BIMONTHLY SUMMARY

March - April 2001

Figure 1: MMT spectropolarimetry of the 2MASS AGN J170003+211823 in March 2001, by Smith, Schmidt, Hines, and Marble. At an absolute K-band magnitude of -28.3, this z=0.6 object ranks among the most luminous QSOs. Linear polarization of the optical light is P=10%, implying that the polarized flux spectrum has an apparent magnitude of V=23.5. Note the much bluer slope of the polarized flux vs. the total flux spectrum, and the appearance of polarized Hbeta in emission. These characteristics, plus the very red energy distribution in total flux, are indicative of a QSO which is heavily obscured by dust along our line of sight and appears polarized by light scattered off clouds surrounding the nucleus. Plot and caption courtesy of Gary Schmidt, Steward Observatory.

Personnel

K. Harrar left the MMTO the end of March and moved to Prescott, Arizona. We wish Karl all the best with his new endeavors.

On March 13, 2001, the Pima County Board of Supervisors approved the Canoa Ranch development plan. Under the terms of the agreement, more than 80% of the Ranch's area will be protected from development. The number of residences and the acreage for commercial development is dramatically reduced from those originally proposed in the Canoa Ranch Specific Plan. This ends the fight over the development of the sensitive area at the base of Mt. Hopkins that has been ongoing for more than three years, and countless hours of sometimes-acrimonious meetings. The result is a good one for the observatory – not only will the impact of the Ranch's buildout on the sky brightness be small, but a new and strict Outdoor Lighting Code resulted directly from the negotiations over the Ranch. While we can consider this a victory for the forces of (sky) darkness, we must remain vigilant in our protection of the dark skies.

C. Foltz presented a lecture on the MMT Conversion Project to the "Over 50 Club" of St. Andrew's Presbyterian Church on March 19.

Beginning March 13, W. Kindred and the operators are meeting every third week at the basecamp to discuss operational issues face-to-face. Anyone who needs to interface with the operators as a group is welcome to attend.

Development

SPOL

Gary Schmidt's Spectropolarimeter, SPOL, was mounted on the telescope for the first time in late March. This is a very high-performance instrument, which is well matched to the f/9 focus of the 6.5-m telescope. Although its performance was hampered by the poor reflectance of the primary mirror, the data that were collected are very impressive (see Figure 1 above).

Aluminizing

J.T. Williams and W. Kindred attended a mirror coating and cleaning conference on Mt. Palomar, CA April 25-29. Participants from most major telescope projects around the globe were present. It was apparent that everyone doing 6 to 8 meter class mirrors is having problems with deposition and/or cleaning. The magnetron sputterers have not been able to eliminate the non-reflective zone where the evaporant passes overlap. Some conventional systems appear to be producing highly reflective and uniform coatings. Subaru, e.g., reported good reflectance numbers (they evaporate from 350 filaments) although they were mum about other parameters such as adhesion. The cleaning of large aluminized mirrors is an art in its infancy. There appears to be a growing understanding of how things like CO_2 cleaning can prolong film life, but the very expensive implementations presented did not do an adequate job nor are many of the systems used frequently enough to have a real impact. Many reported an increase of scattering with each "snowing," so there is probably an upper limit to the frequency of such cleaning.

Washing with a detergent solution produces excellent results, but a suitable way to dry such a large surface area without spotting has not been devised. Several observatories are still trying an alcohol rinse to flush water off the surface but everyone reports residues left after alcohol evaporation (our experience from years ago tells us that there is no way around this). Blowing the water off with high pressure gas streams presents its own set of problems. This worked well for our smaller optics but is a different proposition when looking at 33 m^2 of mirror area. In the next few years we are going to be learning a great deal about these issues.

Preparation began for summer realuminizing of the primary mirror, which requires familiarization, updating, and redrawing of all the aluminizing schematics and documentation.

