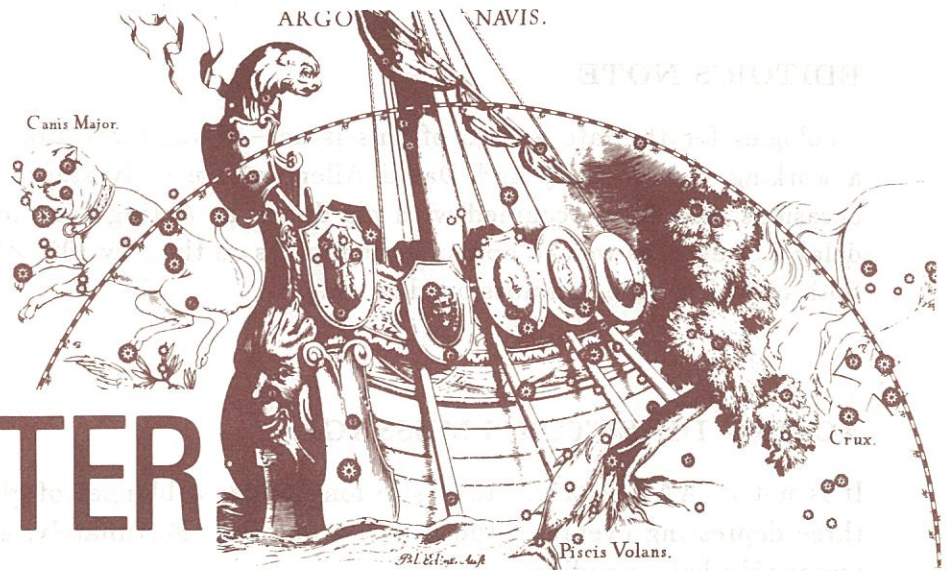


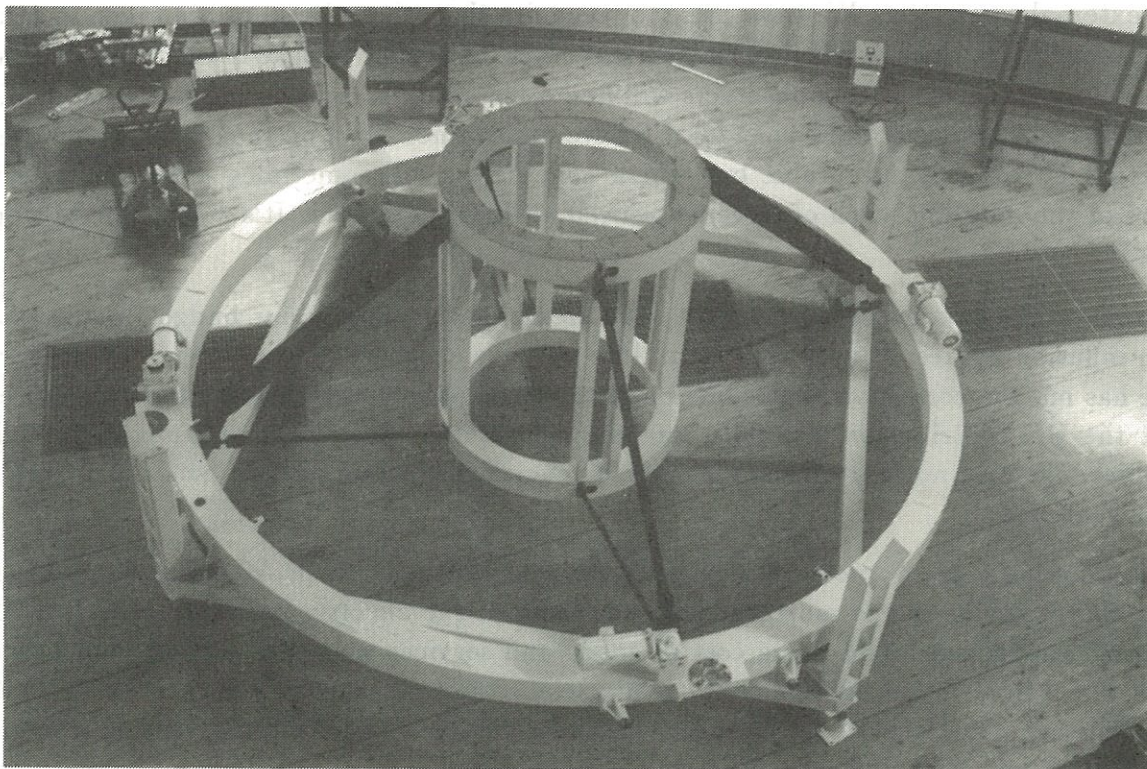
# AAO NEWSLETTER



No 62

July 1992

## TWO-DEGREE FIELD TOP END ARRIVES AT THE AAT



The new 2dF top end ring is shown in its storage frame on the AAT's main floor soon after delivery. The 2dF project continues on schedule, and the new top end and multi-fibre spectrograph should be available to observers by mid-1994. A progress report on the 2dF project can be found inside this Newsletter.

## EDITOR'S NOTE

Apologies for the late arrival of this issue – I was away from Australia for the whole of July on a working visit to Italy and David Allen, who usually steps in to handle the Newsletter on such occasions, was fully occupied with his duties as Acting Director. There is a positive aspect to the delay, however, as we can now include reports on the new 1024×1024 Tektronix CCD and the UHRF, both of which were commissioned in July.

Elaine Sadler

## ACTING DIRECTOR'S MESSAGE

It is not in AAO's nature to nestle long under a blanket of gloom. Nevertheless, I must mention three depressing events of the last few months. Fortunately, at least two of these appear to have reasonably happy endings.

One item already known to many is that Russell Cannon suffered a mild heart attack while attending the PATT meeting in Coventry. We are all tremendously relieved that he has bounced back rapidly to good health, and we're determined to make his transition back into Directorship as stress-free as possible. Directing AAO has become a much more demanding activity over his time here, a fact that was brought home to me in comparing my present stint as Acting Director with a similar episode six years ago. By the time you read this the AAO organization will have returned to its steady state, with Russell's tireless energy evident once more.

