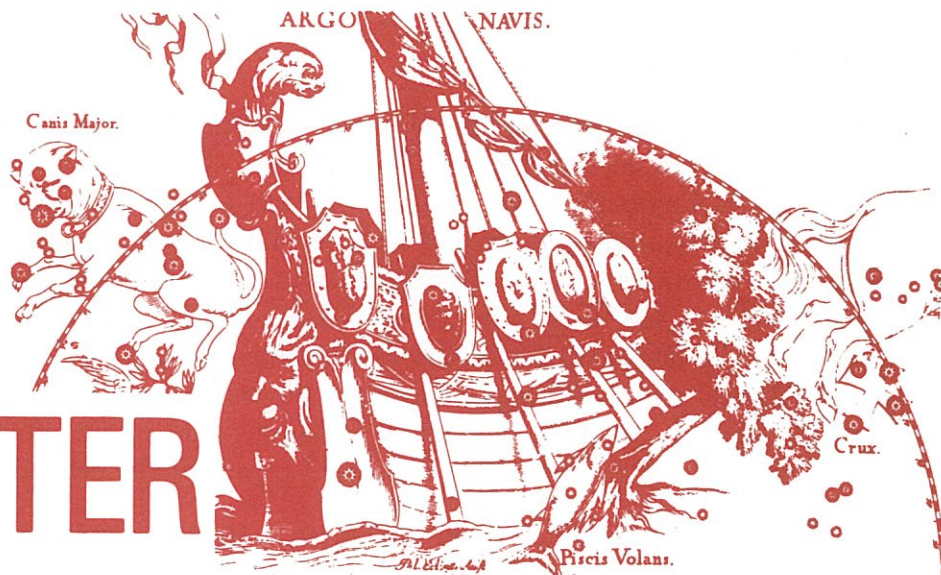


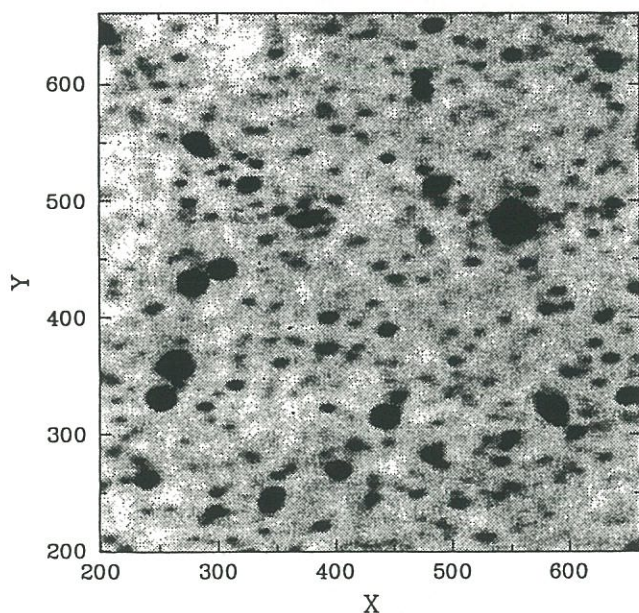
# AAO NEWSLETTER



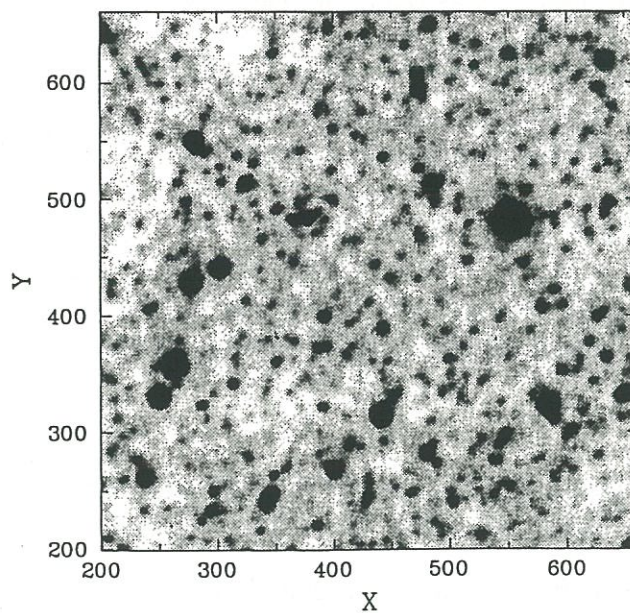
No 67

October 1993

Correction OFF



Correction ON



These images, each 1 square arcmin, are 15 minute unguided exposures, showing the improvement made to the AAO tracking by the new software corrections to the telescope control computer implemented by Pat Wallace and Steve Lee. FWHM measurements of the two pictures show that the seeing was in each case 0.9 arcsec, and that the effect of disabling the new corrections was to broaden the images in the east-west direction to 1.5 arcsec and to reduce the central intensity by one-third. More details are given inside.

## DIRECTOR'S MESSAGE

It has become customary for the Director to summarise major decisions and outcomes in this column after each meeting of the AAT Board. The last meeting, at the Royal Observatory, Edinburgh, in September, was unusual in that a large part of the time was taken up by the Board Members themselves writing a paper. This was a welcome change for those of us who are collectively known as the Board's Servants and who often struggle through the night to generate papers to satisfy the Board's demands. The end result is a major paper setting out the Board's position on the future of the Observatory. Called *Options for the Anglo-Australian Observatory into the 21st Century*, the paper considers the scientific cases for the continued operation of the AAT and the UK Schmidt Telescope, taking account of the advent of several 8m class optical telescopes and such factors as the imminent expiry of the original bi-national AAT Agreement.

The *Options* paper is being widely circulated amongst members of the British and Australian astronomical communities. It is envisaged that this document, amended to take account of the views of users of the AAO and other astronomers, will be one of the main inputs to planned reviews of astronomy in the two countries. It is therefore very important that interested parties do read the paper carefully and let Board Members know what they think of the overall policy, the AAO's long-term instrumentation plans and other issues. General comments should be addressed to Professor Michael Rowan-Robinson (Board Chairman, now at Imperial College) or to Professor Lawrence Cram (Deputy Chair, University of Sydney): specific suggestions on instrumentation should go to ACIAAT (Chair: Dr Gordon Robertson, University of Sydney, email [jgr@astrop.physics.su.oz.au](mailto:jgr@astrop.physics.su.oz.au)).