Servos

The new mount interface chassis was put into service during the reporting period. It was discovered that the LM628 is constantly generating an internal interrupt to capture the index position when the index line from the encoder is held low. Since the MMT mount encoders are high-true, this meant that the internal interrupt created so many interrupt cycles when the telescope velocity got over about 0.5 deg/sec that the LM628 servo loop would go unstable. This internal interrupt occurs whether or not the index-position capture mode is enabled by the host software. The fix was the replacement of the index input optocouplers with a pull-up resistor, preventing the index interrupt from occurring. The new mount interface electronics have performed without problems ever since.

Dan McKenna and Dave Harvey of SO and John Hill of LBTO visited the MMT along with some special test hardware to help debug and tune servos. The servo tuning update was done over a two-day period with good results; tracking of a fictitious point was measured via the tune window at 0.15 arcseconds RMS. The tuning appears to be quite adequate for tracking in no to light wind conditions; further investigations remain to be done to try to increase servo stiffness at moderate to high wind speeds.

Mirror Support

The cell computer back plane has been replaced and significant improvement has been achieved. No actuator failures have been seen that previously would have been attributed to the bad cable interface to the cell computer. This was accomplished when it was realized that the old DAC assignments were acceptable and that the present wiring was easily modified to add the strain relief necessary.

Thermal System

The final connection scheme for the differential type-T primary mirror temperature measurement system was agreed upon. Five hex cells in each of 4 mirror radii will be measured, including a checksum between the inner and outermost cells. Additional differential connections in each radius include the Steward type-E isothermal junction block (for a comparison reference to that system), the lower cell plenum, the mirror backplate, chamber ambient, and OSS steel. Ambient thermocouple housings and enclosures for the mounting of the HP DAU to the mirror cell will be constructed. Each thermocouple housing (most likely a tube) will have its axis run parallel to the elevation axis. The chamber ambient thermocouples from both the type E and T systems will be located inside the housing. The housing ends will be open to ambient air but the housing wall will shield the thermocouples from radiative coupling to the sky. Thermocouples will be installed on the OSS with proper sky shielding using housing similar to those of the ambient thermocouples. Reference MMTO Conversion Technical Memo #99-2, February 1999 for more background.

A Tcl/Tk GUI was written for experimenting with this new system via a serial port using the HP 34970A command language. Extensive logging scripts were written for monitoring the temperatures during telescope operation.

Using the SAO msg software, a temperature server for the original type-E temperature measurement system was written. Now, any client software running on the network can access air and glass temperatures from this system.

The Neslab HX-540 chiller was removed from storage at the basecamp and moved to the summit loading dock for testing. The initial testing was done via the RS-232 interface using the Neslab binary protocol with a Tcl script. The following two figures show the bath temperature response (with the default PID values) to a 30C to 0C step function cooling command (Figure 2) and to +40C step function heating command (Figure 3).

The heating [illegible] he 50 hp off-board blower [illegible]

Figure 3: Bath response to +40C step function heating command on the Neslab HX-540 chiller with the factory PID values.

Software was [illegible] HX-540 recirculating chiller and Linux-based PCs. This GUI allows the user to monitor (Figure 4) and to set (Figure 5) all programmable parameters for the chiller. The Neslab unit will be used to help maintain a uniform temperature within the primary mirror for improved image quality and for stability with fluctuating ambient temperatures. Visual clues are presented by the GUI to the user when parameters reach a critical temperature (e.g., the flow rate of circulating fluid in the chiller is at too low a value as shown in Figure 4). Temperature setpoints and related parameters can be modified through a table-like display of slider bars (Figure 5). This software has been implemented in Perl/Tk.

Figure 4: GUI for monitoring the Neslab HX-540 parameters for the MMTO 6.5-m telescope.

Figure 5: GUI for adjusting programmable parameters of the Neslab HX-540 chiller unit.

The next step will be to allow this and related software to automatically adjust the temperature setpoints to follow the natural cooling and warming of the mirror cell during observing.

