

**Jupiter at 4777 cm<sup>-1</sup> (2.093 μm)**

Figure 6: A monochromatic image and representative spectra of Jupiter are shown. The double circle depicts the ~20" circular field of view of the instrument. The bright spot in the lower right of the field is reflected light from Jupiter's polar region.

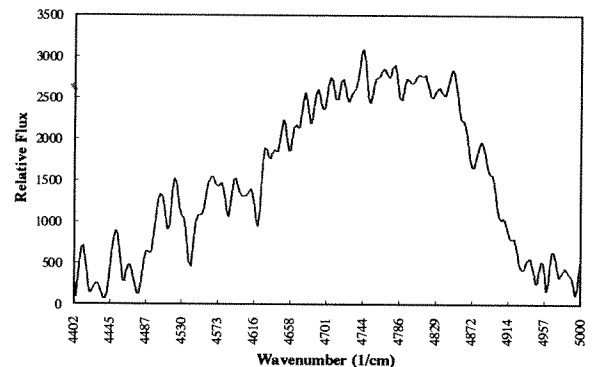
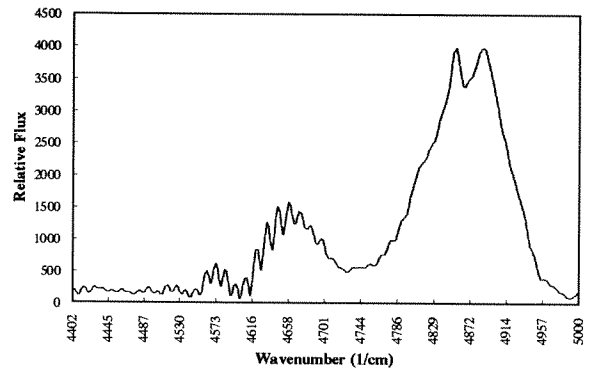
In the mean time, as an example of the type of data acquired during this first test of the instrument, we present spectra and images of Jupiter made through a filter centered at 2.15 μ. The bright zone in the monochromatic image of Jupiter at 4777 cm<sup>-1</sup> (2.09 μ) is due to a high altitude haze located at the pole, which efficiently diffuses incident solar light while the rest of the planet is almost dark.

Representative spectra from two places in the field indicated by arrows are also shown. These spectra have resolutions of ~2 cm<sup>-1</sup>. From these spectra the compositional difference between the polar haze and the atmosphere closer to the equator is obvious. The minimum at 4740 cm<sup>-1</sup> (2.11 μ) in the top spectrum is due dipole pressure-induced absorption of H<sub>2</sub>.

This run posed unique challenges for the Bear team, since we were not only using a new camera system but were attempting to couple that system to the FTS to effectively create a new instrument. The fact that Bear was used successfully for the March 1993 run is a testament to the skill of the CFHT technical staff.

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\* In case you were wondering, the name "Bear" stems from the collective imagination of the CFHT software group and dates back to the days when "Lions (a.k.a. Pumas), and Tigers" were abundant on the summit. They felt a Bear was needed at the zoo. We are still trying to retrofit an acronym onto Bear. Some possibilities include "Bidimensional Experience Adapting Redeye" or "Best Experimental Astronomical Research"!



## PUEO Progress Report

PUEO, if not yet arrived at CFHT, even not being built yet, nevertheless manages to take a lot of time from CFHT staff. We estimate that the CFHT adaptive optics bonnette project monopolizes 4 employees full time.

Many developments have taken place since the last issue of the CFH Information Bulletin. First, two contracts have been finalized, including detailed technical specifications of the instrument, and have been approved by the CFHT Contract Review Committee. They cover the fabrication of the opto-mechanical assembly (Dominion Astrophysical Observatory) on the one hand, and of the real time control software, tip-tilt and deformable mirror on the other hand (Laserdot). A third contract is being prepared for the integration of the instrument. The Observatoire de Paris-Meudon will be responsible for this latter task.

F. Rigaut has studied the behavior of our adaptive optics system using numerical simulations. His model shows that wavefront correction can be done on guide stars of 15th magnitude. A strehl ratio of 0.4 is reached at a wavelength of 1 μm. At the end of 1992, CFHT made an important decision, namely to change the deformable mirror type from piezo-stack to the bimorph technology. The reasons are numerous:

- the bimorph technology has made encouraging progress recently.
- it offers a better match to the curvature wavefront sensor.
- the bimorph mirror shows similar quality of image improvement than the piezo-stack, despite the fact it has 23 less electrodes (result of simulations).
- the cost is substantially lower than for a piezo-stack.
- F. Roddier's AO group at the University of Hawaii has strongly encouraged CFHT to adopt this technology, and

has more experience of such mirror, and therefore is in a better position to provide help and advice to CFHT.

The final electrodes geometry design were frozen in last April. Note that the electrode connections, which have been known to produce print-through on the optical surface, have been placed outside the pupil area, therefore not degrading the optical quality of the deformable mirror. A finite element model of the mirror has been completed by Laserdot and confirms an adequate behavior of this geometry.