Elsewhere in this issue there are several items relating to the 2dF Project. The main recent highlight was the completion of the acceptance tests of the optics. Contrary to earlier pronouncements, it has been decided to provide a temporary imaging system to allow some wide-angle photographs to be taken during the next few months, although this facility will disappear when the full fibre-optic spectroscopic system is installed. Work is proceeding very well on all other aspects of 2dF, although the Board has reluctantly accepted a delay in the completion of the project which is now scheduled to come into astronomical use at the beginning of 1995. People are starting to make serious plans to use 2dF; important discussions took place in the UK at Stirling, Durham and Cambridge during September and there will be a meeting for all interested Australian astronomers at Epping on November 10.

Russell Cannon

### IAU Colloquium 148: The Future Utilisation of Schmidt Telescopes Bandung, Indonesia, 7 - 11 March 1994

#### *Scientific Organising Committee:*

R D Cannon (Aust, Chair), B Hidayat (Indonesia, Chair LOC), V M Blanco (USA), J S Chen (China), K A van der Hucht (Netherlands), K Ishida (Japan), A Maury (France), D J MacConnell (USA), D H Morgan (UK) I N Reid (USA)

The symposium announced in the last newsletter has now received support from the IAU as part of its colloquium series. Arrangements are well underway, and there has been a keen response to the First Announcement distributed in September.

#### *Topics to be addressed:*

- Large scale surveys (status, opportunities, requirements)
- Astrometry (proper motions, parallaxes, galactic kinematics, reference frames)
- Photometry, variable searches
- Solar system studies (asteroid searches, comets)
- Objective prism work

- Use of CCDs in Schmidt telescopes
- Other technical developments (use of film, optical fibres etc)
- Programs for smaller Schmidt telescopes
- Future prospects for cooperation

Abstracts of contributions were due on 1 November – if you have not submitted your abstract, please contact Sandra Harrison (sjh@aaoepp.oz.au) immediately. Authors will be informed sometime in December as to whether their presentation will be in the form of a poster or of a talk.

The Second Announcement, containing full registration papers, information on accommodation, transport etc. will also be circulated in December. These arrangements are being handled by Bosscha Observatory, and enquiries should be directed to:

Bambang Hidayat, Bosscha Observatory  
 Lembang 40391, Java, Indonesia  
 Fax: + 62 22 420 7526

Sandra Harrison

## IMPROVEMENTS TO AAT TRACKING

The tracking accuracy of the AAT depends critically on the 4-metre diameter straight-spur gearwheel which drives the polar axis of the mounting, and on the gear system which couples that gearwheel to the HA encoders. Any imperfections in the shape and centring of these gears will faithfully reappear as tracking errors, unless corrections are introduced via the computer control system. An imperfection of just 0.01mm, for example, would cause an error of 1 arcsec in the tracking.

The designers of the AAT identified gear-error corrections as one of the most important roles of the control computer. However, so mechanically accurate did the gear system turn out to be that only now, after nearly 20 years of service, have the finishing touches been applied.

The gear errors have been modelled using autoguider records obtained during normal use over the last three years. These data – the accumulated positional correction applied by the autoguider logged every second – show clear evidence of cyclic errors at the expected periods of 36 minutes, 160 seconds and 144 seconds. In addition, there are various isolated bumps, the best-known being the brief displacement of over 1 arcsec that occurs exactly on the meridian and every 36 minutes throughout the HA range. The tracking errors arising from all these terms span  $\pm 1$  arcsec, and even short exposures of a few minutes are affected at the  $\pm 0.5$  arcsec level.

The images shown on the cover, each 1 square arcmin, are 15 minute unguided exposures, with the new corrections first disabled then enabled. FWHM measurements of the two pictures show that the seeing was in each case 0.9 arcsec, and that the effect of disabling the new corrections was to broaden the images in the east-west direction to 1.5 arcsec and to reduce the central intensity by one-third.

The improved tracking will have a marked effect for instruments and observing modes where, for one reason or another, autoguiding is impractical – IRIS for example. Calibration procedures, e.g. APOFF, will also benefit. It will often be possible to save time, by not bothering with the autoguider for short exposures, and by getting long exposures underway before setting up the autoguider.

Patrick Wallace & Steve Lee

## EPPING NEWS

David Allen is back in the astronomical saddle again, giving cheek as usual. He was treated to a wide variety of driving skills from the many staff members who volunteered to take him to the

Mater each day for his radiation therapy. This treatment is now completed, much to David's relief, and he is settling into a normal daily routine.

The most spectacular achiever over the last few months is most definitely IRIS. At the awards night of the Sydney Division of the Institution of Engineers, Australia, there were 80 nominations for awards (including IRIS) in 13 categories. IRIS took out one of the research awards, and then eclipsed this by winning the Institution's top award - the Bradfield Award. Congratulations IRIS!

Not to be outdone however, David Malin just happened to collect two more medals in his travels: the Commonwealth Medal for Photographic Technology, presented by the Australian Photographic Society, and the 1993 Photographic Society of America Medal. Very impressive. David said that donning full regalia was becoming quite a load but he was coping well.

We have two first class additions to the AAO's astronomical complement. Charlene Heisler comes to us from York University, Canada, filling the ARC/SERC AAO Research Fellowship position. Charlene has already become a fully qualified IRIS user. Joss Hawthorn comes to us from Rice University, Texas. Keith Taylor is delighted to have Joss on board, rubbing shoulders with the 2dF team. And Neal Schirmer joined the AAO in September, giving much needed assistance to Doug Pos in the mechanical workshop. A combined BBQ for Joss and Neal, and an afternoon tea for Charlene, marked these arrivals.

Mark Noonan's a proud Daddy. Mark and April had a son, Michael, on the 8th of September, weighing in at a healthy 8lb 8oz. Lew Waller, Sally Dale and Keith Willis jointly won the "guess the sex/weight competition" for this auspicious event.

We farewelled Ian Crawford in September after a very successful six months spent with us, under the auspices of a Royal Society Fellowship, enhancing the UHRF instrument.