F/5 Hexapod

Design of the f/5 hexapod control system and mirror support electronics is ongoing. It was decided that the LVDTs on the hexapod should be used to close the position loop of the hexapod actuator servos via a serial link from the f/5 M2 support electronics card. ADCs were selected to provide high-resolution position data. A $sinc^3$ filter will be used for rejecting ripple from the LVDT's internal DC conversion circuit. ADS International provided us with a test report showing their difficulties with this particular measurement, although it is clear from their data that they had only 0.9 micron resolution, and it is unclear what they did to filter the ripple out of the position signal. We expect to handle this signal differentially, and in combination with the $sinc^3$ filter should give us ~100 db rejection of the ripple. This, coupled with the 22-bit NMC performance of the ADC, is expected to give us 10nm resolution for the LVDT length. We have also designed into the mirror support card a test circuit for measuring an incremental encoder channel from the actuator, giving us a sanity check for each strut when needed to verify the LVDT measurement.

The cable and connector design for the system will be completed in the next month or so, and parts should arrive in time to complete construction before the August shutdown.

ADS International has finished the performance testing of the individual struts. The hexapod is being reassembled. ADS will test the platform motion on a 3-D mill and measure the stiffness of the entire unit. They have summarized the results of the performance testing in a report. Once we've reviewed the report and agree that the actuators meet specification, ADS will ship the unit to Tucson.

F/9 Hexapod

The original control software for the f/9-f/15 hexapod was changed so that the LVDT strut lengths were refreshed after each hexapod movement. The LVDT lengths were added to the hexapod msg server written by SAO so that any program running on the network could access them. A msg client, which logs the hexapod commanded motion and the resulting LVDT strut lengths each time the hexapod is moved, was written. The detailed performance and any changes in the behavior of the hexapod can now be easily analyzed by comparing the incremental encoder commanded move with the LVDT strut length changes. Additional logging includes temperature, focus, and collimation. Using these results, it should be possible to build a statistical database of collimation and focus vs. temperature and instrument as the telescope is used nightly.

F/9 Secondary

In March S. Callahan, S. West, and R. James mounted electronic dial indicators to the f/9 M2 to try to determine the source of a collimation shift of the secondary during changes in elevation. Software written in Perl/Tk was developed to collect data via the Cyclades terminal server. By the end of March they isolated the shift movement to either the axial hardpoints or the tangent rods.

F/5 Secondary Mirror

Throughout this time frame the f/5 M2 cell was being fabricated at Aircraft Engineering in Paramount, CA. R. James and S. Callahan inspected the weldment and the machined top plate and completed the first phase of verification. Both were impressed with the quality of the parts. Weekly progress of the fabrication was monitored by telephone throughout the process by R. James.

The f/5 M2 ventilation system was designed, and all of the components have been ordered. All machined components are being detailed for fabrication by C. Wainwright and S. Bauman.

During this reporting period, the mechanical components of the support system were assembled. R. James has been overseeing the quality control of the assembly of all f/5 components.

Computers and Software

Programming work to improve the utilization of network bandwidth by the mount computer continued. A spare VME/167 system downtown was made to run a copy of the mount software in "telescope simulator mode." This system has proven to be immensely useful for testing and debugging new software without disruption of activity on the mountain (and allows such work to be done in a mode that is low-risk and always available to the programmer).

In early April, we took advantage of several contiguous days of engineering time to do work on the telescope on several fronts. We did a new pointing run and were again able to get a 8 arcsecond RMS pointing model with only six coefficients in the model. The residuals show systematic variation, which leads us to believe that fitting additional parameters will yield an even better model.

A telescope status window (Figure 6) and related internet page (Figure 7) were developed to aid in the monitoring of telescope parameters, such as azimuth and elevation, as observing is underway. This GUI is highly configurable by the user, with options for selecting which parameters to display and overall font size. This software communicates with new and existing software from MMTO and SAO that monitors these parameters. This code has been written in Tcl/Tk. The web page, implemented in HTML, is updated at a ten-second interval and is available to offsite researchers through a web server. The user can enable or disable the generation of new internet pages, as desired.

Figure 6: GUI for monitoring the status of the MMTO telescope while observing is underway. Values are updated at an approximately 5-second interval.

Figure 7: The HTML-based internal web page for monitoring the status of the telescope while observing is underway. Values are updated at an approximately 10-second interval. The web page can be configured by resetting web browser parameters.