The second item was less widely broadcast. Another serious accident occurred in the dome at night, to a visiting student. We are all very relieved that the horrific experience seems to have inflicted on him no lasting damage. Once more we have reviewed the safety in the dome, this time with the help of a small external committee. We have come to recognise that whatever steps are taken to minimize risk, circumstances can arise in which accidents still occur. It is time to take more determined action. Over the next few months visiting observers will find a few new procedures and physical restrictions being put in place. Inevitably these changes will have some minor effect on the efficiency of observing, at a level that is perfectly acceptable but which nonetheless will sometimes seem irritating in the small hours of the morning when observers are tired and feel pressured. It's a small price to pay to save a life.

My final item of gloom concerns the budget. We are obliged to match our budget to the standard Australian inflation figures. It appears that of late we have exceeded this rate, and the Department of Finance has made a corresponding reduction in the Australian contributions. Parity requirements mean that the UK contribution also falls, and the net result is an abrupt and unanticipated drop in our budget, effective not only for the present financial year, which began on July 1, but for all subsequent years too.

The official inflation rates do not always match the real world in which AAO has to operate. For example, a sharp decline in the mortgage rate has reduced the effective inflation rate. But AAO is not paying off a mortgage. The rising cost of goods and services we need, plus the effect of salary increments, result in a steady tightening of our financial situation, especially during the present peak of 2dF expenditure. One facet of the finances will already have been noticed by visitors who are now being charged for taxi rides and tape usage in Coonabarabran.

But despite this, high points continue to occur and to maintain our enthusiasm. To end with just one such, the ultra-high-resolution facility, UHRF, has just undergone its first tests. The target spectral resolution of 1,000,000 was attained. This is no mere case of trying to outresolve the competition: there is exciting science to be done with UHRF, and I look forward to seeing some of its early results in subsequent issues of this Newsletter.

David Allen

## BOARD NEWS

July 1 saw a change of membership on the AAT Board with the appointment of Professor Michael Rowan-Robinson of Queen Mary Westfield College. He replaces the Deputy Chair, Professor Alec Boksenberg, who retired from the Board in June.

The next meeting will be held in Oxford from 7 to 9 September, and the new Deputy Chair will be announced after that meeting.

Sandra Harrison

## AAT BOARD SYMPOSIUM

The thirty-third AAT Board Symposium will take place on 9 September 1992 at the Department of Physics, Keble Road, Oxford. Starting time is 9.00 am. Accommodation has been organised at Keble College, and further information is available from Dr. Geoff Smith at Oxford. The program will include the usual Director's report and discussion, 2dF and UHRF reports and scientific papers, and Quentin Parker will be selling 4415 films.

David Allen

## RESEARCH ASTRONOMER POSITIONS

The AAO recently advertised two Research Astronomer positions. The closing date for applications is 30 September 1992, and further details are available from the AAO Director.

## NEXT ATAC DEADLINE

A reminder that the ATAC deadline for Semester X (February – July 1993) is **Wednesday 4 November 1992**. Full application details will be circulated in early October.

Sandra Harrison

## New AAO Executive Officer

I am pleased to announce that Mr Ross Laing has been appointed to succeed Doug Cunliffe, who retires early in November. Ross comes to us from the Department of Foreign Affairs and Trade in Canberra, and has had wide and varied experience in the Australian Public Service in recent years. Prior to joining the APS he was with BHP, initially as a chemist and later in management.

Ross began work at the AAO on 3 August. He will attend the next AAT Board meeting in Oxford early in September and will formally take up the post as Executive Officer at the end of that meeting. Doug will continue to work at the AAO for some weeks afterwards to facilitate a smooth handover of the many responsibilities of the job.

Russell Cannon

## VISITORS' EQUIPMENT

Due care will be taken with equipment owned by other institutions while it is at the AAO, but responsibility for loss or damage normally will not be accepted by the AAO. Visitors should therefore ensure that a member of the staff is well briefed on the precautions to be observed in handling and operating such equipment.

Doug Cunliffe



## Return of photographic plates

The photographic plate archives of both the AAT and UKST are unique and valuable resources, but they are incomplete. There remain many plates tucked away in the drawers and cupboards of astronomers around the world, dusty, neglected, inaccessible. These plates are effectively lost and remain so until recovered, or until the astronomer retires, when they might end up as greenhouse glass. To avoid this possibility, both the AAO and ROE are very keen to encourage the return of any plates no longer in active use. To simplify matters, UKST plates in Australia can be returned to the ROE plate library via the AAO/UKST and UK hoarders of AAT plates can send theirs to Sue Tritton at ROE.

David Malin

## Meeting announcement

'Astronomy from Wide-field Imaging' is the title of a conference to be held in Potsdam, Germany from 23-27 August 1993. The meeting will bring together the large numbers of topics where wide field imaging plays a part, including large scale structure of the Universe, quasar searches, galactic structure and solar system studies. The meeting will also aim to review all aspects of data collection, including photography and electronic methods, and consider techniques of data processing, object classification and methods of data organisation, archiving, storage, calibration and dissemination. The 5-day meeting will consist of both invited and contributed talks and posters. For further details contact David Malin (DFM@AAOEPP.OZ.AU)

## LIBRARY NEWS

The *I.A.U. Astronomy Thesaurus* Preliminary Edition was officially launched at the Special Libraries Association - Physics, Astronomy, Maths Division annual meeting in San Francisco. Delegates were presented with a copy of the thesaurus and encouraged to be involved with the appraisal of the preliminary edition which was distributed initially to some forty institutions in January 1992. Feedback is most valuable prior to the release of the official edition to ensure that the new thesaurus reflects a comprehensive coverage of current terminology in this field.

At the Hospitality Suite in the Marriott Hotel in San Francisco a party was held one evening to celebrate the launch of T-REX. The SLA/PAM delegates are still wondering if they really did see a cuddly green dinosaur cutting a large celebration cake, riding the hotel lifts and then later waltzing around the foyer of the hotel. Perhaps it was the effects of the Californian champagne?

