UKSTU
HANDBOOK

The U.K. Schmidt Telescope Unit
of the
Royal Observatory, Edinburgh

Royal Observatory
Blackford Hill
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UK SCHMIDT TELESCOPE HANDBOOK

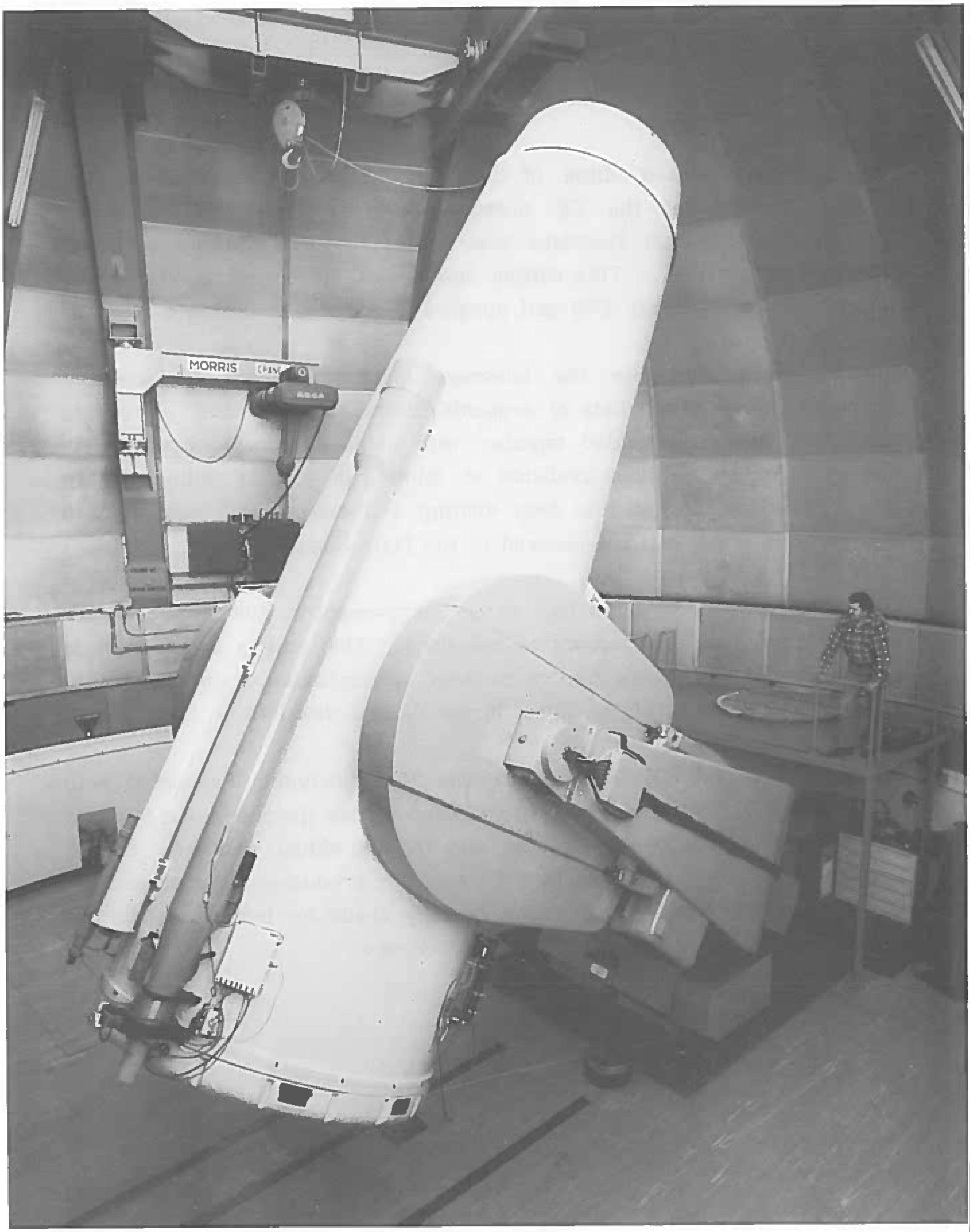
This completely revised edition of the UKSTU Handbook describes aspects of the operation of the UK Schmidt Telescope Unit and the Royal Observatory Edinburgh Photolabs that are of interest to users of UKST material and facilities. This edition supersedes the earlier version which was published in October 1979 and updated in September 1980.

The Handbook describes the telescope including details of auxiliary equipment available and lists of available filters and emulsions. A sample application form is provided together with notes on how to complete it. The sections on facilities available at Edinburgh and at Siding Spring Observatory are designed to help visiting astronomers who may wish to visit either place to use the material in the Plate Libraries.

All suggestions which would lead to an improvement in this Handbook are welcome as are notes of errors or omissions. This edition is expected to last for about five years but corrections and information on changes to facilities and services will be given in the UKSTU Newsletters.

All members of the UK Schmidt Telescope Unit (including Photolabs) both in Edinburgh and Australia have contributed to this Handbook and it would be difficult to single any person out for individual mention. Special thanks though, are due to Marjorie Fretwell for producing the diagrams, to Mark Toner for the cartoons and to Dorothy Skedd for her endless battles (which she finally won!) with the Word Processor.

Sue Tritton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CONTENTS

CHAPTER 1

INTRODUCTION

1.1 THE UK SCHMIDT TELESCOPE UNIT

The UK Schmidt Telescope Unit (UKSTU) is a national facility of the Science and Engineering Research Council operated by the Royal Observatory, Edinburgh. The Unit comprises the 1.2m Schmidt telescope (the UKST) near Coonabarabran, New South Wales, Australia, and the headquarters at the Royal Observatory in Edinburgh, Scotland (ROE). The addresses are as follows.

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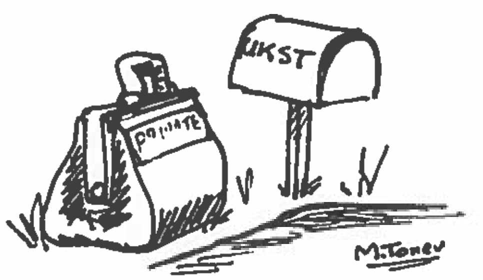


The telescope is sited within the grounds of the Australian National University's Siding Spring Observatory and is close to the Anglo-Australian 3.9m telescope. Extensive facilities are provided for the preparation, development, copying and quality control of the photographic plates taken with the telescope. The exposed-plate store contains plate inspection and measuring machines. Most of the exposed plates are shipped to Edinburgh, where they are added to the plate library collection and stored when not on loan to astronomers based elsewhere. The library and associated photographic laboratories contain a wide range of equipment for the exploitation of this reference material.

The telescope is operated by a team of resident astronomers from the Royal Observatory, Edinburgh, and is not a 'common user' facility. Astronomers requiring plates should use the standard application form (see Chapter 2 and appendix A1), and the Unit will endeavour to supply appropriate films and/or plates.

1.2 SKY SURVEYS

The outstanding attribute of a Schmidt telescope is that it has a very wide field of view, and is therefore ideally suited for systematic photographic surveys of large areas of the sky. The UKST has a field of view of 6.4 degrees; see section 5 for a detailed specification of the telescope.

When the telescope went into operation in 1973, its main task was to obtain photographs for the blue half of the Southern Sky Survey on Kodak IIIa-J emulsion. That survey is now virtually complete, and film copies (made at the ESO Sky Atlas Laboratory in Garching) are being issued to 170 customers world-wide. Together with the European Southern Observatory IIIa-F (red) survey (in production), these films comprise the ESO/SERC Southern Sky Atlas. The full survey consists of 606 fields, covering the sky from -17° declination (-20° plate centres) to the south celestial pole. For further technical details of the UK Schmidt Telescope and the Southern Sky Survey, please see a separate series of papers in 'Occasional Reports of the Royal Observatory Edinburgh', as follows:

- I 'The Telescope' (in preparation)
- II 'Photographic Techniques' by R.D. Cannon, T.G. Hawarden, M.E. Sim and S.B. Tritton. Report No. 4, 1978.
- III 'Plate Copying' by P.R. Standen and K.P. Tritton. Report No. 5, 1979.
- IV 'Accompanying Notes for the SERC (J) Atlas' (in preparation).
- V 'An Absolute Calibration of the Night Sky Photometer of the UK 1.2m Schmidt Telescope' by R.J. Smyth, Report No. 8, 1982.

Data on the individual Survey photographs, including the date and time of exposure, are distributed along with each Atlas issue. They will be collected together at the completion of the Survey as paper IV of the series above. The basic data on all plates taken with the telescope are also held on a regularly updated computer file which can be accessed via the STARLINK network (see Chapter 3.2).