A meeting took place at CFHT Headquarters in mid-April to finalize the control algorithm of the close-loop system. In a spirit of good collaboration, representatives of CFHT, Laserdot and Pr. F. Roddier, reached a consensus on the optimum control algorithm. Issues such as sampling time versus gain adjustments have been settled (the gain adjustment being favored, the sampling time remaining constant), servo-control of the vibrating membrane stroke for optimal sensitivity of the wavefront sensor, and at the time of this writing, two possible algorithms are competing for modal control scheme, but should be decided upon in the next weeks.

Progress on the mechanics have been made; the casting has been ordered (under the responsibility of DAO), and possible manufacturers for the optics have been identified (quotations have been obtained).

A detailed study of a first dedicated instrument for PUEO has been made; OASIS, being studied and designed by the Observatoire de Lyon, combines the following configurations:

- imagery 0.025" sampling, 90x90" field
- TIGER mode (micro lens integral field spectroscopy) with sampling from 0.1" to 0.5" and resolving power from 400 to 3040
- ARGUS mode (optical fibers integral field spectroscopy) with a sampling of 0.23" and resolving power of 280 or 1260
- PYTHEAS (grism+Fabry-Perot, see E. Lecoarer article of this issue) with sampling of 0.2" and resolving power of 9310 or 19450
- Scanning Fabry-Perot with sampling of 0.1" and resolving power of 3200 to 23500
- Long Slit of width 0.06" and resolving power of 1150

It is clear to CFHT that some of these observing modes in order to be useful require an elaborated reduction package.

CFHT has started work on the Pegasus User's Interface to control PUEO; this task will pick up to full speed in the second part of 1993. It is CFHT intention to make this user's interface friendly and usable for astronomers not fully acquainted with the subtleties of adaptive optics. The simple picture at this point would be to offer a simple but very fast (of the order of a few hundred Hz) tip-tilt correction, or a full automatic correction of all modes (19) with gain optimization; the modal control algorithm will, after a few iterations, optimize the gain applied to each mode (may imply slowing down correction of some). Lastly, a more elaborate mode will be available for so-called "experts" to tune-up the system to the best of their knowledge.

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## MOS-SIS News

MOS-SIS was the instrument the most used in the first semester of 1993: 74 nights or 48% of scientific observing time (70% of dark time). MOS-SIS does indeed correspond to a need in our community! Technically, MOS has performed superbly, with redshifts yields in excess of several hundreds for several teams on objects as faint as  $I=22.5$ . The opto-mechanical systems and the user interface are stable entities and have performed very reliably. The detector situation has been improved with new set-up parameters and the removal of the "dead" blue coating on LICK2 and the delivery for general use of the blue coated 2048<sup>2</sup>, 15  $\mu$ m pixels LORAL3 CCD, operational with the new genIII controller (many thanks to our detector group!). The LAMA machine has been performing OK, but with the occasional, and scary, occurrence of coolant leaks near the laser head. The purchase of a new laser cutting system is under investigation with the visit of several vendors and tests of their machines; the old unit will then become a spare.

A small number of technical improvements have been implemented (or will be soon) for the MOS spectrograph:

- New CCD guide field acquisition camera. This will enable guiding with the MOS PMTs and eliminate the current bonnette to MOS differential flexures (0.2 arcsec/h). The new CCD camera has been received, it will provide a sampling of 0.2 arcsec/pix for guide star acquisition to  $V=19$ . The PMTs will be able to guide to  $V=17$ . A modification of the current camera mount is underway to accommodate the new camera, and we expect tests on the sky to take place at the end of the MOS May run.
- Modified and new MOS mask holders. It has been found that the MOS mask holders allowed the aluminum foil used for the masks to wrap, and subsequently imply a poorer cut of slits by the LAMA. This problem has been solved with a new design from OPM and the 11 existing mask holders have been modified. Moreover, 25 new mask holders of the new design are being manufactured by OPM to allow for more flexibility in mask preparation and cutting.
- A tilt on the focal plane of the LICK2 CCD as been shown to degrade the optical quality. Precautions have been taken to reduce the tilt of the LORAL3 CCD to a minimum prior to the MOS May run. Test images show that the CCD tilt problem has been largely solved.
- The CCD LN2, fill time is currently inadequate (6 hours) and implies a refuelling in the middle of the night. An auto-fill solution with a dewar strapped under the Cassegrain bonnette is being used during the May runs.
- Install a filter in the calibration lamp unit to compensate for the halogen flat field lamp illumination as a function of wavelength. The filter has been ordered.

The story for SIS is not as rosy. We have experienced difficulties in operating the active guider since December 1992, even at the limiting magnitude of  $V=14$  identified as the limit with the current guider optics and PMTs. Extensive investigation of the problem, when we were able to take SIS apart in April, has shown that one of the PMTs was not giving proper signals, and was probably flaky at the time of the observations. Moreover, the head of the fiber bundle carrying the guide star signal to the PMTs had slipped in its holder, and the PMTs were not seeing a