The AAO librarian will be absent from the Epping library from 22 July to 20 September. R.M. and R.R. Shobbrook have convened a meeting with the European librarians involved with the proposed multilingual supplement to the main English edition of the thesaurus. This meeting will take place at the Institut d'Astrophysique in Paris on 27 July. Meetings will then be held with some of the UK astronomy librarians to obtain feedback on the thesaurus. DITAC also awarded a grant to allow attendance at the meeting on "Astronomy from Large Databases II" to be held in Haguenau, France in September. A paper will be presented to the European scientists on the thesaurus project and the possible future applications using intelligent or expert systems (the new trend in library management).

Mrs Gwen Crane, a qualified librarian, has taken over the library duties for 15 hours a week until 20 September. The idea is to keep control of the daily influx of library mail; to keep the journal displays current and generally avoid the possibility of the AAO librarian having a heart attack trying to cope with the inevitable backlog after two months gallivanting around Europe (no costume parties on this trip). It is a tough life but somebody has to do it!

Robyn Shobbrook

## Publications distributed

- AAO PP 268-92 Da Costa G S, Armandroff T E, Norris J E  
The metal abundance and age of the globular cluster Ruprecht 106.  
Accepted: *Astronomical Jnl* (July 1992 issue)
- AAO PP 269-92 Burton M G  
The excitation of molecular clouds and the emission from molecular hydrogen.  
Accepted: *Aust Jnl Physics*
- AAO PP 270-92 Burton M G, Bulmer M, Moorhouse A, Geballe T R, Brand P W J L  
Fluorescent molecular hydrogen line emission in the Far-Red.  
Accepted: *Mon Not R astr Soc*

## SCHMIDT TELESCOPE (UKST) NEWS FROM ROE

### Kodak Tech-Pan 4415

Kodak Tech-Pan 4415 emulsion on film is available in 14" × 14" sheets and can now be used routinely instead of glass plates for photography on the UKST. The film is extremely fine grained and, in good conditions, produces photographs which are deeper and have higher resolution than current survey plates taken on IIIa-F emulsion. The film is panchromatic and is sensitive to about 690 nm (similar to the IIIa-F emulsion).

Users should note that, at present, it is not possible to obtain 14" photographs which match the B<sub>J</sub> band as no suitable filter is available. Tests are underway to assess the use of film in the U band and results will be published as they become known. Further details about the film and its properties were given in the April 1992 AAO Newsletter. Anyone wishing to use the new film is invited to contact members of staff at ROE or Coonabarabran for further information or discussions.

### Applications for UKSTU material

Applications for all photographic material (new plates or films, to borrow existing material or to obtain special photographs) can be made at any time and should be submitted to ROE (for UK and Foreign users) or to Coonabarabran (for Australian users). Users are reminded that requests for large numbers of new plates requiring good seeing (especially those around 0 hours RA) may take some time to complete. Requests which can tolerate poor seeing or some moon are likely to be fulfilled within one observing season.

Applications for UK FLAIR time are assessed by the UK sub-committee and are scheduled to coincide with the UK PATT semesters. Applications should be submitted by 30 September for the February-July semester and by 31 March for the August-January semester.

### Return of UKST plates to ROE

Several users have had UKST material on loan for many years. As the Plate Library operates as an archive for all UKST original plates it is most important that users return plates when they have completed their project. This is partly so that the plates can be properly stored and, if appropriate, selenium toned to prevent microspot formation. It is also so that the plates can be made available to other astronomers for other projects. On several occasions ROE has received a request to borrow a plate and has then been unable to trace either the plate or the borrower.

We ask everyone who has UKST plates (including glass and film copies) which are no longer required to return them to ROE. If necessary, we can supply suitable boxes for the safe shipment of the plates and can send these boxes to any address on request. We also ask users who change address and wish to take their plates with them to inform us in order to prevent plates getting lost. If anyone finds

UKST plates which have no obvious owner, please contact us and arrange shipment to Edinburgh. Users in Australia may, of course, return their plates to Coonabarabran rather than to Edinburgh.

### Equatorial (EJ and ER) Surveys and Atlases

As at 15 June 1992, 282 fields have an A-grade accepted for the EJ survey and 211 fields have an ER A-grade. The total number of fields in the survey is 288.

The first issue (50 fields) of the EJ Atlas on film has been sent to over 50 customers and the second instalment (also of 50 fields) will soon be ready for despatch. The anticipated completion date is 1994. We remind readers that this film Atlas can still be ordered from UKSTU, ROE at a cost of £4,000 with payment to be made by instalments. Please contact us for a copy of our special order form.

We will shortly begin the copying of the ER Atlas onto glass. Once production has begun it will not be possible to accept further orders. Any potential customer who would like this atlas should contact UKSTU, ROE as soon as possible.

### Magellanic Cloud Mini-Survey

The UKST is taking plates in various colours on 12 fields covering the SMC (fields 28-9, 50-1) and LMC (fields 32-3, 55-7, 84-6). It is planned to photograph all fields in the following wavebands: U, B<sub>J</sub>, V, OR, (Short)R, I and with the prism. Each set will be copied onto film and the sets of 12 can be purchased individually at a cost of £250 per set. Orders can now be placed for three of the sets; OR,SR and I. The OR consists of sky-limited IIIa-F exposures taken with an OG590 filter. The I and SR sets are made using the same originals as the SERC I/SR Atlas of the Milky Way and Magellanic Clouds (90 minute IV-N + RG715, 15 minute IIIa-F + RG630).

The B<sub>J</sub> set will be made from new originals exposed in dry nitrogen and will therefore be more uniform than the films included in the ESO/SERC Southern Sky Atlas. It is hoped that this set will be available by 1994. We would be particularly interested in hearing from anyone interested in the U and V sets as this would help in scheduling the telescope to obtain the original plates.

### Teaching Projects using UKST material

#### 1. Teaching Packages available

There are three different packages of films, made from UKST original plates, available at present. These are *Edinburgh Astronomy Teaching Package for Undergraduates*, *Edinburgh Astronomy Spectroscopic Teaching Package* and *Edinburgh Educational Packages for Schools* (5 sets). The first two contain specially made films with exercises suitable for use in Universities and cost £100 each. The third package is more suitable for demonstration purposes and each set (cost £50) contains 10 different fields illustrating various types of object.