Pat Wallace visited the AAO for several weeks in August, dividing his time between Epping and site. The computer team welcomed discussions with him on CCD controllers for the 2dF and related matters. The improvements made to the AAO tracking software by Pat and Steve Lee are reported elsewhere in this issue.

Shaun Hughes called in to see us on his way to the AAT. We were treated to delightful photos of Shaun and Mary's new daughter, Belinda Sarah, who weighed in at a solid 11lb 3oz. Shaun assured John Straede that Belinda was cuter than a kitten.

And Chris McCowage popped in on a brief visit from La Palma.

Annette Callow

## AAO LIBRARY NEWS

The distribution of the IAU Commission 5 "*Astronomy Thesaurus*" has begun. Astronomy libraries on the regular AAO mailing list will be supplied gratis as will other libraries which responded to the SLA-PAMnet and ASTROLib network notice. Because of costs the publication has a limited edition run of 1000. It is therefore not expected that more than one copy will be supplied gratis to each library. Extra copies required by libraries and other interested parties will cost A\$25 plus A\$10 for air mail postage overseas and A\$5 within Australia. Prepayment is requested and orders should be sent to the librarian.

An ftp file has been made available for those wanting an online version of the thesaurus. The thesaurus has the potential for other uses besides the cataloguing needs of librarians. Examples are: as a spell checker; a cross-check for observatory passwords; the selection of correct terminology using *Hypertext* to browse through a compendia of inter-related terminology when writing scientific papers and keyword allocation when submitting papers for publication. The latter use

will mean more accurate keyword selection for indexing and abstracting of papers by commercial publishers. The thesaurus files have been compressed for fast transfer and require the PKUNZIP software to expand once downloaded. A special THESAUR directory will be found in the ftp section. Instructions for ftp retrieval will accompany each hard copy of the thesaurus.

In addition to the financial support given by the IAU, DITAC and the Director of the AAO for this project, we are please to announce that Sydney University, Publications Support Fund, has allocated a grant of \$3000 to assist in the publication and distribution costs of the thesaurus. Even with this grant and the IAU grant there is a shortfall of about \$1500 for mailing costs for our regular mail distribution alone, therefore the recent allocation is most appreciated.

The librarian of the AAO has recently been appointed as "SIMBAD correspondent for Australia". This position means essentially that:

- Australian astronomers who wish to become users of the database should contact the AAO librarian for information.
- The AAO librarian will act as liaison between Australian users and the Simbad team in Strasbourg, France.
- The AAO librarian will provide demonstrations and tutorials at venues which are appropriate e.g. conferences and special workshops.

New arrangements are being investigated for the centralising of all Simbad accounts within Australia. Further information will be given when this has been formalised.

At the telescope branch library, a PC database has been installed for access to all library resources held by the AAO at both sites. Instructions for using the database will be found next to the PC and users will be surprised how easy the new version of the CAIRS library software is. Nearly all of the monograph titles of the historic Radcliffe collection have now been incorporated into the main database.

E-mail: lib@aaoepp.oz.au Phone: 02 372 4814 Fax : 02 372 4880

Robyn Shobbrook - Librarian

#### FROM THE PUBLIC RELATIONS ASSISTANT'S DESK

A spectacular 1994 calendar containing twelve David Malin pictures is now available. The calendars, which retail in Australia at \$19.95 each, will make beautiful Christmas gifts. They may be purchased directly from **BooBook Publication Pty Ltd**, PO Box 163, Tea Gardens NSW 2324 (Phone: 049-970811 Fax: 049-971089) and **Pomegranate Publications**, Box 6099 Rohnert Park, California 94927 (Phone: 707-586-5500 or 800-227-1428 Fax: 707-586-5518).

Please let me know if you need a copy of our latest catalogue and price list which includes a colour brochure of all available images as glossy prints, posters and postcards.

Phone: +61 (0)2-372-4800 between 10am and 2pm Fax: +61 (0)2-372-4860 Email: cc@aaoepp.oz.au

Coral Cooksley

#### LETTER FROM COONABARABRAN

Once again a quiet quarter except for a plethora of AAO staff getting into medical trouble. Following David Malin's example, Kevin Cooper is also in hospital after his pet model helicopter

turned savage and attacked him. Kevin is enjoying his sojourn in hospital and will show you his 31 stitches if asked nicely. Actually, Kevin was very lucky he was not hurt more seriously and we wish him a speedy recovery. Don't get to enjoy the sponge baths too much Kevin. The helicopter was put down.

With things mechanical turning savage Roy Antaw's kettle upended itself all over his foot causing severe scalding. Bachelors!

We are pleased to advise that Ed Penny is now on the staff – congratulations Ed – we hope Immigration lets you stay!

Further 2dF commissioning was done during the quarter – once again up to expectations. It is really rewarding seeing all the hard work coming to fruition.

Graham Olde has now joined the AAO to work with Allan Lankshear on the 2dF spectrographs. It is expected that Graham will be with us for two years. Graham is a local in that his weekend home is in Tamworth, only two hours away. Graham lives on the mountain during the week.

The Rev. Bob Evans, supernova discoverer par excellence, is now stationed in Coonabarabran as the local Uniting Church's minister – welcome Bob – we will most likely be seeing quite a bit more of you.

To finish, a mountain legend has moved to Queensland. Yes, Charlie Gale, nerve shattering taxi driver for observers for many years, has followed the sun – or more accurately, his grandchild, to the Sunshine State. It will be very quiet without Charlie – he is known all over the world wherever astronomers meet. Welcome to Ron Dow, his successor.

Rhonda Martin

### **What Questions Can Astronomy Answer?**

Try answering that one in an hour. "What Questions Can Astronomy Answer" was the title of the annual Bok Lecture delivered by Russell Cannon in October in the three local towns of Dubbo, Gilgandra and Coonabarabran. Large audiences were drawn at each venue and they were treated to explanations of some of the exciting discoveries astronomers have made in the last thirty years or so at the AAO and with other telescopes. The audience departed with a greater understanding of the kinds of questions astronomers can confidently tackle and pondering those questions which may always lie beyond the scope of astronomy. All in all, a very successful lecture series.

