the distribution of matter in the universe is homogeneous rather than lumpy on large scales.

As they patch together their myriad snapshots into larger-scale images, Condon and his coworkers can reflect on their narrow window of opportunity to make this survey. Two years ago, they didn't have the computing power or the receiver technology to cover the entire sky with the required sensitivity. Five years from now, satellites broadcasting digital signals in the L band will so contaminate the sky that radio astronomers will no longer be able to make such sensitive observations in this frequency range.

"That's why we have to have it done by 1996," Condon explains. □