Announcement of Opportunity

Science with the 50-meter Large Millimeter Telescope Alfonso Serrano

Observing Period 2018-S1: 1st January 2018 – 30th June 2018

Application Submission Deadline: midnight (CDT) 31st October 2017

Overview

The Large Millimeter Telescope Alfonso Serrano (LMT) invites members of the Mexican astronomy community and members of the Department of Astronomy at the University of Massachusetts and the Five College Astronomy Department to participate in the call for scientific observing proposals (2018-S1). This Call for Proposals will be the first opportunity presented to the community to take advantage of the upgraded LMT following the expansion of the primary reflector from 32-meters diameter, during the earlier operational configuration of the telescope (2014-2017), to the full-size diameter of 50-meters.

This document describes the guidelines for proposers. Further details can be found on the LMT webpage www.lmtgtm.org.

The selection of science projects will follow a peer-review process to be organized by the LMT Scientific Committee (LMTSC). Successful proposals will result in a set of approved Scientific Project Teams. The selection criteria for approved scientific projects is similar to the previous Early Science calls, and will be based on the potential of the proposals to satisfy some or all of the following goals:

1. feasible projects that can be completed by the Scientific Project Teams within the current range of uncertainties on the telescope and instrument performances;
2. generate refereed journal publications that demonstrate the scientific impact of the LMT with an emphasis on research topics for which the telescope provides a unique capability with the initial suite of instrumentation (angular resolution, sensitivity, mapping speed, spectral coverage, etc.);
3. scientific analysis and interpretation of the LMT data that can lead directly to publishable results, and do not require additional supporting observations that are currently unavailable;
4. involvement and training of graduate students and postdoctoral researchers, as well as demonstrations of the relevance of these LMT data to on-going MSc and PhD student research programs;
5. scientific collaboration between the research communities of the LMT partners;

6. provide opportunities and material for immediate educational and public outreach purposes.

Schedule for LMT Science Observations, Proposal Submission and Publication of Results

This Announcement of Opportunity (2018-S1) for scientific observations with the 50-meter LMT is released on September 15th, 2017. **The deadline to receive proposals is midnight central daylight time (24:00 CDT) on 31st October 2017**. The provisional schedule for conducting scientific observations with the 50-meter LMT will provide an operational period from 1st January to 30th June 2018, during which shared-risk commissioning and scientific observations will be restricted to a night-time shift of 8 - 9 hours lasting from approximately one hour after sunset to sunrise.

The proposal submission will be made through an adaptation of a simple web-based form developed for the JCMT (Hedwig) to satisfy the needs of the current call. For instructions on how to submit a scientific proposal to the LMT, visit www.lmtobservatory.org.

The results of the scientific peer review and technical assessment of the submitted proposals, and the prioritization of the projects will be published from mid-December 2017 onwards following the commissioning of the 50-meter LMT and the scientific instruments.

Scientific Project Teams

Membership of the Scientific Project Teams is open to individuals with affiliation at a Mexican research institution or at the Department of Astronomy at the University of Massachusetts and the Five College Astronomy Department. Scientific collaboration between the partners of the LMT project is strongly encouraged. Inclusion of external international collaborators as co-investigators is also encouraged and should be justified in the proposal as contributing an essential capability or unique resource to the project.

Science proposals must identify the full Scientific Project Team that will carry out the observational program. Each Scientific Project Team must demonstrate that it contains team members that are familiar with the operation of the LMT, the preparation of the observing scripts, the use of the scientific instruments and the analysis of the data. The LMTSC strongly suggests that potential leaders of Scientific Project Teams contact the LMT Project Scientists, Miguel Chávez (mchavez@inaoep.mx) and Min Yun (myun@astro.umass.edu), who will facilitate and coordinate the involvement of experienced LMT project personnel, and members of the instrument teams, within the individual Scientific Project Teams.

Depending on the assigned priority and ranking of the proposal, following the scientific and technical peer-review, the Principal Investigator will be contacted before scheduling the scientific program on the LMT to prepare the final selection of the target sources and the generation of the required observing scripts, and to organize the logistical support of the observations at the telescope.