These lectures are held every year and are a combined effort of the AAO and the ANU, aimed at keeping the local community informed of the work that goes on at Siding Spring Observatory.

Sandra Harrison

### **ANGLO-AUSTRALIAN NEAR-EARTH ASTEROID SURVEY**

We continue to search all plates and films taken using the UKST for the tell-tale tracks of asteroids (and comets) near the Earth. Chance statistics seem to have caused a drop in our discovery rate from about one a month in 1991 and 1992 to a rate only half that in 1993 so far, although added attention to other duties may be partially responsible; in particular obtaining follow-up observations using the SSO 40-inch telescope of asteroids discovered by our U.S. collaborators. The more they find, the more there are moving south which we need to take over.

Gordon Garradd has joined the team on a week-a-month basis, which is agreeable to both him and us. Initially he has been helping with runs on the 40-inch, but later we plan to start observations with the UKST during the bright of moon, as and when time is available. The idea

is to take pairs of films spaced by an hour or two, with 5–10 minute exposures so as to overcome the problem of sky limit. All that is necessary is that the exposure be long enough for motion to be obvious, with fast-movers giving no real increase in trail density. Pairs allow searching of the films using the stereo technique, which has been found to be very efficient by the groups using the small Palomar Schmidt. In anticipation of this new observing program we have purchased an automatic film processor, and are planning to build a stereo microscope. This will need to be larger than previous devices due to the large film format. If our calculations are correct, we will be able to find as many Earth–approaching asteroids using the UKST during bright time as the other three programs (in the U.S.) discover in total each month. Only time will tell. David Asher has also just joined the group (*just in time to get his name but nothing else in this Newsletter - Ed*).

In late August the Galileo spacecraft flew by asteroid 243 Ida and sent back pictures of that object, only the second detailed images of an asteroid ever obtained (after 951 Gaspra in 1991 October by the same spacecraft), and the highest resolution due to the close approach executed. This approach was in part thanks to our astrometric observations of Ida in the earlier part of the year. In 1994 the U.S. is sending a spacecraft called Clementine to an Earth–crossing asteroid called 1620 Geographos, the first such object to be studied in close-up. Very precise astrometry will be necessary for the success of that mission, an ephemeris good to better than 0.2 arcsec being needed. However, the asteroid is deep in the southern sky in the 10 weeks prior to the encounter on August 31, meaning that our astrometry is essential if the Clementine camera is to capture the asteroid. Radar detection of the asteroid using the Arecibo and Goldstone radars will also rely upon our observations. In order to get the density of astrometry required, we are planning to equip the SSO 24-inch telescope with a Peltier-cooled CCD, and obtain accurate positions of Geographos every clear night from mid-June through to a few days before the encounter. That CCD will also be used in the future for follow-up of relatively bright asteroids for which we currently need to await time on the 40-inch.

Duncan Steel.

## SCHMIDT TELESCOPE NEWS

### Reduction of FLAIR data

A guide to reducing FLAIR data using IRAF has been prepared at the UKST (“FLAIR Data Reduction with IRAF” by B. Holman and M. Drinkwater). While this is written in the context of the IRAF data analysis package, it does discuss several general issues which will be of interest to all FLAIR users. Both latex and postscript versions of the manual are available in the FLAIR directory of the AAO ftp archive at Epping (ftp aaoepp2.aao.gov.au, name: anonymous, cd aao\_obs, cd flair, get flair\_iraf.tex, etc...). Some short IRAF scripts useful in the reduction process are also available from the same directory.

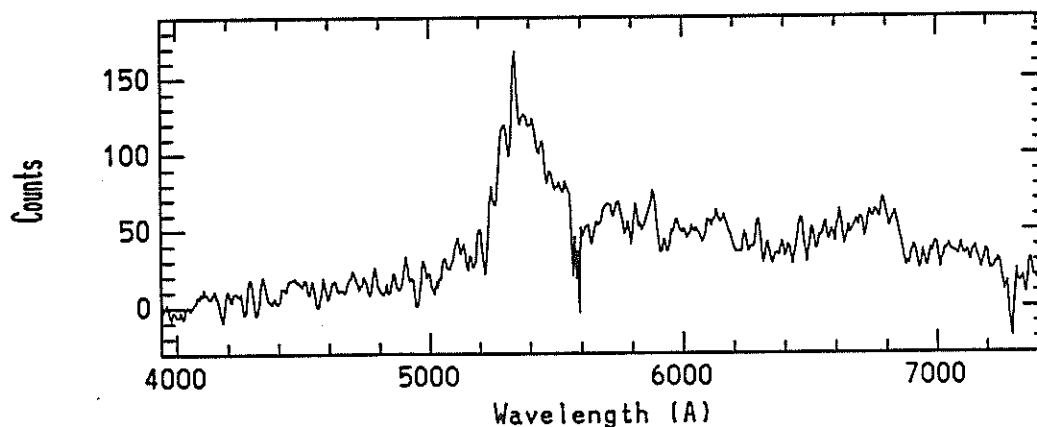
For FLAIR observers visiting the Schmidt, we now offer a service to advise and assist in the reduction of FLAIR data using both IRAF and FIGARO. A Sun workstation at the UKST has both IRAF and FIGARO installed. By prior arrangement, a staff astronomer can help you through the data reduction so that you can take home basic reduced spectra on Exabyte tape (sky subtracted and wavelength calibrated). Please contact Quentin Parker (qap@aaocbn3.aao.gov.au) before your run if you would like to use this service.

Michael Drinkwater & Quentin Parker.

### Schmidt FLAIR Results—Red Bright Quasar Survey (RBQS)

The RBQS project is a large-area search for bright high-redshift quasars based on U.K. Schmidt objective-prism data. We use a red-sensitive emulsion (mostly 4415 film) to increase the redshift

range to  $z > 3$ . Likely quasars are selected using automated methods from digitized scans of the prism films made by the APM at Cambridge. These candidates are then confirmed with slit spectroscopy (eg. a run on the MMT early in 1993).