#### 2. Demonstration Material

A set of film copies of particularly interesting parts of the sky is being collated. Films available so far are *Orion, including the Horsehead and Great Nebulae*, and *Fornax Cluster of Galaxies*. Each film costs £10. Suggestions for other fields to be included are welcome.

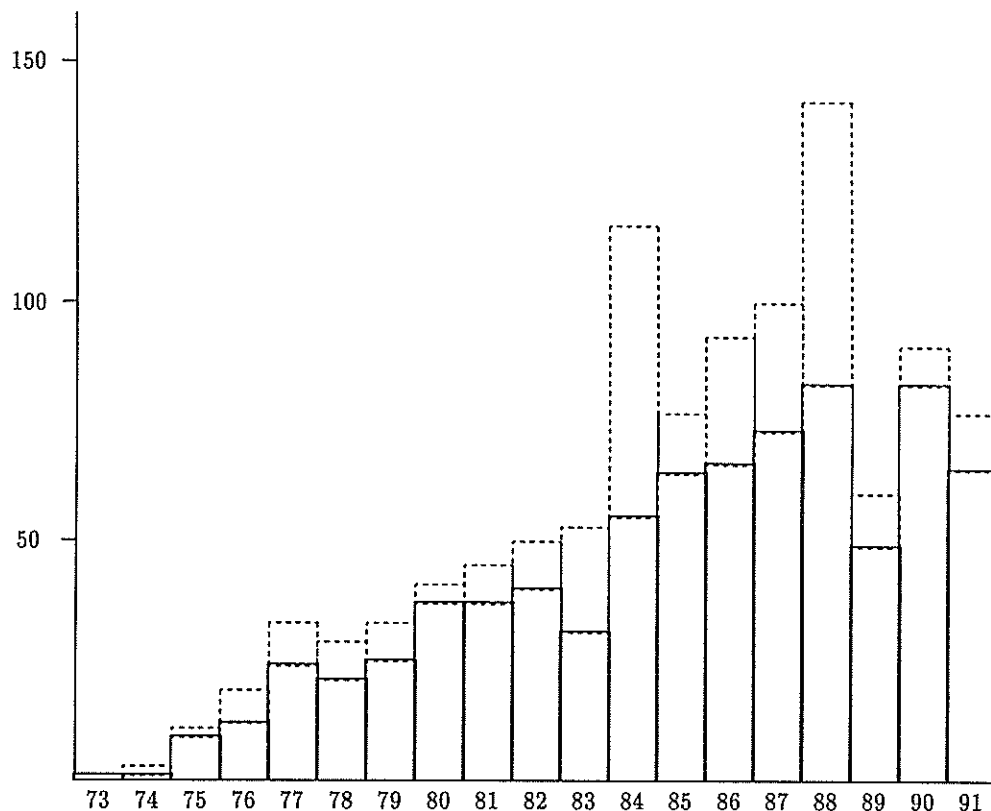
#### 3. Packages under development

Due to popular demand we have decided to make a paper print version of the *Edinburgh Astronomy Teaching Package for Undergraduates*. Some of the exercises have to be modified and a few cannot be done using paper prints but this package should be available shortly at a cost of £50. Some of these exercises are fairly simple and are suitable for use in schools. If there is sufficient demand we propose selecting suitable films and exercises for this purpose. This package could be made available in either film or paper print form.

4. **Exercises in Practical Astronomy using Photographs**, by M.T. Bruck. £18.50  
 This book, written by Dr Mary Bruck who developed the exercises in the University Teaching Packages, is mainly based on photographs made from UKST plates.

Further details of all this material is available from UKSTU, ROE.

UKST Publications 1973–1991



The above histogram shows the number of publications making use of UKST material.  
 — indicates papers appearing in refereed journals  
 - - - indicates papers in non-refereed journals including conference proceedings.  
 The total number of papers is 1075 including 776 in refereed journals.

David Morgan and Sue Tritton (ROE)

**LETTER FROM COONABARABRAN**

This quarter has been the lead-in to a freezing, often cloudy winter, with sleet, fog, a little rain and snow and some of the best frosts ever seen in the area. One was what is called locally a ‘forty footer’, i.e. it extended 40 ft up into the trees — very impressive.

In the warmer times though, we had a VIP visit from the Minister for Science, Ross Free, and the Shadow Minister for Planning and Environment, Pam Allan, both of whom went away well-informed about astronomy.

