RADIO ASTRONOMY

Japanese Mission Stretches Limits of Interferometry

TOKYO—Japanese engineers are readying for launch on 7 February a satellite that should give radio astronomers a much better look at black holes and other extremely energetic objects in the universe. The satellite—if it's lofted successfully—is also expected to boost the fortunes of one of the country's premier research institutes as it seeks a larger role in Japan's exploration of space.

The $90 million MUSES-B satellite, built by the Institute for Space and Astronautical Science (ISAS), will be the first space-based antenna dedicated to very long baseline interferometry (VLBI). The technique allows astronomers to combine signals from widely spaced antennas, generating images as though they were produced by a single instrument with a huge collecting area. MUSES-B, which has an orbit that fluctuates between 1000 and 20,000 kilometers above Earth's surface, will take this technique to new heights, working in tandem with ground-based telescopes to generate images with unprecedented resolution. Says Hisashi Hirabayashi, project scientist for ISAS: "This will be the first mission ever in the field of radio astronomy to [have] a synthetic-aperture radio telescope bigger than the Earth."

ISAS

D. NORMILE

High flyer. Hirabayashi's MUSES-B will link to telescope dishes around the world and help Japan's ISAS strengthen its role in space science at home.

Hirabayashi and his colleagues will be watching anxiously to see this novel vision take shape next week. Their anxiety will be sharpened by the fact that the 830-kilogram MUSES-B will be entrusted to the first launch of ISAS's new M-V rocket, which is capable of lifting more than twice the payload of previous ISAS launchers. It will also provide the first test of an innovative tension-truss design, with a half-dozen booms and cables providing structural support for the 8-meter antenna after it is unfurled in orbit. And if that weren't enough, the satellite's observations, at wavelengths of 18, 6, and 1.3 centimeters, will require exacting choreography among up to 10 telescopes scattered around the globe and five tracking and data-relay stations—all part of a 25-telescope network called the VLBI Space Observatory Program (VSOP).

The end product will be 3 to 5 years of data that should sharpen astronomers' understanding of the environment surrounding black holes, the characteristics of star-forming regions, and radio sources throughout the universe. "It's a major step forward for VLBI," says Roy Booth, director of the Onsala Space Observatory in Sweden, which is participating in VSOP.

In particular, astronomers hope to use VSOP's sharp vision to peer into the nuclei of active galaxies, regions smaller than the solar system that pack the energy and output of an entire galaxy of stars. The nuclei—"the most powerful objects in the universe," notes David Meier, an astrophysicist at NASA's Jet Propulsion Laboratory (JPL) in California—are believed to be comprised of black holes surrounded by rotating rings of gas, or accretion disks. If so, astronomers hope that their glimpse of the accretion disk should shed light on how these systems generate their energy, says radio astronomer Makoto Inoue of Japan's National Astronomical Observatory (NAO).

Astrophysicists also plan to use VSOP to probe the origins of enormous jets of gases that appear to spurt from active galactic nuclei at velocities very near the speed of light. "This phenomenon is physically very interesting, but it is not understood at all," says Hirabayashi.

Other enigmatic phenomena high on the list of VSOP's priorities are maser spots, or point sources of intense microwave radiation. Masers, whose origins are poorly understood, often are found in regions of star formation. They can be used as celestial markers for such regions because their position, direction, and velocity can be determined from their frequency and movement. That information helps scientists determine the distance of these regions from Earth, and their movement can reveal whether the gaseous clouds that envelop the regions are turbulent or flowing linearly. "We'd like to study the maser process for its own sake and also for what we can learn about star formation," says Onsala's Booth.

VSOP may also turn its attention to supernovae. "We hope to observe how their shapes evolve after the explosion," says Hirabayashi, at a level of detail not now possible. And general surveys to refine details of known radio sources could always turn up a surprise. "I think a good mission not only solves some problems, but also finds new phenomena [for] the next mission," Hirabayashi adds.

To coordinate these observations, ISAS and NAO scientists will work with colleagues around the world. An international panel will sort through requests for viewing time. ISAS will operate one of the five stations, with three to be run by JPL and the fifth by the U.S. National Radio Astronomy Observatory, which will also help process and analyze the data from the satellite and ground-based antennas. JPL has set up its own 5-year, $80 million program to work with both VSOP and a Russian space VLBI project, called RadioAstron, that is still under development.

The project is a major step for ISAS and NAO, which teamed up with ISAS because it had no independent launch capability. ISAS—whose scientists have done groundbreaking work in x-ray astronomy and whose YOHKOH solar satellite returned some of the most detailed x-ray images of solar flares ever recorded—is trying to squeeze maximum scientific benefit out of a budget of only $190 million. NAO also has a distinguished track record in solar observations and radio astronomy.

For ISAS, which is trying to extend its technological capabilities in anticipation of future missions to the moon and Mars, a lot will be riding on next week's launch. Not only will it be a critical first test for the agency's new rocket, but MUSES-B is also breaking new ground in such areas as orientation control and high-bit-rate signal transmission. Indeed, in many ways, MUSES-B is an engineering test mission that just happens to be carrying a payload of interest to radio astronomers and astrophysicists. "Our mission just fit [ISAS's needs]," says Hirabayashi, a former NAO astrophysicist who joined ISAS to oversee the scientific aspects of the mission. But with the international community hungering for this kind of facility and a long list of interesting phenomena to observe, he says, "this is very good timing."

–Dennis Normile