We now report a bright high-redshift quasar confirmed by the Schmidt telescope itself. On Tuesday 1993 October 12 we observed one of the RBQS fields with FLAIR, the multi-object spectrograph. We used the 92-fibre plateholder with 100 micron fibres. From the initial analysis of  $4 \times 3000$ s exposures we were able to confirm discovery of the quasar shown above at  $z = 3.4$ ,  $m_R = 17.5$  (the units are counts per 3000s exposure). The very strong emission line is Ly $\alpha$ . This is among the brightest dozen or so quasars at  $z > 3.2$  and marks a very encouraging start to the survey.

Katrina Sealey (UNSW), Michael Drinkwater (AAO), Mike Irwin (RGO), Wilfred Walsh (UNSW) and John Webb (UNSW)

### MIRAS/NIMPOL An Imaging Polarimeter for the Mid-Infrared

The infrared astronomy group in the Department of Physics, University College at the Australian Defence Force Academy has recently operated their new mid-infrared Imaging Polarimeter, NIMPOL, in a successful commissioning run at the AAT in July. This instrument represents the first part of a two phase instrument development program. The next step is the construction of a long-slit spectrometer (MIRAS or mid-infrared array spectrometer) for the 8 - 13  $\mu\text{m}$  region, using the same detector array and readout electronics as the imaging polarimeter, but with different optics and cryostat.

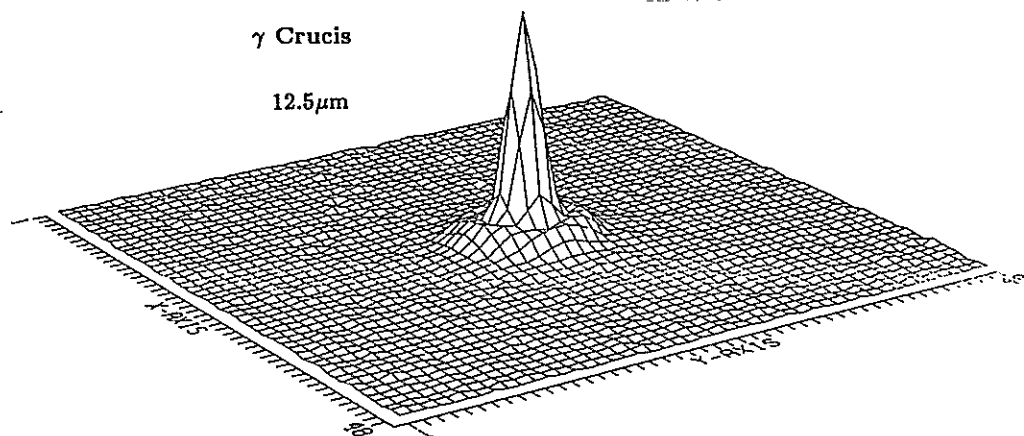
The detecting element of NIMPOL is a 128 x 128 element Si:Ga Focal Plane Array, supplied by Amber Engineering, USA. The polarimeter itself provides diffraction limited images on a 4 m class telescope and has a field of view of about 32 arcseconds of sky with  $\frac{1}{4}$  arcsecond pixels. Polarization plane rotation is effected with a CdS half wave plate, and a wire-grid is used as an analyser. During the commissioning run in July we used a single wire-grid analyser, but a wire-grid beam-splitter assembly, which can simultaneously image orthogonal planes of polarization on the array detector, is now being incorporated into the optical system. As explained by Jeremy Bailey in his article about the new polarization module for IRIS, the use of a beam splitter significantly improves polarization systematics and the the reduced field of view is compensated by observing two polarization planes at once. In the mid-infrared, however, a Wollaston prism isn't feasible as there are no sufficiently birefringent materials.

A CVF and discrete filters are provided for wavelength selection. The CVF provides a spectral resolution of  $\sim .25 \mu\text{m}$  over the 8 - 13  $\mu\text{m}$  region. Although the detector/camera are capable

of accepting a much higher photon flux than this, the narrow bandwidth is necessary to help separate emissive from absorptive polarization, which have different polarization profiles over the 8 – 13  $\mu\text{m}$  window.

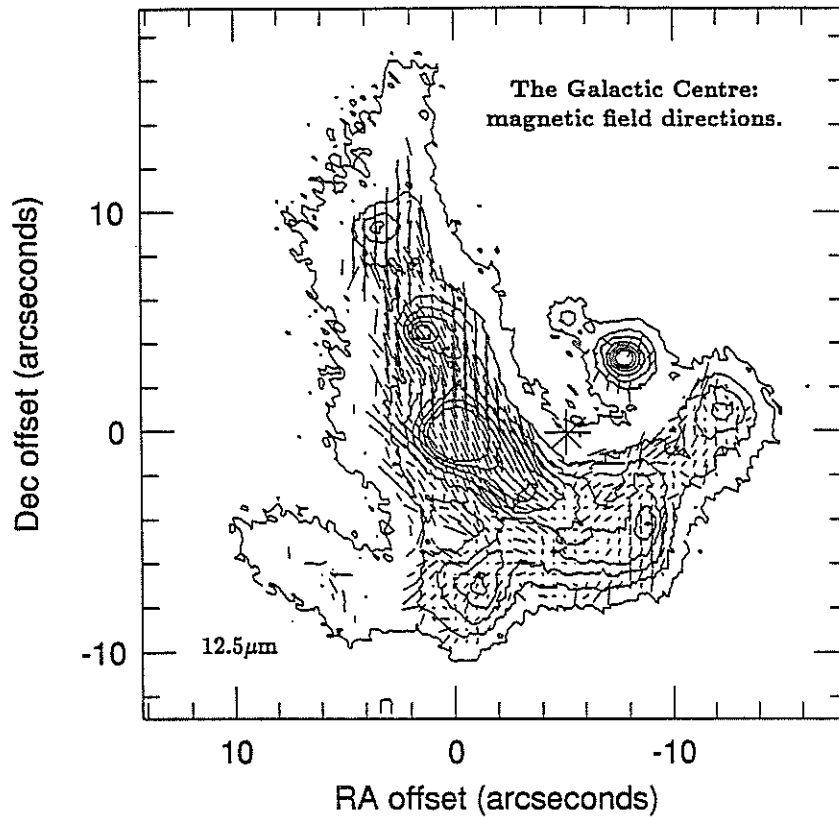
The AE159 128  $\times$  128 FPA has two analog outputs. These are fed through a trans-impedance amplifier and some other signal conditioning to two Analogic 500 kHz 16 bit A/D converters. The digital data is then coadded on two 50Mhz Digital Signal Processors (TMS320C25/50). The two output channels are sampled virtually simultaneously, providing a 1 MHz pixel read rate and a limiting frame rate of  $\sim$  50 frames/sec for the system. This read rate, coupled with the deep wells ( $2 \times 10^7$  electrons) of the AE159 means that the readout electronics can handle detected photon rates of up to  $1.2 \times 10^9$  ph/s. The digital signal processor boards are the heart of the data acquisition system. As throughput is a premium in mid infrared instrumentation all of the time critical acquisition software was written in assembler and uploaded to the DSP's from the control computer at the telescope. The DSP software provides co-adding and co-subtracting of data frames, as well as an on-line shift and add capability to maximize image resolution, even in less than optimum seeing conditions. The data is then downloaded to the host PC through direct memory access and then sent via an ethernet link to the main control computer where the data is processed, displayed and stored to disk. A third PC, also on the network, provides off-line, but very nearly real time, reduction of the incoming data.