An optimized algorithm for adding or stacking of images obtained from the DT3155 framegrabber was written in C. The DT3155 is a high-accuracy, monochrome framegrabber for the PCI bus, currently installed on the computer named hoseclamp. This software obtains 30 images (i.e., the second-long output from the DT3155) and adds them into a single composite image. This image is then averaged with the image from the previous second to produce a new image, following a leaky memory approach. The stacking of images allows for recognition of faint objects while the leaky memory approach includes a time-averaging of images. The algorithm used combines the stacking and image averaging processes into a single nested for loop, resulting in improved computing efficiency.

Optics

Reports of deteriorating and unpredictable optical collimation, as well as randomly changing mount offsets, were received during this reporting period.

An engineering night was spent recording the f/9 (M2) tilt required to keep the telescope collimated as the mount was repeatedly cycled in elevation. The X and Y tilts required to maintain collimation for two complete cycles of elevation are shown in Figures 8 and 9 below and illustrate the new problems in collimation and pointing.

Figure 8: f/9 M2 X-axis tilt required to maintain collimation for the current support problems.

Figure 9: f/9 M2 Y-axis tilt required to maintain collimation for the current support problems.

The f/9 secondary hexapod and primary mirror (M1) hardpoint system were checked and ruled out as the cause of the collimation non-repeatability. A detailed inspection of the f/9 M2 support system has shown that several of the position-defining hardpoints appear to be "loosening" up. Whether or not the system can be repaired without removing the secondary system from the telescope will be addressed in early May.

General Facility

The cable buried with the new air duct has been terminated in the RUPS room and extended to the blower building. This cable will provide remote access to the equipment in the support building such as RUPS, the blower, the Neslab, the heat exchanger, and the chiller. It will initially be used as a direct connection for quick startup of this equipment as necessary. The intention is to add optical isolators and up to three RS-422 links to this interface to provide safer and more functional operation in the future. The cable must now be terminated in the pit and extended up the maypole to the drive room, and an interface installed there.

Beginning April 4, we rearranged the control room furniture on an experimental basis with an eye toward improving ergonomics (operator-observer interactions). This will probably be an ongoing effort, and any comments/suggestions will be considered.

Maintenance and Repair

K. Van Horn added new temporary telephone cabling and completely disconnected all the old cabling inside the MMT. While this has eliminated 95% of the problems we have been experiencing, this cabling needs to be made permanent and the old cabling removed or abandoned in-place. Ken will hold a seminar on how to use the system as soon as possible.

K. Van Horn spent considerable time researching the Carrier water chiller and trying to get it operational again. We finally got the local Carrier service organization involved and seem to be on the way to getting it functioning. We ordered, and Ken replaced, the processor board only to find out that the board had "lost its memory." We now have a spare. Completion of the reinstallation process required the services of a refrigeration mechanic, who found additional problems with the electronic expansion valve driver board. When this was replaced it was found not to be the problem. We now have a spare. Carrier decided that both the expansion valves themselves were bad and ordered one to replace them. Carrier has now ordered another valve and will replace the second one when the new part arrives.

Other mountain tasks included the troubleshooting and the addition/rerouting of some network cables. The actuator test stand now has a dedicated network cable back to the hub in the drive room. Also, one each network cable was added to the old control room and to W. Kindred's lab. During the installation of these cables, two more channels in the drive room network hub were found to be faulty.

Visitors

April 17: Dr. Alessandro Omizzolo of the Vatican Observatory and Dr. Josef Bremer, a Jesuit philosopher, accompanied by Dr. Chris Corbally, S. J. (VATT).

April 19: Eleven students and three faculty from Columbia University's Biosphere 2 Center's Astronomy Program, led by Dr. Karen Van Landingham, toured the Mt. Hopkins facility, accompanied by C. Foltz.

April 23: Several members of the Smithsonian National Board toured the mountain. The evening included dinner at Rex Ranch and a visit to the summit to watch the start of observing. The guests were Jim and Mary Patton, Gay Wray, Michael Wray (Gay's brother-in-law), Paul Hertelendy, and Barbara and Dick Blake. The evening was hosted by Craig Foltz, Amanda Preston (SAO), Dan Brocious and David Aguilar, the new SAO Public Information Officer.