Since 1978 several new sky surveys have been undertaken following extensive consultation with the UK astronomical community. The system for taking non-survey plates has also been made more formal, to cope with the ever-increasing demand for UKST plates. The overall programme of the UKST is as approved by the Panel for the Allocation of Telescope Time (PATT), which oversees the operation of the UKST on behalf of the SERC. The principal sky surveys being carried out are:

(i) The original SERC(J) Survey. (This was originally known as the SRC(J) survey. The name was changed to SERC(J) in 1981). This is effectively complete. In addition to obtaining top quality plates for a few remaining fields, some earlier fields need to be repeated before glass copies can be made.

(ii) The UKST Near-Infrared Sky Survey. This is taken on hyper-sensitised Kodak IV-N emulsion and covers the wavelength range from 715nm to 920nm (I) together with a set of matching short exposure red (IIIa-F) plates(SR). The first phase, consisting of 151 fields with $\delta \leqq 0^\circ$ and $b < 10^\circ$, and 12 fields in the Magellanic Clouds, is almost complete and is being issued as a set of film copies made in the Photolabs at ROE. About 70 sets are being distributed world-wide. The I Survey is now being extended to high galactic latitudes (SR plates are only being taken in fields close to the plane or which show obscuration). Most of the plates for this survey are taken in grey time (i.e. in partial moonlight). See also ref (14).

(iii) The UKST Equatorial Survey (EJ) and (ER). The southern sky survey is being extended northwards to the equator, taking advantage of the greatly improved photographic emulsions available now compared with those used 30 years ago for the Palomar Observatory/National Geographical Society Sky Survey. On average the new plates record objects about 1.5 magnitudes fainter, and they also have much higher spatial resolution. A series of 288 pairs of IIIa-J and IIIa-F plates is being taken, covering $-18^\circ < \delta < +3^\circ$ (i.e. four zones with plate centres at -15°, -10°, -5° and 0°). These plates are being copied in the ROE Photolabs and will be available as sets of either film or glass copies. One set of EJ glass copies is being provided for the Guide Star Selection System for the Space Telescope.

(iv) A start has been made on a high latitude survey with the low dispersion (44') objective prism. However this is temporarily in abeyance pending assessment of the new intermediate dispersion (2 1/4°) prism, and because higher priority is being given to the Equatorial Survey and to some non-survey programmes.

1.3 NON-SURVEY PROGRAMMES

The initial SERC(J) survey originally had very high priority, and good-seeing dark time ('prime' time) was used almost exclusively for this project. A considerable number of non-survey requests were fulfilled in grey time or in poor seeing, on a relatively informal basis. However, pressure for high quality non-survey plates increased rapidly, especially after the high-speed plate measuring machines (COSMOS at ROE and APM at Cambridge) began to work well.

The current pattern of usage allocates at least 60% of the 'prime' time for survey work. This means that up to 40% is available for non-survey work, up to a third of this for PATT-approved 'large' programmes, a third for less formal 'small' programmes (see section 2.3) and a third for prism work. There is less pressure on grey time, so that programmes requiring short exposure plates can normally be accommodated in parallel with the I/SR survey. All observing time with seeing ≥ 3 arcsec is normally used for non-survey programmes.

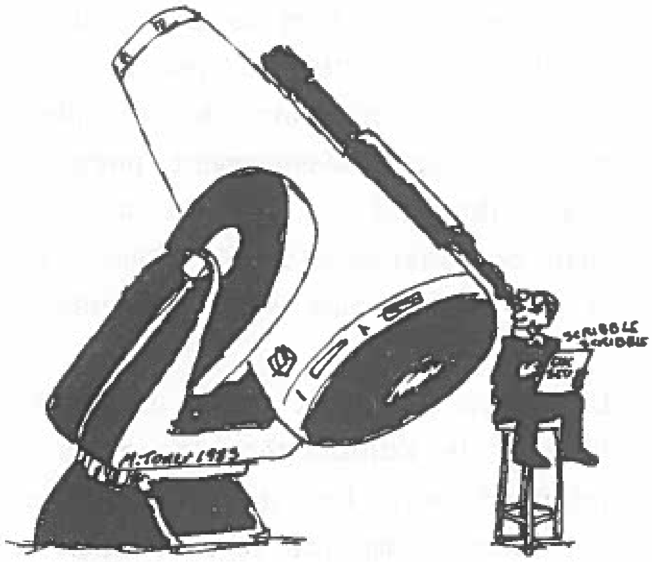
There are currently some 200 'active' non-survey programmes, i.e. programmes requiring either new plates to be taken or copies of existing plates to be made. It should be noted that the UKST is operated on every usable night throughout the year, except for about five nights around full moon each month which are normally used for telescope maintenance and tests, and that on average about 800 astronomically useful photographs (survey plus non-survey) are obtained each year.

The remainder of this handbook is designed to help potential users of UKSTU facilities to exploit the existing surveys and other material in the plate libraries or to frame their requests for the use of the available non-survey time on the telescope.

CHAPTER 2

SERVICES AVAILABLE

2.1 SUMMARY



ALL UK SCHMIDT PLATES ARE PAINSTAKINGLY PRODUCED BY HIGHLY TRAINED ASTRONOMERS.

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The plate libraries of the UK Schmidt Telescope Unit at Edinburgh and Siding Spring Observatory provide a comprehensive array of astronomical reference material in the form of sky atlases and original plates which may be inspected, measured, or borrowed, in original or copy form, by any astronomer. In Edinburgh there are extensive facilities for visual inspection, photographic reproduction, measurement and data reduction. Similar but more limited facilities are available at Siding Spring Observatory. Full details are given in chapters 3 and 4 of this handbook.

These libraries contain high quality UKST original plates or film or glass copies of plates of almost all of the southern sky. The plates comprise both rejected Survey plates and plates taken for special programmes. The film copies include test Atlas samples and therefore cover many Atlas fields not yet generally available. The Edinburgh library holds complete sets of glass copies and paper prints of the Palomar Sky Survey (including the Infrared survey and Whiteoak Extension), and complete glass and film sets of the ESO(B) Atlas.

Most Atlas sets are available only for reference by users coming to the plate libraries. (The Edinburgh Library, at present, has a second glass Atlas set of SERC(J) which is available for loan.) However original UK Schmidt Telescope plates, other than accepted survey originals, are available for loan for use at other institutions. Requests for the loan of plates will, as often as practicable, be met by providing a copy of the original in question. This is intended (a) to protect the fragile and irreplaceable originals (b) to allow the library to keep on hand, for reference and measurement purposes, as complete a set of material as practicable and (c) to make plates of particular interest available to more than one investigator at a time. However, users requiring certain types of quantitative data will be provided with original plates.

UK users and most other users should normally apply to the main Plate Library in Edinburgh; the much more limited facilities in Australia are intended only for the use of visitors to Siding Spring and for the provision of material to Australian astronomers. When existing material in the plate libraries is inadequate for a research programme, a request may be made for appropriate original plates to be obtained with the UK Schmidt Telescope.

In summary, a user may

- (i) use the plate libraries for reference
- (ii) borrow material from the libraries in copy or original form
- (iii) request new plates to be obtained on the UK Schmidt Telescope
- (iv) request photographic services to obtain reproductions or enlargements of library material

It is not normal practice for observers to be allocated their own observing time on the UK Schmidt Telescope, but such a request may be considered if there are very exceptional circumstances.

2.2 HOW TO APPLY FOR PHOTOGRAPHIC MATERIAL

Applicants are asked to complete a special form: a specimen of the current form and explanatory notes is included in this handbook as Appendix 1. It is recommended that, if possible, applicants discuss their programme with UKSTU staff at the ROE or Siding Spring before completing the form. Provision of advice as to the best choice of plate material, the fastest way of obtaining it, and even the best way to exploit it, is an important function of the Unit's staff. The form is not intended to be a rigid framework within which proposals must be constrained, and covering letters, clarifying notes and references to other work are welcome. Lists of existing plates are held at the plate libraries, and on the STARLINK system. (See Chapter 3.2 for details.)

The pressure from users requiring large numbers of deep plates for machine measurement has forced the introduction of a formal refereeing system for 'large' programmes. A 'large' programme is defined as one requiring more than four high quality deep plates within one observing season. Applicants for such programmes must complete an UKSTU application form giving a full scientific justification for their programme and send the form to UKSTU at ROE. Such applications will be considered by a sub-committee of PATT and referred as necessary to PATT. PATT will approve 'large' programmes requiring a total of about 10% of the available prime time each year. (This normally yields fewer than 50 top-quality deep plates.)

'Small' programmes (i.e. those requiring $\leqq 4$ deep plates or a somewhat larger number of short exposure or poor-seeing plates) are dealt with as before, generally in order of receipt except where there are special reasons for according a programme high priority. Applicants should complete a standard UKSTU form and send it to UKSTU at ROE (Australian applicants may submit their forms directly to the Unit at Siding Spring).