The detector sensitivity is not yet at its optimum, ( $\sim$  80 mJy per square arcsec  $1\sigma$  1 min was achieved during the commissioning run), but a number of improvements have been made since then. Before the observing run in July we had a near calamity with the detector separating from its substrate just a week before the observing run was due to begin. However, a generous response from Amber Engineering, and some fast delivery by DHL couriers gave us a replacement detector which arrived the day before observing was to commence. Not surprisingly, we didn't get much time to characterize this array. We now have our original array back, re-glued to its substrate so we can now settle down to a real optimization of the system. Despite these problems the array performed well, with some of the most remarkable features being the absence of dead pixels and an incredibly uniform detector gain matrix. In fact it is so uniform that the images shown are not flat fielded, but just background subtracted in real time by chopping, which leaves a very flat sky/background at a zero level.

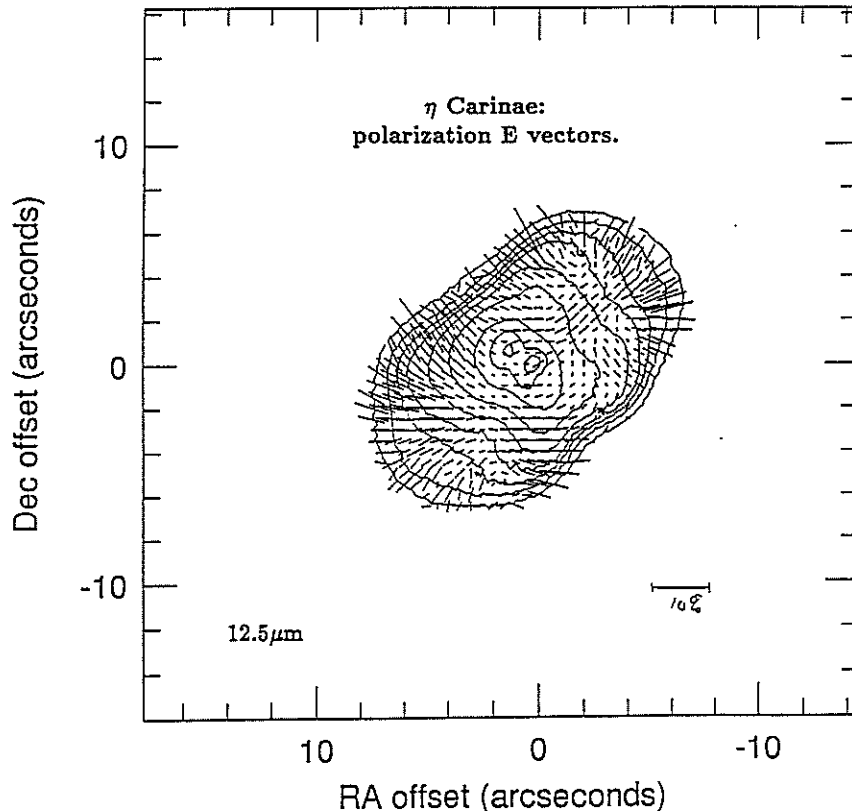


One of the most satisfying aspects of the commissioning run was the image quality of both the instrument and the AAT site in the mid infrared. The image of  $\gamma$  Crucis shown above (taken from a subset of the array) shows essentially diffraction limited conditions at 12.5  $\mu\text{m}$ . The first Airy maximum is seen, enhanced here because of the large central obstruction of the AAT primary, with a diameter of 2 arcseconds (expected 2.06 arcsec), and a central core of FWHM 0.8 arcseconds ( $1.22\lambda/D = 0.79$  arcsec). A  $\lambda^{-1/5}$  wavelength dependence of seeing is expected and our infrared image is indeed half of the visible seeing disk measured to be 1.6 arcsec (FWHM).

These diffraction limited conditions appeared to prevail during the run whenever observations were possible; the images of  $\eta$  Carinae and the Galactic Centre shown below may be the highest spatial resolution observations of these objects so far made at these wavelengths. Credit must also go to the excellent and newly improved telescope tracking software supplied by Steve Lee and Pat Wallace.



Shown on this page are polarization maps of  $\eta$  Carinae and the Galactic Centre region. The polarization in these objects is due to emission from aligned dust grains. In the Galactic Centre the grains are aligned by the ambient magnetic field and the emitted direction of polarization is at right angles to the field: here the displayed vectors are orthogonal to the polarization and hence give the field direction. These results confirm and extend earlier work at UKIRT with a smaller array, but here the area coverage is increased by a factor of four in roughly the same observing time.



