Multiple Mirror Telescope Observatory

Tucson, Arizona 85721

This report covers the period 1 October 1986 - 30 September 1987.

I. INTRODUCTION

The Multiple Mirror Telescope Observatory (MMTO) is a joint facility of the Smithsonian Institution (S.I.) and the University of Arizona (UA) which has the operation of the MMT for the scientific staffs of these organizations as its main purpose. The MMTO is a department of the University of Arizona which derives its funds from the State of Arizona and contracts with the Smithsonian Institution. The MMT is located on the 2600 m summit of Mt. Hopkins, approximately 60 km south of Tucson, Arizona, on the grounds of the F.L. Whipple Observatory.

II. PERSONNEL

As of 30 September 1987, the MMTO staff complement of 24 consisted of F.H. Chaffee Jr. (Director), C.C. Janes (Assistant Director, Engineering), F.H. Sharp (Assistant Director, Operations), C.B. Foltz (Staff Astronomer), B. Russ (Department Secretary), C. Pagnotta (Mountain Secretary) H. Lester (Business Manager), D. Blanco (Mechanical Engineer), A. Poyner and J. Montgomery (Computer Specialists), D. Barlow, J. Sjogren, and R. Holleman (Electronic Engineers), F. Dascoli, C. Thompson, and Q. McClure (Electronic Technicians), C. Heller, J. Robertson, J. McAfee, and A. Alday (Telescope Operators), B. Sabol and D. Ouellette (Instrument Specialists), R. Stenman (Mechanical Technician), and D. Smith (Maintenance Mechanic).

III. ASTRONOMICAL RESEARCH

Ninety percent of the scheduled nights on the MMT are now devoted to astronomical research, with the remainder of the time going to telescope and instrument maintenance and improvement. Most astronomical research makes use of the three MMT facility instruments -- MMT spectrograph, echelle spectrograph, and IR photometer. Descriptions of the instruments and their capabilities are available from the MMTO department office. Specialized instrumentation during the reporting period included a CCD camera, grism spectrograph, speckle camera, IR polarimeter, and 10 micron direct imaging camera. A total of 47 scientists from the Center for Astrophysics, 45 from the Arizona Universities, and 38 from outside either parent institution were involved in MMT observing programs. Included in the latter group were scientists participating in the MMTO visitor program in which 6% of the available time on the MMT is made available to the community at large. Details of this program are available from the MMTO Director's office.

IV. TELESCOPE INSTRUMENT DEVELOPMENT

The MMT closes down nighttime operation in August, during the height of the Arizona rainy season, to allow for any major maintenance of the facility. Ten percent of the rest of the time on the MMT is devoted to maintenance and development of the telescope and its instruments. Development efforts were concentrated in six areas:

a. Fabrication of 7th MMT Primary Mirror

Since no aluminizing plant is available on Mt. Hopkins, MMT optics must be transported to the UA facility in Tucson for realuminizing. A primary mirror can be out of the telescope for as much as a week during this process. To minimize the realuminization down-time, the MMT is having a 7th primary mirror fabricated at the UA's Optical Sciences Center. This mirror will be figured to produce 0.25 arcsecond (FWHM) images. During the reporting period, software and hardware were developed to allow production and interpretation of interferograms in real time. Completion of the 7th mirror is anticipated for early 1988.

b. Phasing the MMT

The array of six telescopes was co-phased successfully in 1983 over a limited wavelength range through the use of adjustable wedges in the beam between each of the six tertiaries and the f/8.39 monolithic beam combiner. Beginning in July 1986, MMTO received funding from the NSF (AST-8418188) to address: (1) The design and construction of new low-compliance tertiary mirror mounts (2) techniques of modeling path length changes resulting from thermal charges in the optics support structure (3) design and construction of a computer-controlled achromatic beam combiner wherein optical path length changes are compensated for by motor-driven facets (4) other improvements that will help make phased operation of the MMT routine.

A prototype tertiary mount has been installed on the telescope and is undergoing evaluation. An array of temperature sensors has been installed on the optics support structure. Data from the array are being analyzed. The articulated beam combiner has been installed and tested successfully. Tests to date show that all six images remain coaligned and in phase for as long as 30 minutes under open-loop computer control using empirically-determined coefficients relating path length to telescope elevation.

IR interferometric measurements using the new beam combiner are planned for next year.

c. MMT Red Channel

A versatile CCD spectrograph has recently been completed in the Steward Observatory shops for use as a second channel of the MMT spectrograph, with which it shares a slit assembly and two filter wheels. The performance of the so-called Red Channel should be complementary to the moderate-resolution, high UV sensitivity of the MMT Spectrograph. The Red Channel uses a TI 800x800 CCD as a detector and is optimized for performance in the red, yielding good images over the usable field of the MMT in the range from about 3800 Å to 1 μ. The spectrograph can be used with a variety of dispersers including normal low-order gratings as well as a high-throughput mode using a prism disperser. In addition, an 80 grooves mm^{-1} echellette grating blazed at 9000 Å in 4th order can be used with a cross-dispersing prism to provide single exposure coverage from 4500 to 9500 Å at a resolution of about 250 km s^{-1} with a 20 arcsec long slit. The disperser can also be replaced with a flat mirror so that the spectrograph can be used as a focal reducer for direct imaging with a resulting scale of 0.3 arcsec $pixel^{-1}$. The spectrograph is currently undergoing evaluation on the MMT and the first scientific observing runs have begun. We anticipate that it will be commissioned as a facility instrument early in 1988.

d. Use of MMT in the Thermal Infrared

Under the same NSF contract as mentioned in b, MMTO is developing a 10-20 micron photometer for use on the telescope.

e. Microwave Link to MMT

Through the acquisition of a government surplus microwave system by the Smithsonian, a direct link between the MMT and Tucson office complex was established in April 1986. As a result, spectrographic observational programs can be carried out remotely from the "remote observing room" in the MMT Tucson offices. Real-time video and status displays for all computers on the mountain can be selected easily by the observer, who has complete control of spectrograph and data acquisition computers. Control of the telescope itself remains the responsibility of the on-site telescope operator.

f. Possible Upgrade of MMT to Single Primary 6.5 Meter Telescope

Based on the early success of spin-casting of mirrors at UA, the MMTO is considering the possibility of replacing the six 1.8 meter primary mirrors with a single primary mirror which would be at least 6.5 m in diameter and as fast as f/1. To this end, Blanco and Montgomery have been working extensively with the UA large telescope group to explore the problems of supporting lightweight mirrors.

Contingent upon the availability of funding, an upgraded MMT is targeted to be put into operation by the end of 1993.

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