All applicants should be aware that the pressure is greatest on good-seeing dark time (especially in the 22^h-6^h and 12^h-16^h areas), and any relaxation of the acceptable seeing limits or any decrease in exposure time will greatly enhance the chances of obtaining plates quickly. Details of the current RA distribution of plates on request will be given in the Newsletters.

The available emulsions and filters are listed briefly in the explanatory notes, and further details are given in chapter 5 of this handbook.

Users requesting new deep plates are asked to try to accommodate their photographic requirements within the framework of the surveys. The corresponding plate (or plates) will then receive priority in the survey programme and as soon as it is photographed an Atlas-quality copy will be made and provided to the user. The copies can be made on glass or film; the latter is considerably quicker and easier to provide.

Photographs for 'non-survey' programmes, irrespective of waveband, exposure or quality requested, will normally be taken on survey centres unless adequate justification for the use of non-standard centres is provided. The only programmes which are likely to require such centres are those involving quantitative measurements over large and specific areas (e.g. extended objects) where vignetting would cause problems near the edge of a standard survey field.

Standardisation to survey centres, besides simplifying the operation of the telescope, leads to the accumulation of series of plates on common centres which are of greatly increased value for future astrometric and variable star studies.

Where non-survey programmes result in the production of deep, high-quality plates, users will be requested to accept Atlas-quality copies rather than the original plates, so far as their work will allow.

In a few special cases it is very desirable for the applicant to be present at the telescope when plates are taken, e.g. to assess plates taken through a new special filter, or where special calibration procedures have to be followed. In these cases application should be made to PATT if SERC travel funds are required. Although astronomers do not normally take their own plates on the telescope, close interaction between applicants and the team who operate the telescope is strongly encouraged. All astronomers visiting Siding Spring who have an interest in the material produced by the UKST are most welcome to visit the telescope while they are on the mountain.

2.3 POLICY

The use of copies of plates

Many UKST plates can be of use to several astronomers for different programmes. Unfortunately a significant fraction of the plates lent out by the Unit are returned broken, scratched or otherwise damaged. Usually this is not attributable to any one culprit or procedure, and has to be accepted as a consequence of the fragility of 1mm thick glass plates 356mm square covered with vulnerable emulsion (the Kodak type IIIa emulsions are unfortunately much more easily damaged than the types IIa or 103a). Unless specially requested original plates are now normally fitted with a 2mm thick cover glass before despatch.

However a much better and safer solution is to make use of copies wherever possible. Glass copies are 3mm thick and therefore far less fragile. Film copies, of course, are almost immune to breakage. Other advantages are that (i) both film and glass copies have harder emulsions and so are much less vulnerable to abrasion; (ii) copies can be replaced if the worst comes to the worst; (iii) several reproductions of a single plate can be made available to different people at the same time.

Film copies in particular are more easily generated and can safely and rapidly be sent by post. There are of course some disadvantages with copies. A negative copy is the product of two successive stages of contact printing, using copy materials with grain size and resolution not much smaller than that of the original in the case of a IIIa emulsion. Thus there must be some decrease in signal-to-noise and resolution, with additional degradation from faults and blemishes introduced during copying. However experience has shown that the loss is very small for most qualitative applications, and is probably only significant when the highest precision astrometric or photometric data are required. In some cases copies, with low levels of sky fog, may be preferable; for example when a high density original plate is measured on a measuring machine which has poor signal-to-noise at low transmission levels.

Thus applicants are strongly encouraged to make use of copies wherever possible; by so doing not only will the fragile original plates be likely to survive much longer, but applicants will also have more rapid access to a large selection of existing plates.

Small numbers of copies can be made in specialised ways: high or low contrast reproduction and large-scale unsharp masking can be employed. Often the background density to which they are exposed can be adjusted to suit the user's requirements.

The policy of the Unit is to ask applicants to make use of copies if the plates they wish to borrow are of wide potential interest. This would include most good deep IIIa-J and IIIa-F plates and objective prism plates as well as all accepted Survey plates. If originals are particularly requested, detailed reasons should be given. On the other hand, original plates which are too specialised to be of much interest for other programmes, or which have short exposures (say ≦ 20 min) and so can easily be replaced, will normally be provided without hesitation.

Overlapping and competitive programmes

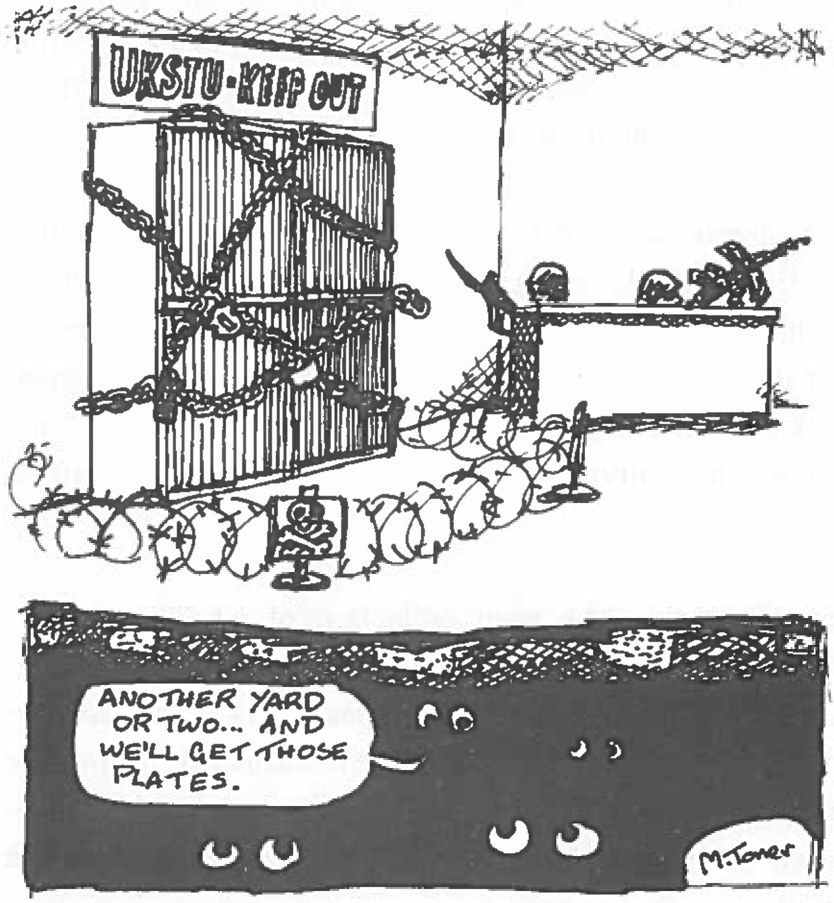
Material from the UK Schmidt Telescope is currently being used in ~ 200 active research programmes, for applications ranging from the making of finding charts to the measurement of every image on a plate. It has become increasingly common for some degree of overlap between existing and proposed programmes to occur. Applications range from proposals to use the same or similar plate material for different programmes, to requests which involve the use of the same material in the same fashion to conduct the same investigation. In the first case UKSTU simply attempts to satisfy both applicants, usually by the provision of copies. In the second case, the first applicant has priority for two years from the provision of the plate material and the second applicant is asked either to withdraw or to contact the first applicant.

The greatest difficulties arise in intermediate cases, where there is some degree of overlap in the material, methods or objective of two programmes which do not, however, coincide completely. An attempt is usually made to deal with such cases by consulting both applicants, with the aim of maximising the utilisation of the material while minimising the risk that competitive duplication of projects will occur. A number of useful collaborations have originated in this way.

CHAPTER 3

FACILITIES AT EDINBURGH

3.1 PLATE LIBRARY



In February 1982 the Plate Library at Edinburgh moved into permanent specially designed buildings. The accommodation available now allows the visiting astronomer to make full use of the extensive plate material available. Indeed, astronomers are encouraged to visit the Library to use the material there; this allows all the material to be available to more users and also minimises the risk of loss or damage which can occur when plates are sent directly to the user. If possible, users are requested to contact the Library staff shortly before a proposed visit.

The main Library is fully air-conditioned; this provides suitable archival storage conditions for the plates and also a comfortable working environment. Glass plates, originals and copies, are stored on specially designed shelving units while the film and paper copies are housed in easily accessed cupboards. The original UKST plates are kept locked up but may be used by arrangement with a member of the UKSTU staff.

The Library is provided with light tables some of which have built-in zoom microscopes to allow plates or films to be studied at high magnification. Three Polaroid cameras are available to enable instant photographs to be made at various magnifications. These may be required as finding charts or as a record of an interesting discovery. More sophisticated photographic facilities are provided by the Photolabs.

