

MEMORANDUM OF AGREEMENT


THE NATIONAL ASTRONOMICAL OBSERVATORY, JAPAN
AND
THE NATIONAL RADIO ASTRONOMY OBSERVATORY, USA

Cooperative Studies of Potential Astronomical Sites for
The Large Millimeter and Submillimeter Array
and
The Millimeter Array

June 12, 1995



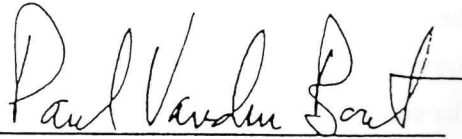
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1. Background

Astronomers in Japan and the United States are planning major astronomical instruments capable of making images of celestial objects at millimeter and submillimeter wavelengths. In Japan the planning is being done at the Nobeyama Radio Observatory (NRO); in the United States the planning is led by the National Radio Astronomy Observatory (NRAO).

The NRO instrument is the Large Millimeter and Submillimeter Array (LMSA), an aperture synthesis telescope comprised of fifty antennas of ten meters diameter designed for the study of distant and faint astronomical objects. The NRAO instrument is the Millimeter Array (MMA), an aperture synthesis telescope comprised of forty transportable antennas of eight meters diameter designed for rapid imaging. Each of these synthesis array telescopes will be equipped with superconducting mixer receivers for operation at wavelengths of 10 mm to less than 1 mm, and each anticipates employing array configurations with antenna separations greater than one kilometer as to achieve sub-arcsecond angular resolution.

Optimum performance of the MMA and the LMSA depends on locating the instruments on a site with dry and stable atmospheric conditions. Independent site studies done by the groups in Japan and in the United States have led both groups to focus their site evaluation on two areas that offer exceptionally favorable atmospheric conditions for millimeter and submillimeter astronomy. These two areas are: (1) Mauna Kea, a mountain on the island of Hawaii with a well-developed observatory complex; and (2) sites at elevations greater than 4000 m in the Atacama Desert of northern Chile.

2. Site Studies

Independent studies of the atmospheric conditions are underway by both the NRO and NRAO groups in Hawaii and Chile. On Mauna Kea, the NRAO is operating a tipping radiometer to measure the atmospheric transparency at 1.3 mm wavelength; they are also operating an interferometer on Mauna Kea which measures the effect of atmospheric phase distortions of a signal from a geostationary satellite. In northern Chile, the NRO is studying meteorological conditions on four possible sites. The NRO will also deploy a tipping radiometer and a satellite interferometer on one of the four sites. The NRAO is operating similar equipment on a site at 5000 m elevation east of the village of San Pedro de Atacama. In Chile, both groups are working collaboratively with the University of Chile.

Since the effort involved in the study of all the sites is very large, particularly in the remote areas of northern Chile, both the NRO and the NRAO groups recognize the value of working together. By sharing data we can jointly understand the atmospheric conditions on the various sites that will affect the performance of the LMSA and the MMA. By sharing equipment in Chile where this is possible, we minimize logistical difficulties. By working collaboratively in Chile, we share effectively the time of our Chilean collaborators.

3. Agreement

Recognizing that we share common goals for the LMSA and MMA projects in determining the best site for the arrays, we agree to cooperate on the following:

- We will share all site-testing data obtained in both the studies on Mauna Kea and in Chile;
- We will identify opportunities to share site-testing equipment, facilities and personnel;
- We will jointly conduct array configuration studies by sharing the time of specialists;
- We will share technology developed for the arrays via reports and visits of engineering and scientific personnel.

4. Term

This agreement is for a term of three years and can be renewed or amended, as necessary, by mutual agreement.