Shared Risk Observations with the 50-meter LMT

The call for science projects is made with the understanding that all successful proposals and scheduled observations are considered as "shared-risk". This will be the first observing season in which the LMT is operating using the full 50-meter diameter primary reflector and a new upgraded secondary mirror optical system to increase the overall telescope performance and sensitivity.

A description of the available instruments and the tools to calculate the feasibility of the proposed observations (updated instrument sensitivities, expected weather conditions and atmospheric transparency, integration time calculators etc.) are provided at the LMT proposal submission page www.lmtobservatory.org and on the LMT webpage (www.lmtgtm.org).

During this period of commissioning the 50-meter LMT and the subsequent scientific observations, the LMT user-community should be aware that the feasibility of the proposed observations may change due to differences in the instrument sensitivities and the efficiency of the telescope performance compared to those that are advertised in this call. Scientific observations may be rescheduled or cancelled according to the need for additional commissioning and engineering activities associated with the optimization of the instrument and telescope performances.

Scientific Instrumentation & Available Observing Time

Both scientific instruments offered in the previous observing periods, the Redshift Search Receiver (a 3mm heterodyne receiver and broad-band spectrometer) and AzTEC (a 1.1mm continuum imaging array camera), will again be available in the observing period 2018-S1. Modifications made to the optical illumination of the RSR will enable the receiver to take advantage of the 50-meter primary reflector of the LMT. The scientific operation of AzTEC however will continue with the illumination of the inner 32-meter diameter of the primary reflector in the observing period 2018A, before this instrument is retired and replaced with large-format and multi-frequency cameras in future semesters.

During this observing season, SEQUOIA, a 16-pixel 3mm spectrometer array, will be introduced for the first time to the suite of LMT instruments. SEQUOIA is an upgraded instrument compared to the original receiver installed on the FCRAO 14-m telescope until 2006.

Finally a new 1.3mm VLBI receiver, provided by the Event Horizon Telescope (EHT) experiment, will be installed and commissioned in the coming months. A supplementary call for proposals to use this new receiver will be made when this instrument is commissioned and is ready for scientific observations.

Given previous experience and taking into consideration the variable weather conditions and the telescope operational efficiency, we anticipate a total of ~600 hours of on-source integration, excluding all observing overheads (slewing, pointing, focus, calibrations etc). Depending on the scientific demand for instruments and the scientific priority awarded to the individual projects, we expect ~200 hours of AzTEC on-source integration time in the 1mm band and ~400 hours on-source integration time for instruments operating in the 3mm band will be available during the next observing period (January to June 2018).

AzTEC

AzTEC is a 144-pixel millimeter-wavelength camera that operates at 1.1 mm. The detector array is cooled to ~250 mK via a three-stage, closed-cycle ^{3}He refrigerator. Radiation is coupled to Si-Ni "spider-web" bolometers, arranged in a close-packed hexagonal pattern, with an array of conical feedhorns separated by $1.4 f\lambda$. Scanning of the telescope across the sky provides fully-sampled images. The current optical design and coupling to the telescope allows AzTEC to illuminate the inner 32m of the primary surface, resulting in a FWHM beam-size of 8.5 arcsecs. More technical information regarding the instrument can be found in the published article "The AzTEC mm-wavelength camera" by Wilson, G.W. et al. 2008, MNRAS, 386, 807.

The following link provides the AzTEC sensitivity and integration-time calculators (http://www.lmtobservatory.org/gtm/). These calculators consider the latest values of surface accuracy and efficiency for the inner 32m diameter primary surface illuminated by AzTEC.

Redshift Search Receiver

The Redshift Search Receiver (RSR) is a MMIC-based receiver designed to maximize the instantaneous receiver bandwidth to cover the 90 GHz atmospheric window (73-111 GHz) in a single tuning. The receiver has four pixels arranged in a dual-beam, dual-polarization configuration. Orthogonal polarizations are combined in waveguide-based orthomode transducers. Beam-switching at 1 kHz on the sky is achieved with a fast Faraday rotation polarization switch and a wire-grid to interchange the reflected and transmitted beams to each

receiver. This ultra-wideband receiver typically achieves noise temperatures < 50K between 73-111 GHz. Because of the fast beam-switch involving no moving mechanical parts, the Redshift Search Receiver has exceptional baseline stability, well-suited to the detection of redshifted molecular-line transitions of the CO ladder from star-forming galaxies at cosmological distances. An innovative wideband analog auto-correlator system which covers the full 38 GHz with 31 MHz (100 km/s at 90 GHz) resolution serves as the backend spectrometer.