The complete catalogue of UKST plates is stored on both ROE computers together with other details such as plate locations, and whether copies exist. Up to date listings are available for consultation by the visitor. Computer terminals are available in the Plate Library and simple programs enable the user to interrogate the catalogue directly. Copies of all original observing cards giving complete details of each original plate are also kept.

The Plate Library contains the main collection of UKST non-survey plates as well as plates taken for the sky surveys. Plates which are currently assigned to an individual research programme are indicated by a green sticker bearing the reference number of the relevant programme and the name of the principal investigator. Such plates are not normally released for use by other astronomers without the consent of the person to whom they are assigned.

The computer terminals are connected to both ROE computers, the GEC 4090 and the VAX 11/780, part of the STARLINK system. Some of the STARLINK software is useful for work in the Plate Library, in particular the CHART and ASTROM routines for producing overlays or finding charts and performing astrometric reduction.

The Plate Library also contains a fairly comprehensive reference library of catalogues and charts which are available for consultation.

Adjacent to the Plate Library are suites of smaller rooms; the offices of the UKSTU staff who are available to assist the visitor, and rooms containing all the ROE plate measuring machines except COSMOS.

HOLDINGS OF ROE PLATE LIBRARY

1) Sky Surveys

a) Complete

Palomar Observatory Sky Survey	Sky survey in blue and red (+90° to -33°)	Glass Paper
"Whiteoak Extension" to Palomar Survey	Red only (-33° to -45°)	Paper
Palomar Infrared Sky Survey	Galactic plane north of equator; near infrared and red	Paper
ESO (B)	Atlas (-17° to -90°)	Glass Film

b) In production

ESO/SERC	Southern Sky Survey -17° to -90° SERC(J) and ESO(R)	Glass Film
SERC	Near Infrared Southern Sky Atlas; Part 1:Galactic Plane south of equator and Magellanic clouds; near infrared and red (I/SR)	Film

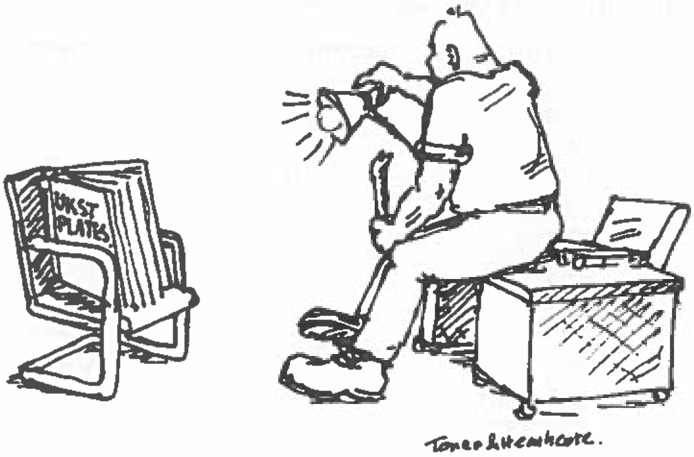
c) In preparation

SERC	Equatorial extension of Southern Sky Survey (EJ and ER) +3° to -18°	Glass Film

2) Other material

UKST	Reject original survey plates Non survey original plates (restricted access)	4000 increasing (~500 per year)
UKST	Glass copies of original plates (general access)	250 increasing
UKST	Film copies of original plates (general access)	750 increasing
ROE	Spectroscopic plates from ROE 36in reflector (1938 - 1963)	1500
ROE	Schmidt plates taken with ROE Schmidt (1962 - 1974)	3000
ROE	Schmidt plates taken with Monte Porzio Schmidt (1967 - 1975)	2000

3.2 INTERROGATING THE UKST PLATE CATALOGUE



UK Schmidt plate users who have access to a Starlink terminal may be interested to know that the full catalogue of UKSTU plates is available on-line at the ROE node, together with a simple program for interrogating the catalogue. Because the Starlink network is unsuitable for copying large amounts of data from node to node, the program is designed to allow a user to inspect only a small subset of the UKSTU catalogue for display at any one time. Users simply log in to the ROE node, remotely if necessary, user name/password UKSCAT, and enter the command UKSCAT. The user is then prompted through the selection routine. A brief HELP facility is avalable on-line, and more extensive documentation is available in the file REVAD::DISK$USER1:[UKSTU]UKSCAT.DOC.

The UKST Plate Catalogue is stored one plate to a record as follows:

Columns	
1- 2	Plate prefix
3- 7	Plate number
8	Plate suffix
9-11	Survey code (if relevant)
12-15	Non-survey code (T number)
16-20	Field number or other identification
21-25	RA (hhmmt) (t is tenth of a minute)
26-30	Dec (±ddmm)
31-36	Date of exposure (yymmdd)
37-40	LST of start of exposure (hhmm)
41-46	Emulsion
47-52	Filter
53-56	Exposure time (mmmt) (t is tenth of a minute)
57-61	Plate grade
62-64	Prism code (for prism plates only)

Plate Prefix (Cols 1-2)

A one- or two- character code for the filter/emulsion combination. The two-letter codes are interpreted as follows:

First letter	Filter	Second Letter	Emulsion
U	None or WG 305	-	-
B	GG 385	B	IIa-O
J	GG 395	J	IIIa-J
Y	GG 455	-	-
V	GG 495	V	IIa-D
O	OG 590	-	-
R	RG 630	R	IIIa-F or 098
I	RG 715	I	IV-N
W	RG 830	-	-
Z	RG1000	Z	IZ

Certain standard filter/emulsion combinations have a single letter code:

U	IIa-O or IIIa-J emulsion with	UG1 filter
B	IIa-O	GG 385
J	IIIa-J	GG 395
V	IIa-D	GG 495
R	IIIa-F or 098	RG 630
I	IV-N	RG 715
Z	IZ	RG1000

Certain other filters are given special codes (see under filters)

Plate number (Cols 3-7)

A running number for all UKST plates.

Plate suffix (Col 8)

P indicates a full aperture objective prism was fitted (see also cols. 62-64)

S indicates a sub-beam (Pickering) prism was fitted

G indicates an objective grating was fitted

Survey code (Cols 9-11)

An entry here indicates that the plate was taken for one of the UKST Sky surveys.

J	Deep IIIa-J survey (ESO/SERC survey), Dec -20° to -90°
I	Deep IV-N survey (Southern Declinations)
SR	Short red survey (comparison to I survey)
R	Deep red survey, declination -20° to -90°
EJ	Deep IIIa-J survey, declintion -20° to 0°
ER	Deep IIIa-F survey, declination -20° to 0°
P	Objective prism survey

Non-survey Code (Cols 12-15)

Non-survey code number (T number) - if plate taken for non-survey programme.

Field number or object name (Cols 16-20)

Field number is the ESO/SERC Survey field number. (See Appendix 3).

RA and Dec (Cols 21-30)

Equinox 1950 coordinates of the plate centre

Date (Cols 31-36)

UT date of exposure

LST (Cols 37-40)

Local Sidereal Time of start of exposure

Emulsion (Cols 41-46)

Expanded details of prefix data;

Filter (Cols 47-52)

Expanded details of prefix data; data on special filters

Prefix	Filter Col	Size	Details
O2	AAO372	130mm sq	Interference filter centred on 3727A ([OII])
HG	AAO434	130mm sq	" " " " 4340A (Hγ)
IF	AAO460	130mm sq	" " " " 4600A
HE	AAO468	130mm sq	" " " " 4686A (HeII)
IF	AAO486	130mm sq	" " " " 4860A (Hβ)
O3	AAO500	130mm sq	" " " " 5007A ([OIII]
IF	AAO540	130mm sq	" " " " 5400A
IF	AAO562	180mm sq	" " " " 5620A
HE	AAO587	130mm sq	" " " " 5870A (HeI)
O1	AAO630	130mm sq	" " " " 6300A ([OI])
IF	AAO643	130mm sq	" " " " 6430A
S2	AAO672	130mm sq	" " " " 6725A ([SII])
HA	AAO656	250mm sq	" " " " 6567A (Hα)
IF	MB 675	200mm sq	" " " " 6751A
IF	MB 569	200mm sq	" " " " 5696A
IF	MB 666	200mm sq	" " " " 6668A
HA	MB 657	330mm Mosaic	" " " " 6567A (Hα)
HA	RG630H	400mm Mosaic	" " " " 6567A (Hα)
IF	MB 486	200mm sq	" " " " 4861A (Hβ)
IF	HZ 580	21cm circ	" " " " 5800A
IF	HZ 600	21cm circ	" " " " 6000A
IF	HZ 620	21cm circ	" " " " 6200A
IF	HZ 640	21cm circ	" " " " 6400A
IF	HZ 660	21cm circ	" " " " 6600A
X	HZUBLK	21cm circ	UV-Blocker
X	VLZ520	150mm sq	Waveband (1/2 power):25nm at 520nm
X	VLX400	150mm sq	Waveband (1/2 power):45nm at 400nm
P	HN 32		Linear polarisation
P	HN 38		Linear polarisation
LP	HNCP37		Left-handed circular polarisation
RP	HNCP37		Right-handed circular polarisation

Exposure time (Cols 53-56)

Exposure time in tenths of a minute

Quality control plate grade (Cols 57-61)

All plates are quality controlled and assigned a grade. The first letter of the grade (usually A,B,C) indicates the overall quality of the plate. The subsequent letters indicate specific defects as follows:

I	Denotes image size larger than 40 microns
T	Denotes detectable image elongation on most images
U	Denotes underexposure (relative to exposure time)
E	Denotes emulsion blemish(es)
P	Denotes processing marks
F	Denotes fogged plate or high chemical fog
D	Denotes overexposed plate (high central density)
S	Denotes marks caused by electrostatic discharge
H	Denotes haze haloes
X	Denotes any blemish not listed above.

