ASTRONOMY

Submillimeter Astronomy Reaches New Heights

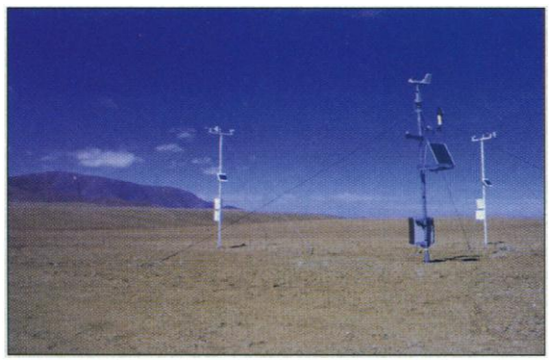
High in the Chilean Andes, astronomers are planning the world's loftiest observatory: a 10-kilometer-wide array of dishes to peer into the universe's cold recesses

LLANO DE CHAJNANTOR, CHILE—At over 5000 meters above sea level, this large plateau in the Chilean Andes, near the border with Bolivia and Argentina, is not a nice place to spend time. In the thin air, breathing is laborious, quick movements produce instant dizziness, and it soon becomes hard to think straight. But this very airlessness makes the site a haven for submillimeter astronomy. Water vapor in the atmosphere easily absorbs photons at submillimeter wavelengths, sandwiched between the infrared and radio bands. So Llano de Chajnantor, which not only lies in one of the driest deserts on Earth but also is perched above 50% of the atmosphere, is the next best thing to outer space for submillimeter studies. Within 10 years, 64 12-meter radio dishes will sprout from the barren plateau, forming an array 10 kilometers across and opening a sharp eye on celestial features ranging from surface markings on Pluto to extrasolar planets to the dusty central regions of active galaxies.

At least that's the vision of astronomers in a nascent collaboration between the European Southern Observatory (ESO), which already runs a number of telescopes in Chile, the U.S. National Radio Astronomy Observatory (NRAO), and possibly Japanese astronomers as well. The United States and Europe have earmarked $40 million for 3 years of design and development starting this year, with the final cost estimated to be $400 million. On 7 March, ESO officials and astronomers shared their vision of a submillimeter array with journalists and guests at the site, following the inauguration of ESO's Very Large Telescope on Cerro Paranal, a few hundred kilometers to the west and 2.4 kilometers lower in altitude. Provided with personal oxygen flasks and watched closely by physicians for signs of puna—the Chilean word for altitude sickness—the visitors slowly walked around the site, where automatic instruments are continuing to assess the observing conditions. Although most visitors suffered no ill effects beyond headaches and nausea, one of the party was brought down the mountain by ambulance, while others were under close medical supervision.

The submillimeter waves that the Chajnantor array would observe come from the coldest regions in the universe. Millimeter telescopes are already operating in the United States, Europe, and Chile, which have studied cool nurseries of stars as well as distant, dusty galaxies. But the new array would be able to see details as small as 10 milli–arc seconds, an improvement of about 50 times over current scopes, and it will be sensitive to a wider range of wavelengths, from 10 down to 0.3 millimeters. Those capabilities should allow astronomers to see extrasolar planets directly, image protoplanetary disks around other stars in great detail, and observe extremely distant galaxies in the young universe. "It's a major step in astronomy," says Karl Menten of Germany's Max Planck Institute for Radio Astronomy.

The first plans for a Large Submillimeter Array (LSA) surfaced in ESO about 10 years ago, says Roy Booth of the Onsala Space Observatory in Sweden. The Swedish-ESO Submillimeter Telescope had just been built at ESO's La Silla Observatory in Chile and, as in radio astronomy, researchers realized that to get better resolution they would have to build an array of dishes and combine their signals through a process known as interferometry. "An interferometer was the next logical thing," says Booth.



A higher plane. Weather stations on Llano de Chajnantor.

NRAO was also planning its own Millimeter Array (MMA) at Mauna Kea, Hawaii. Then, "a few years ago, the Americans decided that northern Chile would be a much better site [for submillimeter astronomy] than Mauna Kea," says Booth. "Japanese radio astronomers were also planning their own interferometer. It seemed ridiculous to have two or even three arrays." In 1997, ESO and NRAO began to discuss the possibility of merging their two projects. Later this year, the discussion will be formalized with the signing of a "memorandum of understanding"—the first step in major international collaborations. "There are very good chances that the Japanese will also join the collaboration," says Menten.

Originally, the NRAO planned to build a relatively small array of 40 8-meter antennas, with a total collecting area of 2000 square meters. ESO favored a 10,000-square-meter array of 60 15-meter dishes. The two partners have now compromised on 64 12-meter dishes with a collecting area of 7000 square meters. Although ESO originally tested another site in the Andes, both partners now favor Llano de Chajnantor, which lies in the Atacama desert, one of the driest regions on Earth. "The site is extremely well suited to do submillimeter observations for 50% of the time," says Menten, because of its still air and low water vapor content. Although remote, it is within easy reach of San Pedro de Atacama, an oasis that has been continuously inhabited for almost 10,000 years by the Atacameños and Aymaras Indians and is now a village of some 1000 people, popular with adventurous tourists.

The 64 dishes will probably be built in or near San Pedro and transported to Chajnantor by truck. At the site, their configuration will be adjustable. Every 6 months or so, workers will move them from one set of bases to another to form a compact group with a diameter of some 3 kilometers (best for picking up weak signals) or a 10-kilometer-wide ring (giving the best resolution), says Booth. Astronomers will control the array remotely from San Pedro, which is at a comfortable altitude of 2400 meters. According to Booth, "there will be no scientists on the site. We'll probably hire Chilean workers who are used to the high altitude."

Despite the successful collaboration so far, the partners have not yet been able to agree on a name for the array. Candidates include the Atacama Array, LAMA (Large Array for Millimeter Astronomy), COSMIC (Chajnantor Observatory Sub-Millimeter International Collaboration), and VLSA (Very Large Submillimeter Array). "Right now, we simply call it the LSA/MMA," says Menten, "but within a few months, a better name will be chosen." **–GOVERT SCHILLING**

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