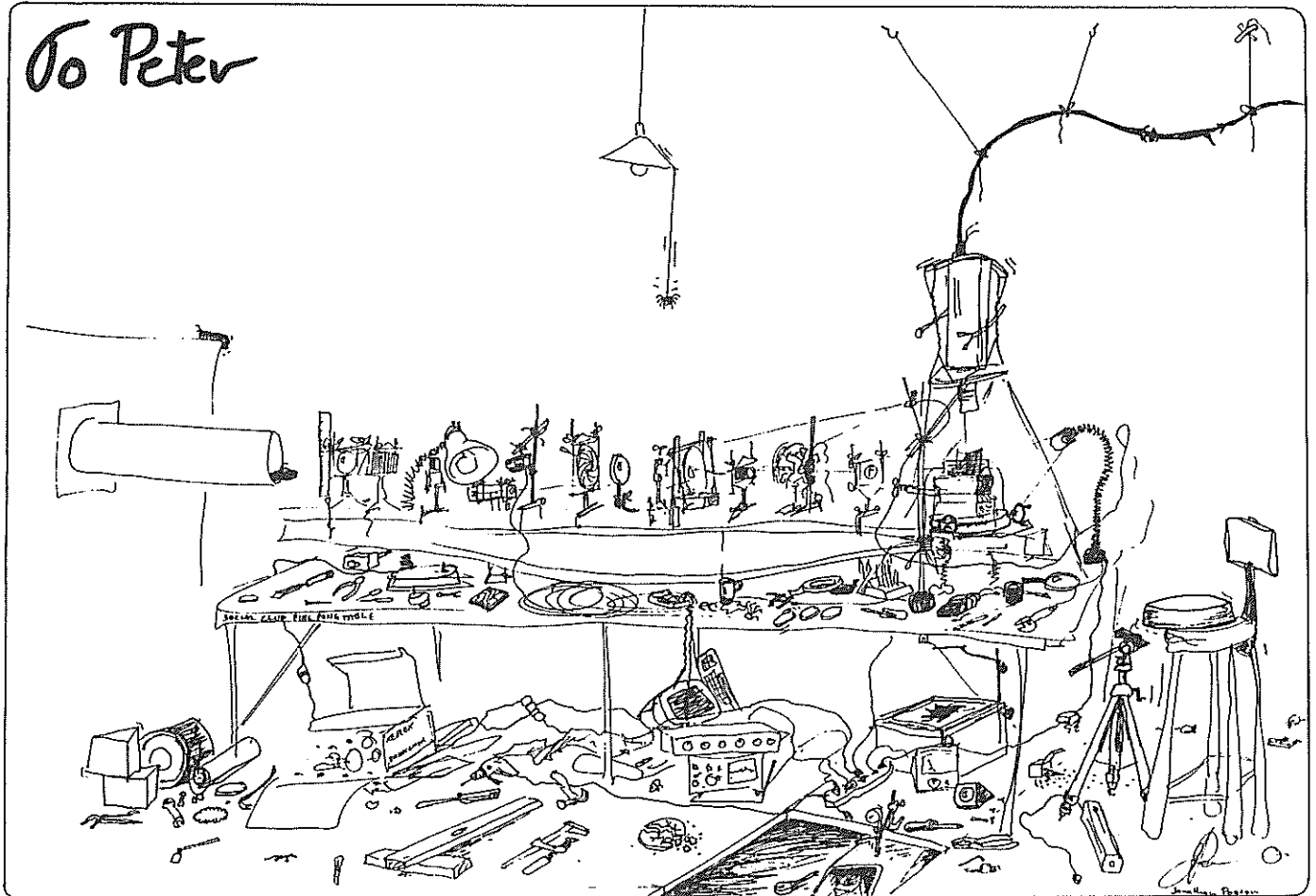
An event of a different kind was a visit from NASA’s SETI (Search for Extra-Terrestrial Intelligence) team. This search is mainly done with radio telescopes so we felt ourselves fortunate that they could come to the AAT and give a very well-attended talk.

The AAT will be featured in the ABC-TV programme “Holiday”, along with the Warrumbungles and other tourist attractions in the area. It made for an interesting Easter with the local astronomical society (which is just chock full of AAO staff) giving the tourists in the National Park a chance to

look at the few stars visible in the light of the full moon. This was duly recorded on video tape by the eager ABC crew and should be televised sometime in August.

In July we had Adrian Fish, Mark Dryburgh, Francisco Diego and Ian Crawford from UCL on site, commissioning that exciting new instrument the UHRF.

On a sadder note, we have lost our Officer-in-Charge, Peter Gillingham, to the new 10m Keck Telescope in Hawaii. Apart from the fact that since he cleaned out his office we have discovered that there actually IS a floor in there, there is a big hole to fill with his absence. Peter has been with the AAO for a long time and all of a sudden it is very quiet without his shrieking in agony whenever we gave him a purchase order to sign.



" AN EMPTY BENCH IS AN EMPTY MIND.....!" AAT staff

The mountain-top gave Peter and Mary a farewell barbecue on an absolutely freezing lunchtime, when he was presented with a large cutaway picture of the dome. This was followed up in somewhat warmer surroundings at a local restaurant, where a great time was had by all. Congratulations Peter, and all the best in the future for you and Mary.

Rhonda Martin

## EPPING NEWS

### Gossip column

A recent departee from the AAO was Johanna Einfalt, from the Accounts Department. Johanna plans to complete her MA degree, then live it up in the U.K. for the next twelve months on a working holiday. A BBQ lunch highlighted the farewell.



Robyn de Burgh is Johanna's replacement. Robyn, who comes to us from Westpac, began work at the AAO on the 1st June. As an aside, arrangements are underway for her wedding on 8 August and Robyn is taking it all in her stride.

James Wilcox, who recently graduated from Sydney University, was given a merry send off at the El Rancho in April before flying to the U.K. for three months' holiday. James spent several months with us on a part-time basis, working on the pick-place operation of the positioner for the 2dF project. His final thesis on this detailed operation was awarded a High Distinction.

Interesting colloquia were given in May/June by Peter Strittmatter and Jeremy Mould, who called in to the AAO briefly on their return from Canberra. Philippe Véron, Director of the Observatoire de Haute Provence, gave a joint ATNF/AAO presentation. John Straede stimulated vigorous discussion with an informal lunch-time report on the Remote Observing Workshop he attended in the US.

Last but not least, we said a sad farewell to Peter Gillingham at Epping on 2 July. The Director's words were: "Peter's contribution to the AAT has been quite outstanding throughout the entire history of the telescope, both in maintaining us at the forefront of world astronomy for 17 years and for his many innovative ideas and instruments. The 'wooden spectrograph' for SN 1987A and IRIS are just two of the most obvious and spectacular examples". David Allen presented Peter with a leather briefcase from Epping staff which was considered befitting his new position. [We all noticed him looking sentimentally at his 'old faithful' satchel]. Peter moves on to an exciting challenge as Project Manager of the Keck Observatory in Hawaii. The AAO wish you every success Peter.

Annette Callow

## INSTRUMENT NEWS

### 2dF Progress

**Top-End Ring** – the new 2dF top end structure was fitted to the top of the telescope and (despite a minor glitch necessitating judicious use of an angle grinder) was found to fit correctly. A preliminary alignment of the mounting cups was done to confirm the dimensional accuracy. The next step is to tension the spider vanes fully and align the central hub structure precisely. Work has also begun on the wiring of the motors and switches and this is expected to be completed in the next month. A dummy corrector/instrument load will then be attached to allow the ring to be flexure tested at a range of zenith distances. The cover picture shows the new top end ring in its storage frame on the main floor soon after delivery.

**Corrector Optics** – the final polishing and figuring of the lenses continues. Some components are now close to final specification, and are awaiting acceptance and anti-reflection coating. One component, C1, unfortunately developed a strange edge crack propagating radially in from around the circumference. This was thought to have been caused by the method used to support the element during polishing. The crack was removed by grinding an additional edge step and the lens mounting modified to suit with no significant loss of performance. Despite this, the work program remains on schedule for the January 1993 delivery.

