MMT Observatory

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This report covers the period 1 October 2000–30 September 2001.

1. INTRODUCTION

The MMT Observatory (MMTO) is a department of the University of Arizona and is jointly funded by the Smithsonian Institution and the University of Arizona. Its primary mission is to operate, maintain, and develop the 6.5 m MMT for use by the scientific staffs of the parent organizations. 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 (FLWO).

2. PERSONNEL

As of 30 September 2001, the MMTO staff complement of 22 consisted of C. B. Foltz (Director), J. T. Williams (Conversion Project Engineer), S. Criswell (Conversion Project Manager), S. West (Associate Staff Scientist), T. Pickering (Assistant Staff Scientist), B. Russ (Administrative Associate), H. Lester (Business Manager), S. Callahan (Mechanical Engineer), T. Trebisky and D. Gibson (Computer Specialists), J. McAfee and A. Milone (Telescope Operators), W. Kindred (Instrument Specialist, Sr.), D. Smith (Staff Technician, Sr.), P. Spencer (Electrical Engineer), M. Alegria (Engineer Associate), D. Clark (Electrical Engineer, Sr.), K. Van Horn (Electrical Engineer), R. James (Instrument Maker / Designer), R. Ortiz (Engineer Associate), C. Knop and B. Comisso (Electronic Technicians, Sr.).

3. ASTRONOMICAL RESEARCH

Until its shutdown in early 1998, ninety-four percent of the scheduled time on the MMT was devoted to astronomical research, with the remainder going to telescope and instrument maintenance and improvement. Most astronomical research made use of the MMT facility instruments: MMT spectrograph-blue channel, MMT spectrograph-red channel, and echelle spectrograph.

On the morning of March 2, 1998, the chamber doors closed on the 4.5 m MMT. The telescope was decommissioned in preparation for the installation of the new 6.5 m instrument. The new telescope saw first light in May 2000 and was dedicated on May 20 of that year. Astronomical observations began shortly thereafter. During the period from October 1, 2000 through July 15, 2001, approximately sixty percent of the available time was scheduled for scientific observations. Among the instruments mounted at the Cassegrain focal plane were: the Blue Channel of the MMT Spectrograph, Minicam (an optical imager), F-Spec (a near-IR spectrometer), MIRAC/BLINC (a mid-IR imager and Bracewell interferometer), FLAMINGOS (a near-IR imager and spectrometer), and SPOL (an optical imaging spectropolarimeter). In addition, a high-resolution interferometric Shack wavefront sensor was used at Cassegrain to investigate telescope alignment and primary mirror support.

The MMTO maintains a web site containing documentation on the telescope and instruments, as well as information on the progress of the MMT Conversion Project. It can be accessed at the following URL: http://mmt.as.arizona.edu. (Address comments or queries to cfoltz@as.arizona.edu.)

4. TELESCOPE INSTRUMENT DEVELOPMENT: CONVERSION OF THE MMT TO A SINGLE-PRIMARY 6.5 M TELESCOPE

As a result of the success of spin-casting of mirrors at the Steward Observatory Mirror Laboratory (SOML), the MMTO and its two parent institutions have replaced the six 1.8 m primary mirrors with a single 6.5 m diameter, f/1.25 paraboloidal borosilicate honeycomb primary mirror. Three secondary mirrors will be available: an f/9 classical Cassegrain to allow the use of existing instrumentation and high-resolution narrow-field imaging, an f/15 classical Cassegrain secondary for use in the infrared and for adaptive optics applications, and an f/5.27 Cassegrain, corrected to f/5.4 with a three-element refractive corrector with atmospheric dispersion compensation to produce a full one-degree field of view. The telescope is installed in the existing MMT building on the existing yoke. All observations during this reporting period were obtained at the f/9 Cassegrain focus.

Due to the space constraints both in the MMT building and on the summit of Mt. Hopkins, aluminization of the primary mirror is done in situ, i.e., in the telescope using a large steel belljar that mates to a flange on the primary mirror cell. The MMT is the first large telescope to attempt such a method and the first two attempts were less than satisfactory. The coating applied in April 2000 was contaminated with copper that had evaporated from the power cables connected to tungsten rods wetted with aluminum. Since it was expected that the reflectance would not be severely compromised at red and longer wavelengths, it was decided to defer another aluminization until summer 2001. The telescope was shut down in mid July of 2001 to repeat the coating. Preparation for this activity included the replacement of the filament system within the belljar with coiled tungsten filaments, redesign of the power system to insure more uniform application of power to the filaments, and installation of a second large cryogenic pump to handle the pressure increase just prior to evaporation. At the end of the reporting period, we were within six weeks of aluminization. We preemptively note that the aluminization was carried out in mid November of 2001. The system performed flawlessly, depositing approximately 1000 Å of Al with a resulting reflectance within a few tenths of a percent of perfection.