The following link provides the RSR sensitivity and integration-time calculators (http://www.lmtobservatory.org/gtm/) , which consider the latest values of surface accuracy and efficiency of the 50-meter primary surface of the LMT.

SEQUOIA

SEQUOIA is a cryogenic focal-plane array of 16 pixels, arranged in a 4×4 array, that operates in the range 85 – 115 GHz. The array, which is feed by square horns separated by $2 f \lambda$, is cooled to 18K and use low-noise Indium Phosphide (InP) monolithic microwave integrated circuit (MMIC) preamplifiers designed at UMass to provide a characteristic receiver noise of 55K in the range 85-107 GHz, increasing to 90K at 115 GHz.

The refurbished SEQUOIA has a new digital spectrometer with three total bandwidth options of 200, 400, & 800 MHz. All pixels of the array track the same frequency window, so nominally a single spectral line is observed at a time by the array. However, we note that in some cases two lines may fall within the same spectral window so that they may be imaged simultaneously (e.g. HCO+ J=1-0 and HCN J=1-0 in the 800 MHz bandwidth mode of the spectrometer).

Parameter	**IF Bandwidth Options**		
MODE	W	I	N
Bandwidth (MHz)	800	400	200
N Channels	2048	4096	8192
Resolution (kHz)	391	98	24
HCN J=1-0 (88.6 GHz)			
Bandwidth (km/s)	2707	1353	677
Resolution (km/s)	1.32	0.33	0.08
CO J=1-0 (115.3 GHz)			
Bandwidth (km/s)	2080	1040	520
Resolution (km/s)	1.02	0.25	0.06

Sensitivity and integration time calculators for SEQUOIA are available at the following link (http://www.lmtobservatory.org/gtm/).

Staffing the Scientific Observations

Scientific observations will be flexibly-scheduled within a queue-observing mode to maximize the efficiency of the overall scientific program and the telescope operation. The LMT Project will provide telescope operators and site-staff to perform routine start-up & shut-down procedures, and safety checks at the telescope. The Scientific Project Teams with an approved observing program are required to provide a minimum of one observer at the telescope with experience in the use of the scientific instruments and LMT data reduction. Training of new observers as part of the LMT science program is strongly encouraged and supported by the LMT staff scientists. Further information on the staffing of the scientific observations can be provided by the LMT Project Scientists, Miguel Chávez (mchavez@inaoep.mx) and Min Yun (myun@astro.umass.edu). For safety reasons the observers must be able to drive and have a valid driver's license.

Publications and the Public Release of Science Results

The primary objective of science observations with the LMT is to generate published scientific results that illustrate the competitiveness and uniqueness of the telescope. The LMTSC will assist this effort by coordinating the communication between the individual Scientific Project Teams, and encouraging the sharing of technical details during the data analysis, to enable increased efficiency, reliability and accuracy in the production of the final data products. The instrument teams will, if necessary, review the reduced scientific data products to ensure uniformity and quality prior to publication. Scientific press releases to the media involving LMT data, or the use of LMT data for educational purposes, should be coordinated through the LMT Project office (contact mchavez@inaoep.mx).

Further Information

Questions related to the LMT operational policies associated with scientific observations should be directed to the LMT Project Scientists, Min Yun (myun@astro.umass.edu) or Miguel Chávez (mchavez@inaoep.mx). Specific questions related to the use of the scientific instruments should be sent to Gopal Narayanan (gopal@astro.umass.edu) for queries regarding the Redshift Search Receiver and SEQUOIA, and to Grant Wilson (wilson@astro.umass.edu) for queries regarding AzTEC. For general assistance with the proposal submission process, contact Alfredo Montaña (amontana@inaoep.mx).