**Fibre Positioner** – detailed design work and selection of components is now well underway. A few design decisions remain to be made on the layout geometry and these are being investigated to assess the detailed consequences of each alternative. Ordering of components and some final detail drawing work will begin soon.

**Spectrographs** – a final selection between the various optical design alternatives for the collimator and camera has now been made. The collimator optics will be an off-axis Maksutov-type design. Two camera designs remain under assessment, the first is a more "conventional" design of an internal  $f/1.2$  Schmidt, single aspheric corrector and internal thinned Tek 1024<sup>2</sup> which is our fallback option. A more radical approach also being investigated will require a custom curved package CCD inside a

Schmidt-type design with achromatic, twin aspheric corrector plate. The latter design has significant advantages of minimal central obstruction, good wide field imagery and few air-glass surfaces. A second stage of detailed optical design work to fine tune the selected designs has just begun.

Staff - interviews for the 2dF programmer position have recently been conducted and an appointment is expected to be made soon.

Peter Gray

### BVRI filters for CCD imaging

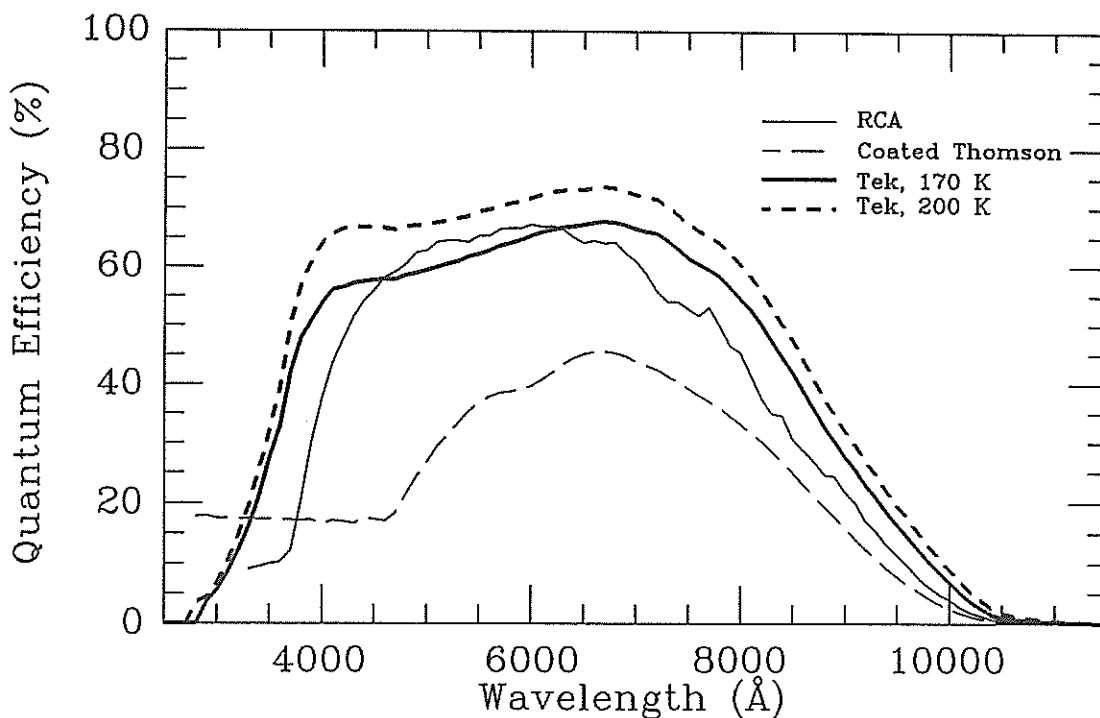
While loading filters for the commissioning run of the Tektronix CCD at  $f/3.3$ , I noticed that the 'V' filter had a small bubble in the middle between the elements. So I have used the opportunity to replace all the CCD filters (KPNO BVRI set) with the spares. Astronomers should be aware that from the start of the Tek chip at prime focus, there is a new filter set in use.

Steve Lee

### Tektronix CCD

The 1024×1024 Tektronix CCD had two commissioning nights on the telescope early in July, and after further tests at Epping was made available for general observing at the end of July. It can be used both for spectroscopy and (with a newly-commissioned large shutter) for direct imaging at  $f/3.3$  prime focus. Pixels are 24  $\mu\text{m}$  square.

The following information is provided to assist prospective users. More complete information is available in "Information for Astronomers using the TEK #2, 1024 square CCD", a document being updated as we gain experience with this CCD.



Since the QE of this CCD falls rapidly as the CCD temperature is reduced (see attached figure), we have decided to offer observers two operating temperatures, 170 K and 200 K. Running the CCD at 200 K rather than the usual 170 K increases the QE by 20% in the UV, about 16% in B, 10% in V and R and from 10% to more than 100% at lengthening wavelengths through the I band. However, this comes at the expense of an increased dark current of about 0.1  $e^-/\text{pix}/\text{sec}$ . We expect that most

spectroscopic observers will choose to run at 170 K to minimize noise, while observers doing direct imaging where frames are sky-limited will choose the 200 K mode to give enhanced sensitivity.

There is also a new readout speed, XTRASLOW, which can be used with the Tek CCD and provides the lowest readout noise of  $2.3 e^-$  rms. By using smaller windows and/or binning, the readout times are not excessively long. If windows are carefully placed, columns with hot pixels and the trailed columns they may produce can be avoided. XTRASLOW requires the preamplifier offset to be accurately set — check with the electronics staff that this adjustment is satisfactory.

NONASTRO with the Tektronix CCD is not compromised by poor horizontal charge transfer (HCTE) and does not need the minimum level of several hundred  $e^-$ /pix required by the Thomson CCD in NONASTRO mode. NONASTRO has some of the electronic settling times reduced to produce the fastest possible readout, and uses a minimum format. This may cause more rollover and ramping on bias frames, so users should take bias frames or ensure that there is sufficient bias accuracy in the overscan to take out these errors if the observation is critical in this regard.

