

1. Executive Summary

The Large Millimeter Telescope (LMT) is a major new astronomical facility being built through a collaboration among astronomers in the United States of Mexico and the United States of America. When completed it will be the largest telescope in the world operating at short millimeter wavelengths, enabling dramatic scientific advances in many areas of astronomy.

1.1 Science Goals

The LMT will revolutionize humanity's understanding of the universe in which we live by looking back towards its origin to:

- make sensitive measurements of structure in the cosmic microwave background radiation, thus illuminating the nature and content of the universe itself;
- detect and study hundreds of thousands of new galaxies near the time of their formation, to understand the origin and evolution of structure in the universe;

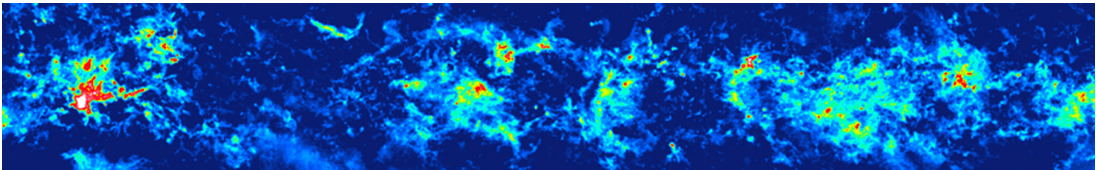


Figure 1.1 The Milky Way's dominant star-forming structure, the Galactic Ring, as imaged with the SEQUOIA multi-pixel array receiver on the UMass Amherst/FCRAO 14 m telescope. SEQUOIA will be one of the LMT's first instruments. Integrated $^{13}\text{CO } J=1-0$ intensity from the first 16 square degrees covered by the Boston University-FCRAO Milky Way Galactic Ring Survey (GRS)¹.

- penetrate the dust that obscures the process of star formation in distant galaxies, to elucidate the history of star formation over time;
- analyze the environment of active galactic nuclei, to probe the relationship of supermassive black holes to their host galaxies; and
- quickly follow up detections of gamma-ray bursts, to increase our understanding of the death of massive stars and the origin of the heaviest chemical elements.

This new telescope and its innovative mm-wavelength cameras will examine our own Milky Way and other galaxies in the local universe to:

- provide new insights into the nature and distribution of the interstellar gas and dust from which stars form;
- elucidate the process of star formation itself; and
- establish the existence and nature of the massive black hole at the center of the Milky Way, by providing critical North-South coverage and unparalleled sensitivity to Very Long Baseline Interferometry observations.

In addition, the LMT will be a powerful tool for astrobiology and planetary science by:

- providing the sensitivity to allow searches for complex organic molecules in space;
- detecting and providing an initial characterization of the disks of gas and dust around stars from which planets form;
- analyzing with unprecedented sensitivity the chemistry and physics of comets, the most pristine samples of the material from which our solar system was formed;
- making the first comprehensive survey at mm wavelengths of small bodies in the solar system, including Near Earth Objects, Main Belt asteroids, Centaurs, and Kuiper Belt Objects; and
- studying the atmospheres of planets and satellites in our solar system.

1.2 The Telescope and its Instrumentation

The LMT is a single, high-precision mm-wavelength telescope 50 meters in diameter, sited at an elevation of 15,000 feet on Tliltepetl, an extinct volcano in central Mexico. It will operate with good efficiency at wavelengths as short as 1 mm, and it will be capable of observations at 0.8 mm. The LMT will be equipped with innovative and extremely sensitive receivers which will function as cameras for both heterodyne (spectral line) and continuum observations.

The new telescope marks a significant advance in antenna design, employing various active systems to achieve its design goals. In particular, the primary reflector consists of 180 segments that are moveable under computer control, making the telescope an “intelligent structure” that can change its shape to compensate for distortions produced by gravity and temperature gradients. The large diameter produces a collecting area almost three times greater than that of any existing telescope operating at these wavelengths.

1.3 Importance for the United States and Mexico

The LMT is the largest science project in any field ever undertaken by Mexico, and it is certainly the largest collaborative science program between the United States and Mexico. It is conceived as an equal partnership between these two neighbors, creating a powerful scientific facility at an excellent site which it would have been difficult for either country to build independently.

Both countries are committed to using the LMT project not only to perform innovative science, but also to train the next generation of scientists

and engineers in the many fields that are impacted by such an endeavor, to stimulate the development of new technology with broad economic applications, and to educate the general public in astronomy and technology.

1.4 The Large Millimeter Telescope Observatory

The project has been developed through a collaboration between the University of Massachusetts Amherst (UMass Amherst) in the United States and the Instituto Nacional de Astrofísica, Óptica y Electrónica (INAOE) in Mexico. Together these institutions have formed the Large Millimeter Telescope Observatory, which will operate the telescope. The Observatory has an advisory committee of outstanding scientists from around the world. Observing time on the facility will be divided between the US and Mexico on the basis of each country's contributions to the capital cost of the telescope and its instrumentation. Guest instruments, built by groups outside of UMass Amherst and INAOE, will also be welcomed.

1.5 Relation to Other Telescope Projects

The high sensitivity and excellent mapping speed provided by the large-aperture, single-dish configuration, and state-of-the-art instruments of the LMT make it a unique facility. It offers a natural complement to the next generation of mm and sub-mm interferometers, ALMA and CARMA, as well as to major facilities operating at other wavelengths, such as GBT, EVLA, Herschel, JWST, and future large optical telescopes.

1.6 References

1. Simon, R. et al. (2001), "The Structure of Four Molecular Cloud Complexes in the BU-FCRAO Milky Way Galactic Ring Survey," *Astrophys. J.*, 551, 747.