Survey plates are normally also given a grade number; the lower the number the better the plate quality. An 'A' grade plate scores 3 or lower. (See also Ref (7).)

Prism code (Cols 62-64)

This is a three-character code giving information on the prism(s) used

(I) Shows prism dispersion
- 1 dispersion of 2440A at Hγ (44' prism alone)
- 2 dispersion of 1260A at Hγ (prisms in anti-parallel)
- 3 dispersion of 830A at Hγ (2 1/4° prism alone)
- 4 dispersion of 620A at Hγ (prisms in parallel)

(II) Shows prism orientation
- N prism apex north (180°) (spectra north-south)
- E prism apex east (270°) (spectra east-west)
- S prism apex south (0°) (spectra south-north)
- W prism apex west (90°) (spectra west-east)

(III) shows if spectra widened or not
- W indicates spectra widened

3.4 PHOTOLABS

Photographic Laboratories at ROE. These were developed as part of the UKSTU facility for high quality reproduction of the SERC Sky Survey Atlases, for the production of 'one-off' copies of original plates, and for exploiting UKST plates by a variety of specialised photographic techniques. They also provide a general photographic service.

The range of services provided includes the following:

Contact copy glass positives from original plates.
Contact copy glass negatives from positives.
Contact copy films from positives.
High contrast films and photographic paper prints.
Normal contrast photographic paper prints.
Enlargements from sections of original plates to selected contrast.
Photomacrography and photomicrography from original plates to selected contrast.
Unsharp masking technique for enhancing detail.
Kodak C41 colour negative processing.
Kodak E6 colour transparencies.
Colour prints up to size 500 mm x 600 mm.

Although the photographers will make every effort in special cases to complete a particular request on demand the laboratories are most efficiently used if a number of similar jobs can be done together. Users should note that a typical 'wait time' for normal photography is about three weeks, the provision of film or glass copies of original plates about two months while special requests (e.g. unsharp masking) may take considerably longer.

CHAPTER 4

FACILITIES AT SIDING SPRING OBSERVATORY

4.1 PLATE LIBRARY

The Plate Library is a smaller version of the ROE Library and many of the facilities available at Edinburgh are also available at SSO. The original atlas material available in general only covers the Southern skies but at least one plate or film copy should be available of each field south of the equator to enable the visitor to make finding charts or check identifications.

The Library is well equipped with light tables several of which are provided with binocular zoom microscopes. Two Polaroid cameras are available to enable finding charts to be made. Desk top computers are available for position reductions etc. to be made on the spot.

HOLDINGS OF SSO PLATE LIBRARY

1) <u>Sky Surveys</u>

a) Complete

"Whiteoak Extension" to Palomar Survey	'Red' only (-33° to -45°)	Paper
ESO (B)	Atlas (-17° to -90°)	Glass Film
Palomar Infrared Sky Survey	Galactic plane north of equator; near infrared and red	Paper

b) In production

ESO/SERC	Southern Sky Survey -17° to -90° SERC(J) and ESO(R)	Film
UKST	Near Infrared Southern Sky Atlas; Galactic plane south of equator and Magellanic clouds; near infrared and red (I + SR)	Film

c) In preparation

SERC	Equatorial extension of Southern Sky Survey (EJ and ER)	Glass Film

2) <u>Other Material</u>

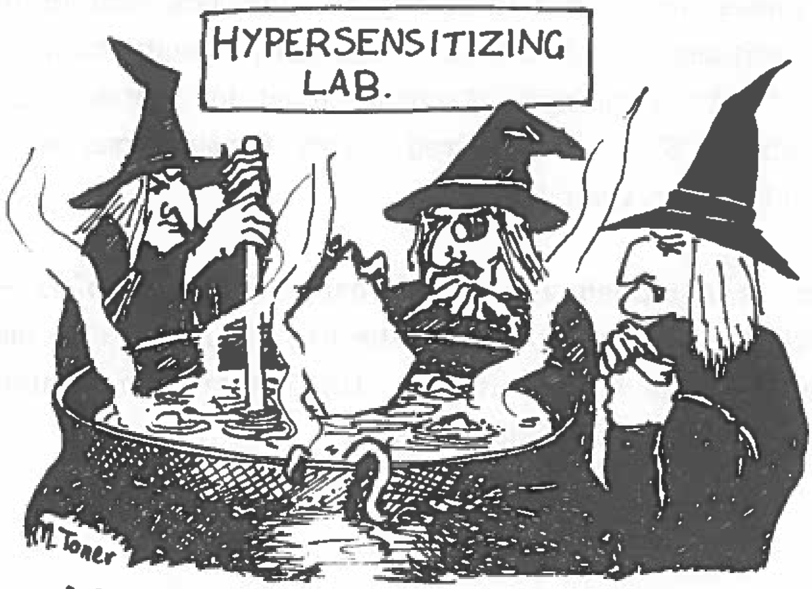
UKST	Reject original survey plates Non survey original plates in use at SSO
UKST	Accepted original survey plates (In archival storage-not accessible to visitors)

4.2 MEASURING MACHINES

Bolton Machine. A closed-circuit TV plate comparator is available, built to a design by J.G. Bolton. This has been used principally for scanning objective prism plates in searching for quasars. A special effects generator permits the images of two plates to be compared or superimposed, together with a fiducial marker for position measurement (attainable accuracy ~ 1 arcsecond).

Joyce-Loebl Microdensitometer. This has been modified to permit two-dimensional scanning under the control of a microcomputer. A Watanabe digital plotter, with 300mm bed, and a line-printer are available for data output.

4.3 HYPERSENSITISING FACILITIES



"A LITTLE MORE EYE OF NEWT, I THINK."

The hypering facilities at Siding Spring do not normally concern users since plates are routinely hypersensitised by the UKSTU staff. However a brief description of the methods used is given here as background information for applicants. In some circumstances UKSTU staff can hypersensitise plates for use in other telescopes on Siding Spring Mountain.

Kodak IIIa-J and IIIa-F emulsions are normally hypersensitised by successive soaking in nitrogen gas and hydrogen gas. IV-N and I-Z plates are soaked in silver nitrate solution. Other emulsion types are not normally hypersensitised. Detailed descriptions of the methods of hypersensitisation in use are given in references (1), (2), (5), (8).

A small room is fitted with nitrogen distribution lines to enable plates to be soaked in a nitrogen atmosphere at 20°C for extended periods. This is the hypersensitising pre-treatment used prior to a hydrogen soak and is used for most IIIa-J and IIIa-F plates taken by the UKST. An alternative treatment to nitrogen soaking, introduced in 1981, is the exposure of plates to a vacuum. The vacuum technique is a more rapid process but only a few plates can be treated at a time.