In  $\eta$  Carinae the situation is not so clear cut. Here the alignment is probably due to streaming of the dust grains through the expanding material in response to the radiation pressure from the central source. Provided the ambient magnetic field is extremely weak the E vectors show the direction of streaming relative to the gas. This looks quite plausible in the extreme outer regions of the outflow, but not in the interior or closer in to the two central peaks. However, because of precession of the grain spin axes in a magnetic field, a magnetic field will determine the orientation of alignment if its strength is more than a few tenths of a microgauss. In that case the E vectors are orthogonal to the magnetic field. This seems to fit better and imply a predominantly dipole field but in turn this is hard to reconcile with other observational aspects of this source. Who said that polarimetry is a can of worms?

Finally we would like to thank all of the AAT support staff who helped make our first observing with this instrument enjoyable and successful. We would welcome proposals for collaborative research to do imaging or polarimetry with this instrument. Interested parties should contact any of the authors.

David K. Aitken, Craig H. Smith & Toby J.T. Moore

## 2df PROGRESS REPORT

Since my last report to the Newsletter we have seen the second 2dF corrector commissioning run and the first attempt at 2dF photography with 14-inch plates and films.

I am happy to report that the acceptance tests for the corrector were completed successfully in late August. Further examination of the distortion mapping as a function of both ADC angle and telescope orientation revealed nothing untoward while photometric measurements, made with respect to the prime-focus singlet, produced throughputs as a function of wavelength (from U to I) consistent with expectations based on the glass manufacturer's absorption melt data and on the reflectivity of the A/R coatings. Indeed, in the critical U-band where the BK7 glass transmission is falling rapidly, we have been fortunate to achieve a  $\geq 35\%$  throughput enhancement with respect to published figures, entirely justifying our economy measure of using BK7 rather than the more expensive UBK7 glass. The cement used in the two doublet components does not add significantly to the absorption.

A very recent Director's night saw the first attempts at doing prime-focus photography with the 2dF corrector. The main motivation was to establish the plate distortion imposed by the corrector/ADC combination, however it also offered us an opportunity to evaluate the performance of the 2dF corrector as a general purpose photographic imager. A special 2dF 1-inch plate-holder was designed and manufactured at site - 14 inches is the maximum plate size we can routinely process and it just happens that the corners of such a plate extend to the full 2 degree field. An ST-4 autoguider was mounted on one of the unused cords of the 2dF's circular field .

Although the weather was iffy, we nevertheless succeeded in obtaining many 14-inch 4415 films (and one IIIa-J plate) for astrometric test purposes. In addition we succeeded in obtaining a 70 minute "sky-limited" exposure of the Sculptor Dwarf galaxy which itself extends over nearly the full 2 degrees. Inspection of the processed films reveals that we were observing in very good seeing conditions (a fact we were unaware of at the time!). The images (especially those of the Sculptor system) are very impressive. A careful, by[-eye, inspection indicates that star images are uniformly round and close to 1" over the whole plate, even out to the very extremities of the field, despite the fact that we expect a small degradation in image quality there. Furthermore, we see absolutely no visible signs of ghosting of bright stars. As expected, the 2dF film has much better resolution and goes significantly deeper than Schmidt sky survey photographs of the field. A quantitative analysis of the images awaits their digitization. However, I am now even more confident that the corrector has been designed and manufactured to the highest standards and that photography with the 2dF is indeed practical.

Potential users should be warned however; the 2dF's photographic option is not *common user* and will not be generally available through the 1994 period when we are concentrating on commissioning the fibre positioner. We are, however, willing to consider user requests for a small number of 2dF plates and films, especially in the early half of the semester beginning February 1994, provided it is understood that such allocations can be over-ridden by the general requirements of the 2dF project and that users are fully aware of the additional overheads involved: there is only one plateholder so there is a lot of dead time between exposures. Remember too that the field is *only*  $1.5^\circ$  on a side so the area covered is only double that of the normal triplet  $1^\circ$  prime focus field. Please contact me directly for further information.

Keith Taylor

## INITIAL USE OF THE 2DF

Now that completion of the 2dF facility is in sight, it is time to consider in detail how the facility will be operated and how astronomers will use it. This note summarises the expected timescales for the availability of 2dF and the plans for its initial use.

The simplest model is simply to operate the 2dF like any other AAT instrument, with individuals or teams of astronomers applying for time every semester and the successful ones getting allocations of a few nights at a time. The 2dF certainly will be available in this mode and we hope that many astronomers will use it for a wide variety of separate projects. It is expected that the 2dF will supersede Autofib for most purposes, even when the wider field or larger number of fibres are not actually necessary, since the spectrographs should be more efficient than the RGO spectrograph with its 25cm camera. The Board and the time assignment panels have confirmed that scientific excellence will be the dominant criterion for awarding time, as for all other AAT instruments, and that proposals must not be penalised if they use only a subset of the fibres.

However, the 2dF differs from most other AAO instruments in one crucial respect, in that it was designed specifically to be a survey instrument which will collect very large data sets, to try to answer some of the fundamental questions on the large scale structure of the universe and of the Galaxy. If it is to achieve this aim there will have to be some large allocations of time, probably spread over several years, so the question arises of whether the AAO should introduce 'key projects' or expand the currently little-used long-term programme concept. Related questions concern the extent to which the 2dF will be used in service observing mode, whether there will be background projects to utilise unallocated fibres and how much the AAO staff will be involved in any long-term projects. These issues are being actively discussed in a series of meetings in the UK and Australia. There will be a special all-day meeting in the ATNF/Radiophysics Lecture Room at Epping on Wednesday, November the 10th, organised by Mark Walker, of the Research Centre for Theoretical Astrophysics, to which all interested astronomers are invited. Please contact Mark (email [maw@physics.su.oz.au](mailto:maw@physics.su.oz.au)) for more details.

Although some basic decisions have yet to be taken, it is now becoming clear when the 2dF will first become available and how it will be operated initially. At the time of writing, the main two-degree field optics have been installed and a temporary plateholder has been fitted to enable test photographs to be taken. By about March 1994 we expect to install the fibre positioner with a temporary set of 50 fibres. This again is intended only for commissioning tests; the 2dF spectrographs will not be available until later and there are no plans to do any astronomy with this set-up. The full 400-fibre system, with spectrographs, is due to be installed towards the end of 1994. Thus the first use of the 2dF by visiting astronomers should be early in 1995; the current plan is that users will be invited to apply for time during Semester A of 1995, i.e. before the PATT and ATAC deadlines in September-November 1994. Even then, any time allocated will probably be on a 'best efforts' basis throughout 1995 and it is very unlikely that any programmes will be awarded long-term or key status during this first year. Nevertheless it is hoped that potential large survey programmes will get under way during 1995, using that year

to explore the performance of 2dF and determine optimum observational strategies.