The primary mirror thermal control system was installed in the spring of 2001. The design of this system is a departure from those used with other spin-cast borosilicate primaries and is a prototype for the thermal control system to be used with the Large Binocular Telescope. Instead of using distributed liquid-air heat exchangers and fans, the MMT system brings roughly 2200 cfm of conditioned air to the mirror cell from a large remote blower/heat exchanger/chiller via underground duct to the primary cell. The air is then piped to a set of jet ejectors that mix with the air in the cell in a semi-recirculating system, which supplies 8 liters/sec of temperature-controlled air to each of the more than 1000 hex cells in the mirror. Although more complex than the liquid/air designs, this system is naturally well balanced. Initial tests showed that the primary could both be maintained nearly isothermal and at the ambient temperature with relative ease. The thermal control system will go into routine operation following the aluminization of the primary mirror.

Progress was made on the f/5 and f/15 secondary mirrors during this reporting period:

The 70 cm diameter, 1.6 mm thick f/15 Zerodur 'shell' for the adaptive f/15 secondary was mated to its adaptive control system. The latter provides adaptive correction to 320 voice coil actuators at approximately 600Hz. The system was installed on a large test structure in SOML, and the servo control loops were closed at low frequency. The testing of the system in the presence of artificially-generated turbulence was still underway in SOML at the end of the reporting period. Delivery and installation of the adaptive system on the telescope is expected to begin in the spring of 2002.

Polishing of the 1.7 m diameter f/5 secondary is ongoing at SOML. Polishing is being carried out with a 30 cm stressed lap, and the optic is tested with a computer-generated hologram written on a meniscus test plate. The construction of the telescope cell and the servo control electronics is nearing completion. The large hexapod positioner, designed and constructed by ADS Italia, was delivered and testing was begun. Baffle design is ongoing in collaboration with SAO astronomers and engineers. Delivery of the secondary and cell to the mountain is expected in summer 2002.

The three-element wide-field corrector lenses received their Sol-gel anti-reflection coatings and were ready for assembly into their cell at Raytheon Optical Systems. The corrector will be shipped to Mt. Hopkins following completion of the polishing of the f/5 secondary mirror.

Pointing and tracking tests are ongoing. Using a simple six-term geometric model, the pointing at Cassegrain focus is accurate to about 8 arcsec rms. Mount servo performance is adequate although additional tuning is required to stiffen the elevation axis, which is still a bit soft. The telescope slew rates in both axes are 1.5 degrees/sec, meeting specification.

Two significant problems were encountered during the reporting period:

First, the pneumatic cylinders that provide the forces to support the primary mirror developed air leaks. Inspection of the cylinders showed that the leaks were in internal rubber seals in the pneumatic pistons. The problem was exacerbated at low temperatures and, during the coldest conditions, it became difficult to supply enough air at the requisite pressure to support the primary. The problem was temporarily solved with the installation of Teflon seals, and a more permanent solution involving gluing of the seals was devised and extensively tested. The actuators were all removed, disassembled, and repaired during the downtime for aluminization.

Second, compliance in the f/9 secondary cell developed. This caused erratic collimation behavior that was traced to a loosening of several of the hardpoints in the secondary mirror cell. The cell was disassembled and the compliant parts were replaced with more robust flexures. Several other sources of flexure were also removed during this maintenance that was carried out during the aluminization downtime. The removal of the secondary allowed needed modifications to the secondary hub and spiders to be done as well. The latter were removed and their large turnbuckle nuts, which had previously galled to the spider vanes, were replaced. We anticipate starting observing with a much stiffer telescope top end as well as secondary mirror cell.

5. PUBLIC ACCESS TIME ON THE 6.5 M TELESCOPE

A significant amount of observing time on the 6.5 m telescope of the MMT Observatory is made available to the astronomical community through the NOAO proposal process. Under an agreement with the National Science Foundation, a total of 162 nights of observing time will be allocated to the astronomical community. This Public Access time will be distributed over the phases of the moon and the seasons of the year in the same proportion as the scientific observations scheduled for the staffs of the MMT Observatory's parent institutions, the Smithsonian Astrophysical Observatory and Steward Observatory. Roughly twenty-seven nights per year will be allocated for national access.

Access for visiting observers through the Public Access Program began in June 2000. Proposals are submitted through NOAO using the standard NOAO proposal form. The NOAO TAC reviews proposals, and those approved are forwarded to the MMTO for scheduling. Procedures and forms to apply for telescope time can be found at http://www.noao.edu/noaoprop/noaoprop.html.

During this reporting period sixteen nights of Public Access time were allocated.

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