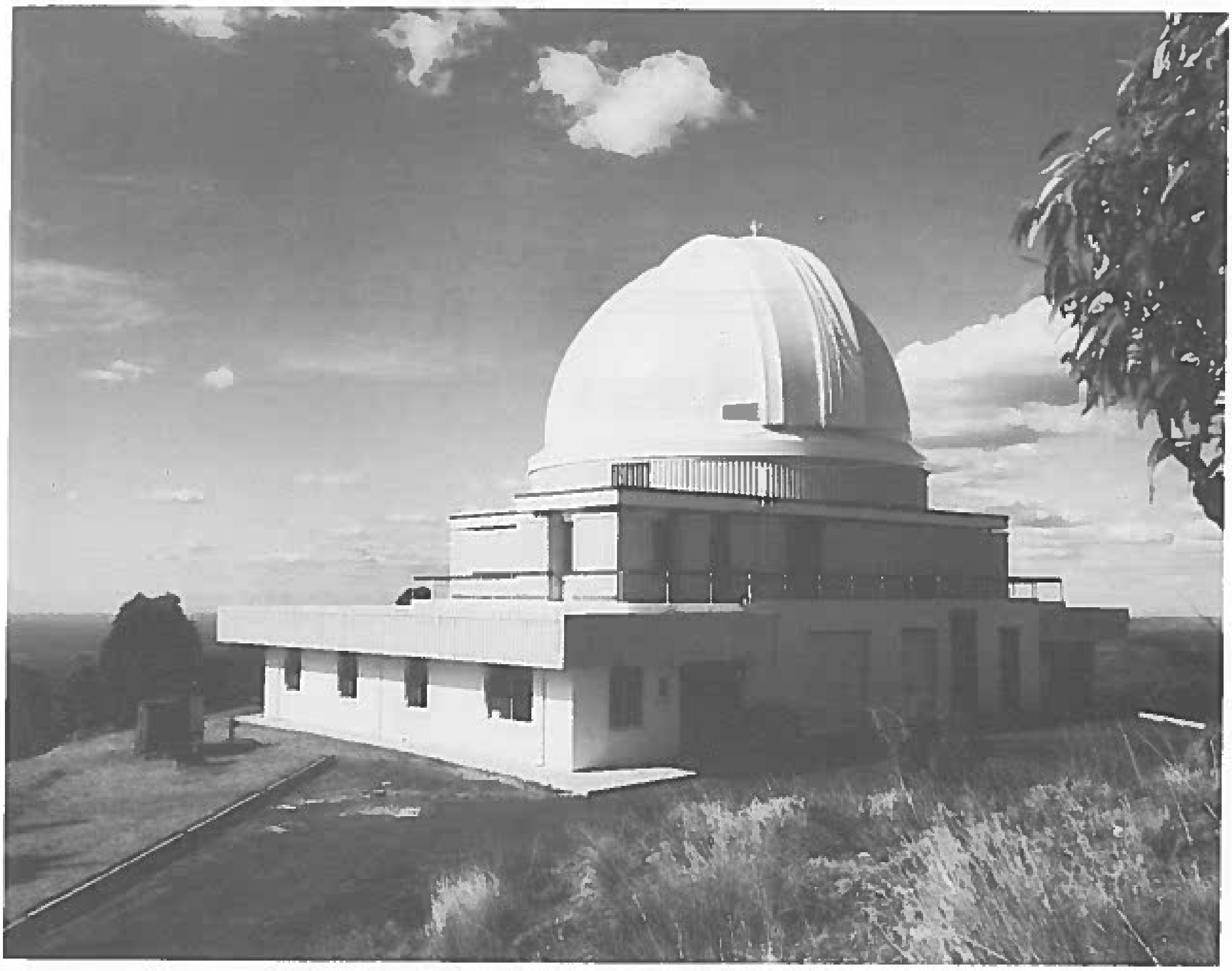
A small extension has been built on the north of the main building where facilities exist for soaking plates in hydrogen. An automatic system controls the duration of the hydrogen soak and ensures that at the end of the soak the plates are stored in nitrogen. The box containing the plates to be hypersensitised is placed in a specially constructed, temperature controlled (20°C ± 1°C) cabinet. Facilities exist for plates to be treated at temperatures up to 65°C if required, with forming gas as the hyper-sensitising agent rather than hydrogen.

One darkroom is equipped for the hypersensitisation of IV-N and I-Z emulsions which require individual treatment. Each plate is immersed in a fresh solution of dilute silver nitrate. UKST staff cannot undertake this work for users of other telescopes on site.

CHAPTER 5

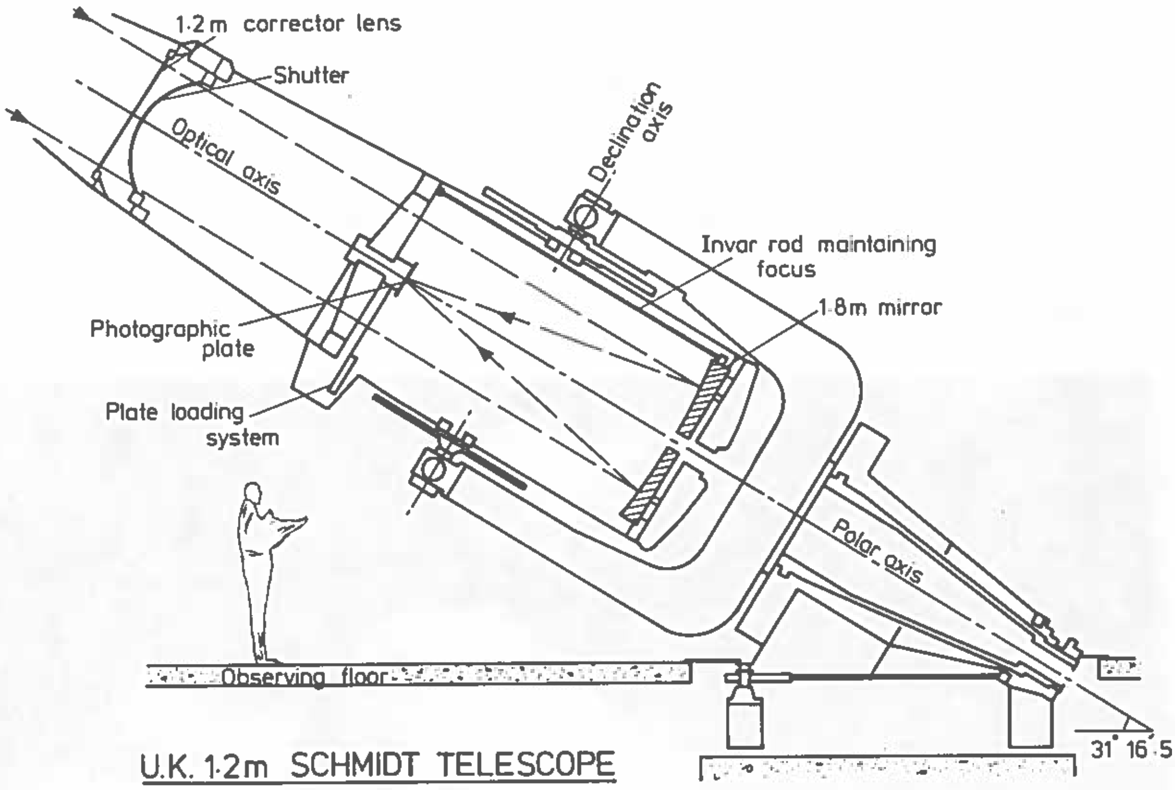
THE UK SCHMIDT TELESCOPE

5.1 THE TELESCOPE



Latitude	-31° 16'.4
Longitude	+149° 04'.2 = $9^h\ 56^m\ 17^s$
Altitude	1130m

The telescope is housed in its own building which also contains offices, the plate library, darkrooms, workshops and an aluminising plant. The dome is a hemispherical steel shell with an inner lining of polyurethane insulation and aluminium, with a ventilated air gap between. Sideways opening shutters give a clear aperture of 2.74m and there is a windscreen. Forced ventilation of the dome is provided by four 0.75m diameter fans.



U.K. 1.2m SCHMIDT TELESCOPE

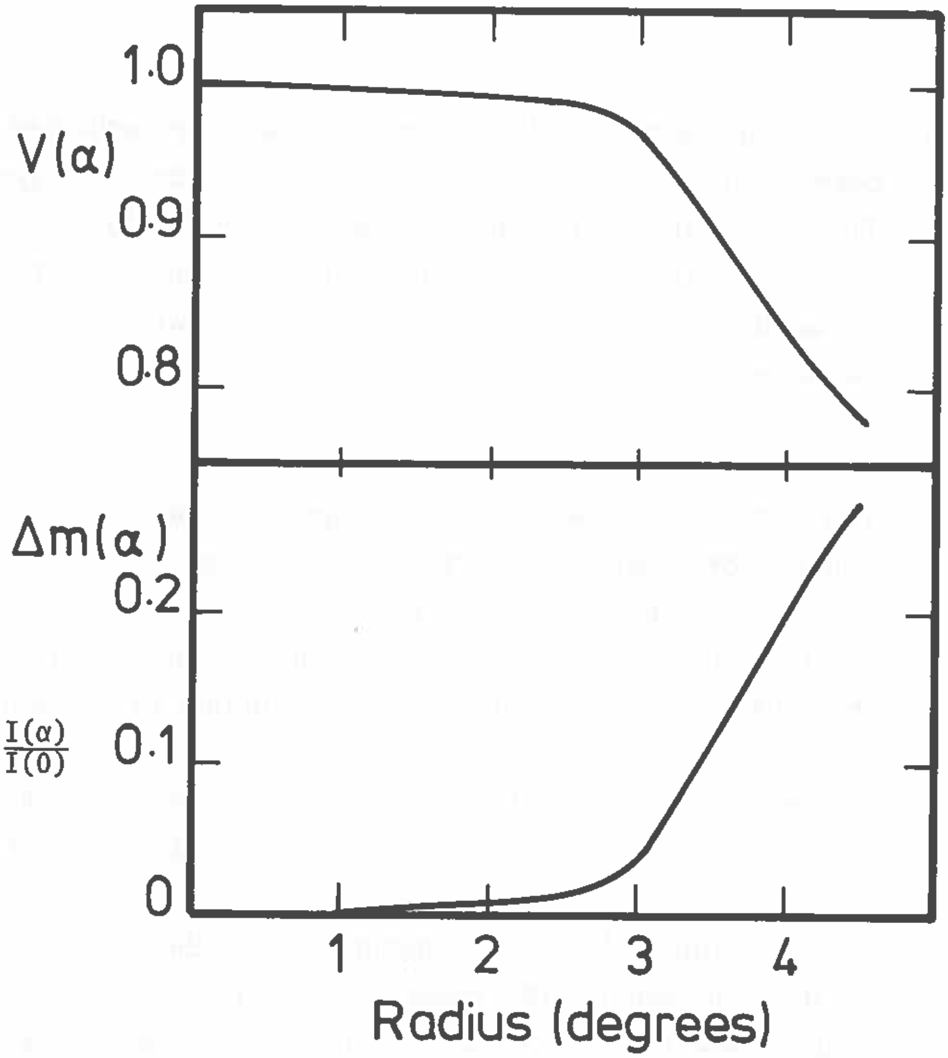
The telescope is a classical Schmidt with the following parameters:

Mirror diameter	1.83m
Aperture diameter	1.24m
Focal length	3.07m
Radius of curvature of focal plane	3.07m
Plate scale	67.12 arcsec mm^{-1} or 14.9 μm $arcsec^{-1}$
Photographic plate size	356mm square, covering 6.4 x 6.4 degrees of sky
Photographic plate thickness	1mm
Unvignetted field radius (nominal)	2.7 degrees

An experimental determination of the vignetting function shows that it commences rather closer to the plate centre than can be accounted for by simple geometric optics, but it conforms to the theoretical curve elsewhere. This early onset is attributable to backscattering of light between the photographic emulsion and the corrector. A graph of this function is reproduced below: [See Dawe, J.A., and Metcalfe, N., 1982 (ref 19)].

$$V(\alpha) = \frac{I(\alpha)}{I(0)}$$

$$\Delta m(\alpha) = -2.5 \log \frac{I(\alpha)}{I(0)}$$



Revised vignetting functions for UKST (in absence of differential desensitisation and night-sky brightness gradient).

The empirical function is appropriate to unhypersensitised plates. Unfortunately, hypered plates may be subject to differential desensitisation in the presence of moist air trapped between the flat filter and the curved plate. This effect steepens the apparent vignetting function, the desensitisation being greatest at the plate corners and least at the plate centre. Quantitatively, the difference between the apparent vignetting functions for hypered and unhypered plates is unlikely to be greater than $0^{m}.04$. [Dawe, J.A. and Metcalfe, N., 1982 (ref 19); Campbell, A.W., 1982 (ref 17)].

The plateholders of UKST have now been refurbished (December 1982) to permit the flushing of the emulsion with dry nitrogen during exposure. This eliminates differential desensitisation and suppresses low-intensity reciprocity failure. To permit unfiltered plates to be exposed in the dry nitrogen-filled plateholders, a Schott WG 305 (colourless) filter is available.

The corrector plate is a full aperture achromatic cemented doublet of Schott UBK7 and LLF6 glass. It gives images with a half maximum intensity width of better than 1 arcsecond at all photographic wavelengths in the absence of seeing or photographic effects. The ultraviolet transmission of the corrector as a function of wavelength is given below.

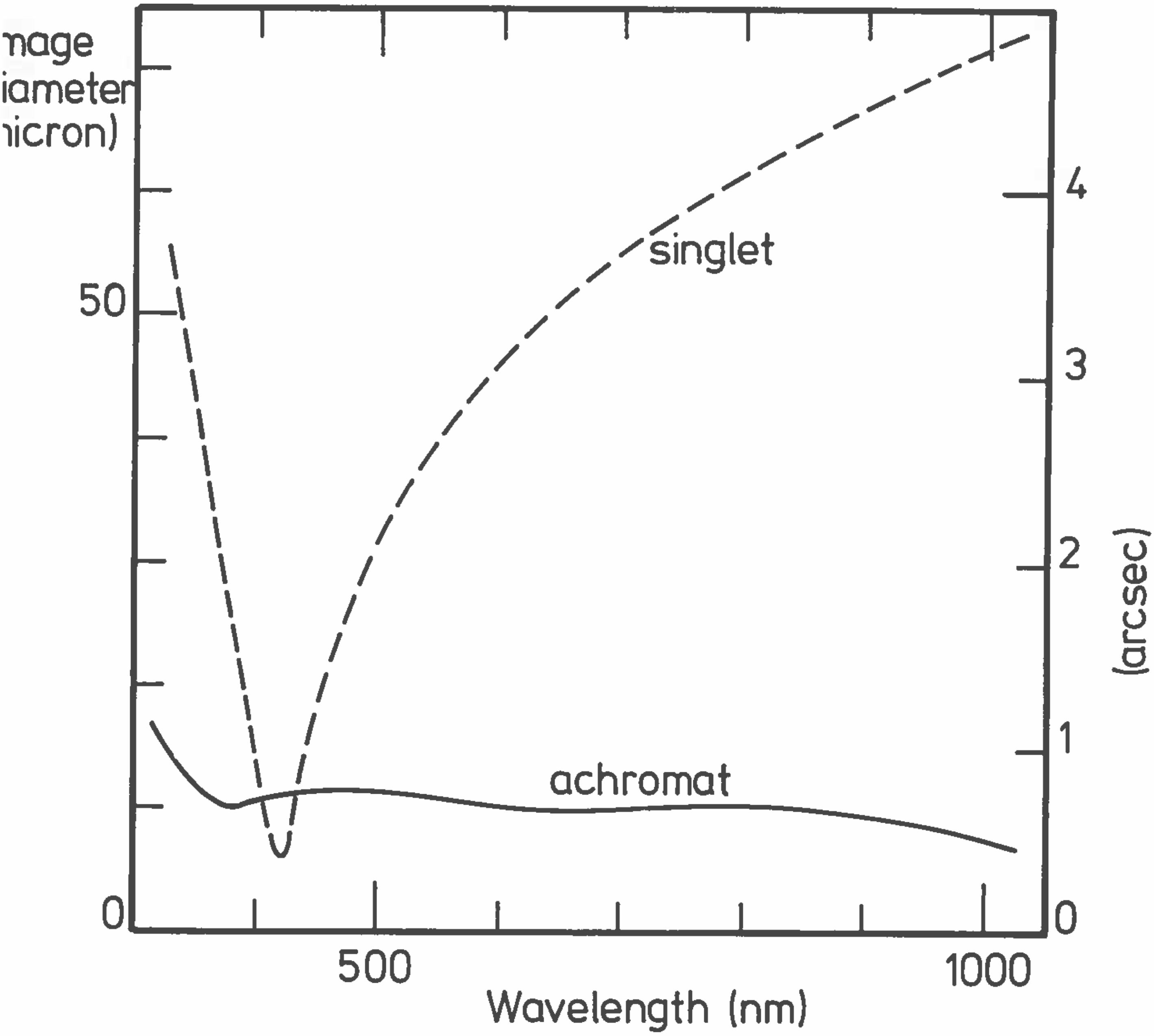
wavelength (nm)	310	320	330	340	350	370	390	420	450
transmission	0.09	0.39	0.56	0.74	0.82	0.90	0.94	0.98	0.98

Up until April 1977 (plate number UR 3148P) a singlet corrector plate was in use, of Schott BK7 glass. The corrected wavelength was 420nm, and image diameters of less than 2 arcseconds were obtained in a 100nm bandwidth centred on the corrected wavelength. See graph on page 5.1.5.

There are two 254mm aperture guide telescopes, which are normally fitted with photoelectric offsetting autoguiders.

The control system allows most of the telescope functions except plate and filter changing to be controlled from a console in a separate room within the dome. The dome azimuth and windscreen automatically follow the telescope attitude.

The polar axis has to be adjusted for optimum off-axis image quality at different declinations, to counter differential atmospheric refraction. This is done for each exposure by means of a motorised jacking system. [Wallace, P.T., & Tritton, K.P., 1979 (ref 10)].



UKST Corrector Plates - Full-Width Half Maximum
Image Diameter vs Wavelength

N.B. The above image diameter is full width at half maximum intensity, whereas the smallest image visible on a IIIa-type plate is about 20μm (=2.0x FWHM).