April 29: Arizona Astronomy Board member Chris Moller (Managing Director of TL Ventures, a venture capital company in Philadelphia), his brother in law from San Francisco, Arizona Astronomy Board member Richard Caris, and CfA astronomer T. K. Sridharan, accompanied by Peter Wehinger of Steward Observatory. Richard Caris' company, Interface Inc., provided the force measuring devices (load cells) used in the MMT, Magellan, and LBT primary mirror cell actuators.

Publications

MMTO Internal Technical Memoranda

01-1 Secondary Mirrors Support: M2/F5 Hexapod Data Package
ADS International s.r.l.

MMTO Technical Memoranda

None

MMTO Technical Reports

None

Scientific Publications

01-5 The Tully-Fisher Relation as a Measure of Luminosity Evolution: A Low-Redshift Baseline for Evolving Galaxies
Barton, E. J., Geller, M. J., Bromley, B. C., Van Zee, L., Kenyon, S. J.
AJ, **121**, 625

01-6 H II Regions and Abundances in the "Dark Galaxy" DDO 154 and the Chemical Evolution of Dwarf Irregular Galaxies
Kennicutt Jr., R. C., Skillman, E. D.
AJ, **121**, 1461

01-7 Observations of Lyα Absorption in a Triple Quasar System
Young, P. A., Impey, C. D., Foltz, C. B.
ApJ, **549**, 76

01-8 Absolute Dimensions of the Unevolved B-Type Eclipsing Binary GG Orionis
Torres, G., Lacy, C. H. S., Claret, A., Sabby, J. A.
AJ, **120**, 3226

01-9 Gliese 569B: A Young Multiple Brown Dwarf System?
Kenworthy, M., Hofmann, K.-H., Close, L., Hinz, P., Mamajek, E., Schertl, D., Weigelt, G., Angel, R., Balega, Y. Y., Hinz, J., Rieke, G.
ApJ Letters, **554**

01-10 The Properties of the Radio-Selected 1JY Sample of BL Lacertae Objects
Rector, T. A., Stocke, J. T.
Accepted by *ApJ*

01-11 A Black Hole Greater than 6 *M*sun in the X-Ray Nova XTE J1118+480
McClintock, J. E., Garcia, M. R., Caldwell, N., Falco, E. E., Garnavich, P. M., Zhao, P.
ApJ, **551**, L147.

Observing Reports

Copies of these publications are available from the MMTO office. We remind MMT observers to submit observers' reports, as well as preprints of publications based on MMT research, to the MMTO office. Such publications should have the standard MMTO credit line: "Observations reported here were obtained at the MMT Observatory, a facility operated jointly by the University of Arizona and the Smithsonian Institution."

Submit publication preprints to *bruss@as.arizona.edu* or to the following address:

MMT Observatory
P.O. Box 210065
University of Arizona
Tucson, AZ 85721-0065

MMTO in the Media

Erratum: The January/February 2001 Bi-Monthly Summary's description of news articles reporting the discovery of a new black hole binary system in the Galactic halo incorrectly attributed the institutional affiliation of the team led by Jeff McClintock to Harvard instead of SAO. We apologize for this error.

MMTO Home Page

The MMTO maintains a World Wide Web site (the MMT Home Page) which includes a diverse set of information about the MMT and its use. Documents that are linked include:

1. General information about the MMT and Mt. Hopkins.

2. Telescope schedule.

3. User documentation, including instrument manuals, detector specifications, and observer's almanac.

4. A photo gallery of the Conversion Project as well as specifications and mechanical drawings related to the Conversion.

5. Information for visiting astronomers, including maps to the site and observing time request forms.

6. The MMTO staff directory.

The page can be accessed in two ways. First, it can be loaded via URL *http://sculptor.as. arizona.edu*. Second, it can be accessed via a link from the OIR's MMT page at URL *http://cfa-www/cfa/oir/ MMT/mmt/foltz/mmt.html.* The former should be used by interested parties west of the Continental Divide; the latter is a copy, which is locally mirrored at SAO and is much faster for East Coast access.