In anticipation of the large amount of commissioning work to be done on different components of the 2dF during 1994, the AAT Board has agreed that extra Director's time, up to another 10% of the total time in addition to the 10% normally allocated for essential AAT maintenance, tests and engineering work, will be made available for 2dF in both the next two semesters. This is an upper limit to what will be required, so the time assignment panels will be asked to make provisional allocations for some of the extra time.

Russell Cannon

## THE ASTROMETRIC ACCURACY OF AUTOFIB AND SOME IMPLICATIONS FOR 2DF

Users of Autofib, and its predecessor FOCAP, have often noted that it is very difficult to centre all of the fiducial guide stars simultaneously. Astronomers, having painstakingly measured plates or obtained astrometric data from a reputable machine, have tended to blame the robotic positioner or the configuration software; the engineers, having confidence in the intrinsic performance of their instrument, have insisted that the fault must lie in the input positions. To quantify the problem, it seems that the positional discrepancies typically have an r.m.s. value of about 0.5 arcsec, so that individual stars can be off position by more than a second of arc, whereas the input positions and the intrinsic accuracy of Autofib are both quoted at about the 0.2 arcsec level. While the larger external errors observed are perhaps only a worrying nuisance with Autofib, the problem threatened to be catastrophic for the new 2dF, depending on its origin. The plate scale for the 2dF, at the prime focus, is 2.5 times smaller than for Autofib at the Cassegrain focus, so the robotic positioner has to work to much higher absolute tolerances; at the same time the field diameter of 2dF is three times larger than that of Autofib, so any errors in the coordinate transformation are likely to be more serious.

In a series of tests last year, Despina Hatzidimitriou and I attempted to test Autofib on a field with good astrometric positions. We selected the nearby old open cluster M67, the subject of several classical astrometric studies. One advantage of using a cluster is that the internal velocity dispersion is so small that relative proper motions between cluster members are negligible. The results were not straightforward: as usual some stars fitted very well while others did not. It also became clear that there were significant discrepancies between different published sets of positions. Our conclusion then was that the main source of error was in the input positions and that Autofib provided an effective if somewhat laborious way of doing real-time astrometry at the telescope, but the argument was lengthy and left some lingering doubts about the instrument.

A recent observing run has finally convinced us that Autofib really does perform according to specification. Shaun Hughes obtained positions from Kyle Cudworth for a set of stars in the globular cluster 47 Tucanae, to use as metallicity standards. Cluster members were selected both as fiducial stars and as programme targets; the observing conditions were good, with seeing between 1 and 1.5 arcseconds. The resultant guide star TV picture showed that all six guide stars were almost perfectly centred, with the central fibre of each guide bundle being clearly the brightest. This implied that the largest positional errors were less than 0.5 arcsec and that the r.m.s. difference was no more than 0.2 arcsec. Furthermore, a virtually identical pattern was observed on a second night, showing that the internal accuracy and repeatability of Autofib is even better. This confirms an earlier finding of Despina's, namely that the *photometric* performance of Autofib is very stable, again implying that any positioning errors are repeatable and are external to Autofib.

The lesson is clear. To make sure that most of the light from target stars will always go down fibres with effective diameters of around 2 arcseconds, as in both Autofib and 2dF, it is essential to keep the total positional errors below 0.5 arcseconds; this requires input astrometry with

an accuracy of better than 0.2 arcsec r.m.s.. It is not particularly difficult to achieve *internal* accuracy of this level with Schmidt plates and good measuring machines; the problems arise in the external corrections.

The biggest single source of error is probably the proper motion of the relatively bright reference stars; to achieve the necessary precision requires either a recent photographic plate or else a pair of plates so that proper motions can be allowed for. It is also necessary to worry about 'magnitude equation'. Since the photographic plate is a non-linear detector with limited dynamic range, any tracking or guiding errors are liable to show up as a systematic apparent shift in position of bright stars relative to faint stars. In the case of Schmidt plates, additional effects arise from various circumstellar reflection ghost images, some of which are eccentric. These effects cannot be completely eliminated but they can be minimised, for example by measuring several plates and by avoiding excessively bright guide stars. The third main source of error is in transforming  $x$ ,  $y$  positions on a photographic plate to coordinates for the fibre positioning robot. Usually this will involve knowledge of the field distortions in two telescopes; again, in the case of the Schmidt, there are extra hazards due to the effects of bending and flattening the plates to fit the curved focal surface of the telescope which can produce local distortions as large as a second of arc. The hope is that these errors will turn out to be repeatable, at least to the required level, although we may have to await the release of the Hipparcos database before we will be confident about any particular patch of sky. About the only bit of good news is that it is not so important to get very accurate *absolute* positions for all the stars; so long as guide stars and targets are all measured on the same system, any zero-point errors will be taken out in the telescope pointing.

What all this means for the 2dF is that preparing for an observing run will be a more laborious process than most people are accustomed to, requiring a great deal of preparatory work. We hope that tests currently under way will enable us to characterise the 2dF field itself to the required accuracy, and one of our other aims is to evolve procedures which will enable people to derive 2dF target lists relatively easily from sets of measuring machine data. The end result should be that most of the light from target stars will go down the fibres if sufficient care is taken; the limits of performance should be set by the optics and the observing conditions, rather than by the accuracy of the input data or the performance of the fibre positioner.

Russell Cannon

## LUNAR CHIAROSCURO

		Bright	Grey(3)	Dark	Grey (1)	Bright	Grey(3)
1994	Feb	1-3	4-6	7-17	18-20	21-28	
	Mar	1-4	5-7	8-18	19-21	22-31	
	Apr	1-2	3-5	6-16	17-20	21-30	
	May	1	2-4	5-15	16-19	20-30	31
	Jun	1-3	4-13	14-17	18-28	29-30	
	Jul		1-2	3-13	14-16	17-28	29-31

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