Binning along the row does not increase the readout noise as with the Thomson, though binning by large factors in X and/or Y may show up an excess readout induced dark current. This excess dark current has been adequately suppressed not to be noticeable in images made with typical binning factors (e.g. binning by 3 or 5). Users of large binning factors should take bias frames and ensure that the overscan truly represents the bias level in the image area. This is more critical when using the XTRASLOW speed with its increased sensitivity.

The Tektronix CCD is thinned, and shows fringes in the red and on flat fields taken on the RGO spectrograph. These are about 1% peak-to-peak (p-p) at  $7300\text{\AA}$ , rising to more than 20% above  $9000\text{\AA}$ . Prime focus imaging through an I filter show fringes at about the 3% level.

The following are the “final” best estimates of readout noise, gain and non-linearity ( $\alpha$ ).

	Readout Noise ( $e^-$ rms)	Gain ( $e^-$ /ADU)	Alpha ( $\times 10^{-6}$ )	Saturation level		Approx. readout time (s)
				ADU	$e^-$ /pix	
XTRASLOW	2.3	0.34	negl.	65 K	22,000	394
SLOW	3.6	1.36	negl.	65 K	88,000	120
NORMAL	4.8	2.74	-0.03	65 K	180,000	75
FAST	7.2	5.5	-0.07	65 K	370,000	52
NONASTRO	11	11	-0.14	35 K	400,000	33

These figures apply to both 170 and 200 K operating temperatures. The readout times are calculated for a  $1050 \times 1024$  window. There is no degradation in readout noise with X binning factor (tested for binning factors up to 10 in the row direction). NOTE: The setting of the preamp offset bias is very critical for the XTRASLOW readout speed.

Quantum Efficiencies (%) at spot wavelengths (nm):

$\lambda$ (nm)	300	320	340	360	380	400	420	440	460	480	500	550
200 K	6.9	15	26	39	57	64	66	67	67	67	67	69
170 K	5.7	12	21	33	48	54	56	57	58	58	59	62
$\lambda$ (nm)	600	700	800	900	1000	1100						
200 K	72	72	60	32	8.9	0.4						
170 K	65	66	54	28	6.8	0.2						

(These QEs were measured on 14 July 1992 with the CCD in the dewar, and include the losses of the dewar window).

Readouts at the XTRASLOW, SLOW, NORMAL and FAST rates are all ADC limited and, except for FAST, at 65K ADUs the CCD is nowhere near saturation. CCD saturation occurs at about  $450,000 e^-/\text{pixel}$ . Readouts using NONASTRO are limited to a maximum of about 35K ADU because of the saturation of the electronics amplifiers ahead of the DCS stage — not that of the CCD.

At 200 K the dark current is about  $0.1 e^-/\text{pix}/\text{sec}$ , and there is some evidence that the dark current generation rate is a rising function of dark frame (DF) integration time. About 50 rows at the top and bottom of a DF are affected by a brightening of the dark current which rises to a level 60% above the average on the first and last rows of the DF. At 170 K the dark current is about  $0.55 e^-/\text{pix}/2000 \text{ s}$ , provided the CCD is not recovering from powering-on or from residuals from saturation or high light level illumination.

Several high light-level defects found during commissioning appear to flat-field out well. A list of the pixels affected can be found in "Information for Astronomers using the TEK #2, 1024 square CCD". No trapping sites have been seen.

The cosmic ray event rate is about 730 per 2000 seconds. This is about double the rate per square cm of chip area of the Thomson CCDs.

Residual images from gross overexposure are very weak. At 200 K, residual images from an illumination ten times saturation level gave a residual of only about  $4 e^-/\text{pix}$  in a subsequent 100 s dark frame (DF) and had disappeared in a second 100 s DF. At 170 K the same test gave only about  $2 e^-/\text{pix}$  in a subsequent 500 s DF and had decreased to less than  $1 e^-/\text{pix}$  in a second 500 s dark frame. Smearing above the saturated image areas due to shifting the saturated charge towards the readout amplifier produced weak residuals of less than  $0.3 e^-/\text{pix}$  in the first frame.

At 170 K, bright non-saturating illumination also produces very weak residuals. Following a  $340,000 e^-/\text{pix}$  exposure, a 1000 s DF had  $1.9 e^-/\text{pixel}$  falling to  $1.4 e^-/\text{pix}$  in a following 1000 s DF.

The Tektronix CCD recovers far faster than the Thomson when powered off and then on again while cold. At 200 K, dark currents after five minutes have settled to within about 30% of their final value. At 170 K, dark current falls to  $10 e^-/\text{pix}/2000 \text{ s}$  after 5–10 minutes, and to less than  $2.5 e^-/\text{pix}/2000 \text{ s}$  after an hour.

The time needed to change between 170 K and 200 K operation depends on the temperature of the dewar. Warming from 170 to 200 K may take over an hour in cold ambient temperatures, and cooling from 200 to 170 K takes up to 75 minutes in warm ambient temperatures. Whenever the temperature is changed, the pre-amplifier offset potentiometer must also be readjusted by a technician.

John Barton

### UHRF commissioning

First light through the new Ultra-High Resolution Facility (UHRF) was successfully achieved on the night of 15 July 1992, the first of 6.5 nights allocated for UHRF commissioning by PATT, ATAC and the AAO Director. Like UCLES, the UHRF was designed and built at the Optical Science Laboratory (OSL) of the Department of Physics and Astronomy, UCL, this time under an SERC grant for ultra-high resolution studies of the interstellar medium. It uses a  $204 \times 408 \text{ mm}$  echelle grating (the same size as for UCLES) and a choice of cross-disperser gratings. The other optical elements are fused-silica lenses with aspheric surfaces produced at OSL. The control system follows the same philosophy as UCLES, in which a dynamic model of the optical configuration was used first in the detailed design by ray-tracing and then in producing the required parameters for positioning lenses and grating angles.

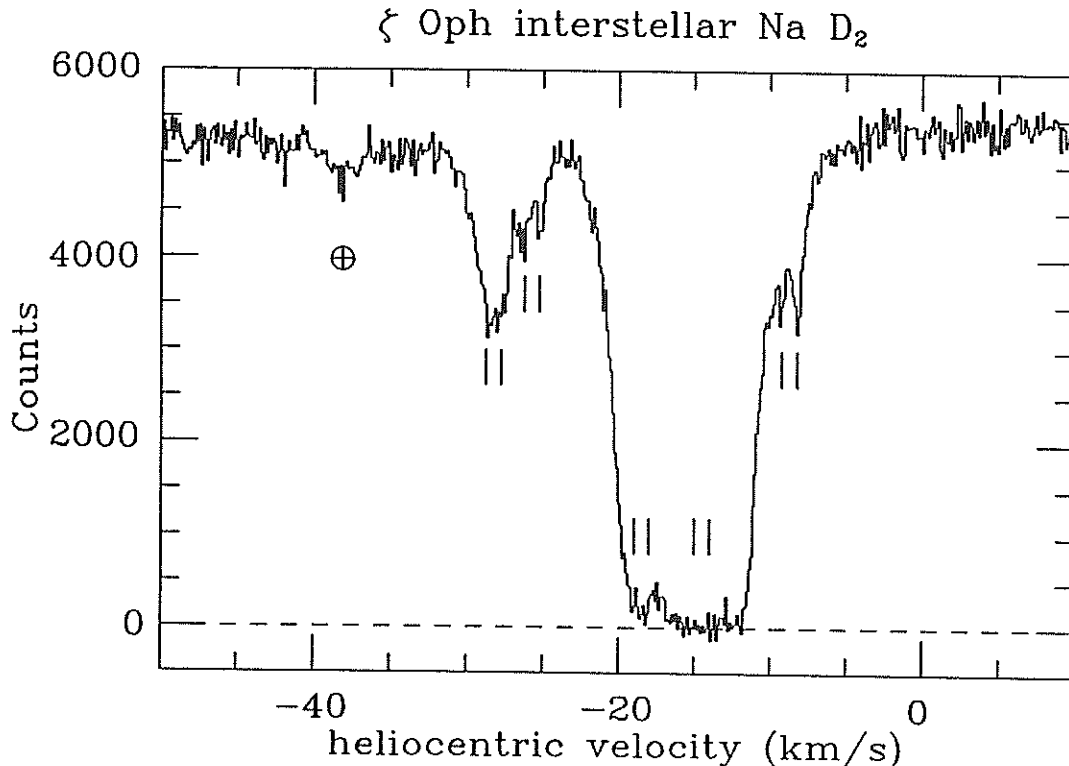
The entrance slit is very narrow (nominally  $40 \mu\text{m}$ , although it was discovered empirically, before fine tuning the spectrograph, that  $10 \mu\text{m}$  was required for the very highest resolution). As  $40 \mu\text{m}$

corresponds to only 0.05 arcsec on the sky, causing most of the light to be lost at the slit, an image slicer has also been successfully commissioned and provides a factor between 10 and 20 increased throughput above the transmission of a single slit. This slicer is at a prototype level and a final version is planned for the next run (patent process is under way).

Despite a few teething problems, the commissioning run was a great success, and clearly demonstrated that the instrument can achieve its intended resolving power of  $\frac{\lambda}{\Delta\lambda} \simeq 10^6$ . Observations included interstellar lines of Na I D (5890, 5896 Å), Na I UV (3302, 3303 Å), Ca II K (3933 Å), CH (4300 Å) and CH<sup>+</sup> (4232 Å) towards ζ Oph, together with Na D and/or Ca K observations towards several other stars.

As an example of the data obtained, the figure below shows a spectrum of the interstellar D<sub>2</sub> line towards ζ Oph. This spectrum has been obtained by averaging two 1800s exposures obtained with a 10 μm slit width and the Blue Thomson CCD; the dispersion was 0.15 Å/mm (at which only 2.9 Å fits onto the entire 1024 pixel length of the CCD) and the resolution was 0.3 km/s (2 × 19 μm pixels FWHM). The throughput of the image-slicer is of course much higher than for the single-slit spectrum illustrated.

The spectrum shows at least five different velocity components present towards ζ Oph. Moreover, the instrument has very clearly resolved the hyperfine splitting (separation 1 km/s) in the -9 km/s (heliocentric) component, and has also done so for the -26 km/s component. The observation that the hyperfine structure is much better resolved in the -9 km/s component than in the others immediately indicates that this cloud is much colder and/or less turbulent than the others. It is worth noting that the hyperfine components in the interstellar Na I spectrum of ζ Oph have not been resolved previously (*cf* the previously highest-resolution spectrum ( $R \approx 2$  km/s) presented by L.M. Hobbs, *Ap. J.*, 157, 135, 1969).



Based on the results of the commissioning run, we consider that one further visit to the AAO by the commissioning team will be required (possibly in January 1993) to iron out the few remaining problems, but are confident that the one-million mode will be available to the community for the February–July 1993 semester. In addition, but depending on how things go on our next visit, we would hope that the intermediate (300,000 and 600,000) resolving power modes will also be commissioned



then, but common-user status for these cannot be guaranteed before the August 1993 - January 1994 semester.

We are grateful to the AAO staff for their excellent collaboration and quality of work. It has been once more a great pleasure to work there.

I.A. Crawford, F. Diego, M. Dryburgh, A.C. Fish, M.J. Barlow (UCL), with J. Spyromilio (AAO)

## LUNAR CHIAROSCURO

		Dark	Grey(1)	Bright	Grey(3)	Dark	Grey (1)	Bright
1992	Jul	1-4	5-7	8-20	21-24	25-31		
	Aug	1-2	3-5	6-18	19-22	23-31		
	Sep		1-3	4-17	18-20	21-29	30	
	Oct		1-2	3-16	17-19	20-28	29-31	
	Nov		1	2-15	16-18	19-27	28-30	
	Dec		1-2	3-15	16-19	20-29	30-31	
1993	Jan		1-2	3-15	16-18	19-29	30-31	
	Feb		1	2-13	14-16	17-28		
	Mar		1-3	4-14	15-17	18-29	30-31	
	Apr		1	2-12	13-16	17-27	28-30	
	May			1-11	12-15	16-26	27-29	30-31
	Jun			1-10	11-14	15-24	25-27	28-30
	Jul			1-9	10-13	14-23	24-26	27-31

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