5.2 TELESCOPE ACCESSORIES

Objective prisms

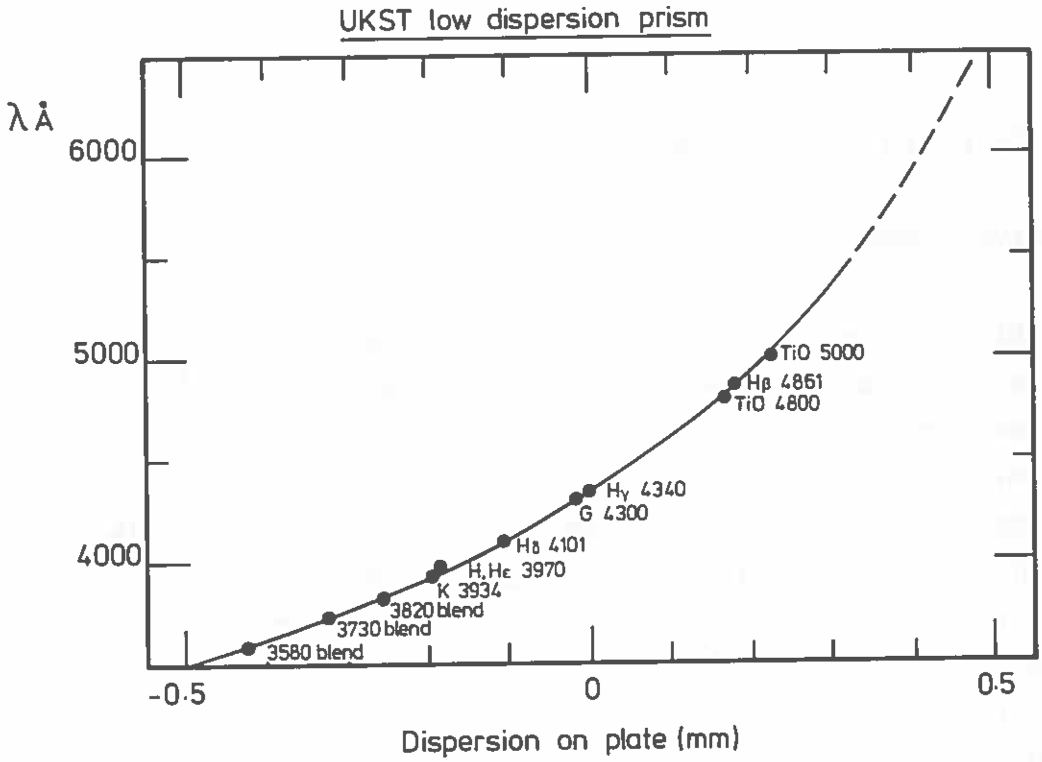
Two full-aperture objective prisms are available for use on the UKST, one with an apex angle of 44 arcmin (2400 Å mm^{-1} at 4300 Å) and the other with an apex angle of 2 1/4° giving very nearly three times higher dispersion. The prisms can be mounted singly or together on the telescope, and the complete assembly can be rotated to give the dispersion direction in any required position angle. The usual 'default option' is to have the dispersion north-south. The various prism configurations are denoted by P1 (44' prism), P3 (2 1/4° prism), P2 (P3 and P1 mounted opposed) and P4 (P3 and P1 mounted in parallel); the numbers indicate the dispersion relative to the original low dispersion prism.

A table giving representative reciprocal dispersions for the various prism combinations is given below, as are graphs of the dispersion curves for the two prisms. Further details on the low dispersion prism are given in Nandy et al. 1977 (ref 4), and on the intermediate dispersion prism in Cannon et al., 1982 (ref 18).

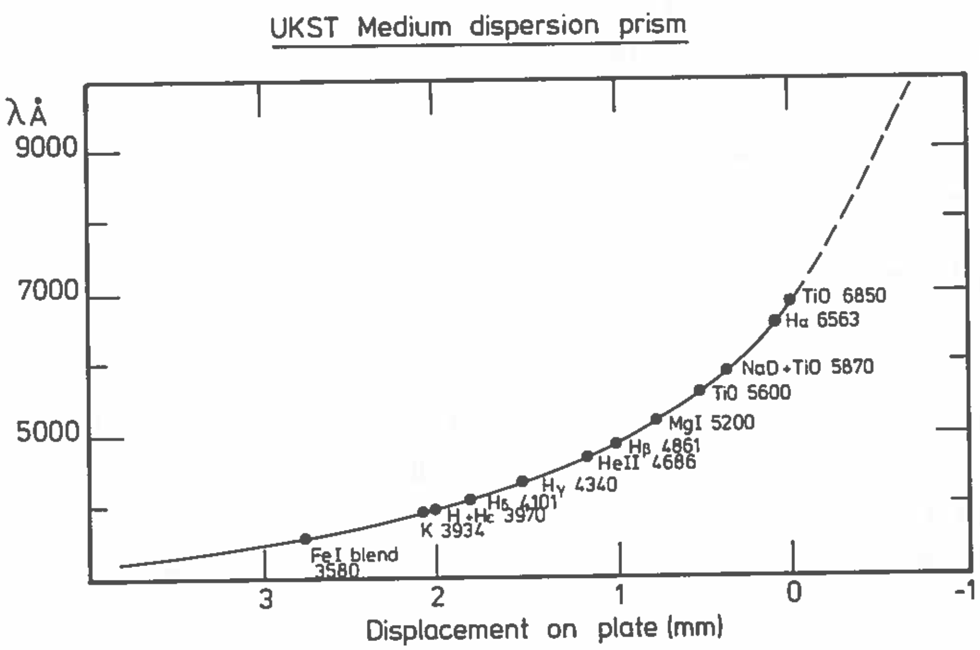
Dispersions and Effective Resolutions for any Combination of Prisms

Dispersion Index	1		2		3		4	
	Å/mm	Å	Å/mm	Å	Å/mm	Å	Å/mm	
Hα 6563 Å	8088	176	4167	91	2750	60	2052	45
Hβ 4861 Å	3470	76	1788	39	1180	26	881	19
Hγ 4340 Å	2440	53	1260	27	830	18	620	13
Hε 3970 Å	1852	41	955	21	630	14	470	10

A tilting block image displacer in front of the autoguider can be used to provide widening for objective-prism plates. It has maximum and minimum rates of 3 and 0.05 arcsec per minute, respectively. The maximum displacement is 1.6 arcmin; some nonlinearity of rate occurs at large displacements. Users are advised to specify the minimum widening practical for their needs.



Dispersion curve for the UKST low dispersion objective prism. Solid line - Hartmann formula fit to the data points. Dashed line - manufacturer's data. The ordinate is the wavelength in Angstroms, the abscissa is the displacement, in mm, from Hγ.



The Dispersion Curve for the UKST Medium Dispersion Objective Prism. Solid line - manufacturer's melt data. The r.m.s. deviation of an individual measurement (°) from this curve is ± 8 Å. The ordinate is the wavelength in Angstroms, the abscissa is the displacement in mm from the cut-off of the IIIa-F emulsion (6900 Å ± 15 Å).

Sub-beam prisms and objective gratings

A sub-beam prism, of approximately 250mm aperture, can be fitted in front of the corrector for photographic calibration, producing single side images from each star with a magnitude drop of about 3^{m}. The full aperture of the sub-beam prism is sufficiently great to ensure that both primary and secondary images are "seeing" rather than diffraction limited. However, a 50mm diameter circular mask may be attached to the sub-beam prism, yielding a magnitude drop of about $6^{m}.5$ but, in this case, the secondary images are diffraction limited.

Originally, the sub-beam prism used was on loan from the INT. This was replaced in May 1982 by a similar prism mounted in a slightly thinner cell. The new sub-beam prism is located in the same position in front of the corrector as the old sub-beam prism, but its direction of deviation has been rotated through about 90° in order that plates taken with the two prisms may be readily distinguished. The differences between the two sub-beam prisms are summarised in the Table below:-

		Old (INT)	New
I.	Position angle (secondary image w.r.t. primary)	155°	247°
II.	Image separation	0.466mm 31 arcsec	0.362mm 24 arcsec
III.	Magnitude drop (geom. prediction)		
	Full aperture	$3^{m}.11$	$3^{m}.12$
	5cm aperture	$6^{m}.56$	$6^{m}.60$
IV.	First plate taken:	B4482S	U7755S

The actual drop in magnitude depends not only upon aperture, but also upon waveband and position in the field. The latter consideration arises from the vignetting by the plateholder and spider, and is a highly asymmetric function because the sub-beam prism is offset from the optic axis. In practice, only a limited part of the field may be used for calibration - see diagram on p 5.2.4. However, it is important to note that the form of the vignetting will be the same whichever of the sub-beam prisms and apertures were in use. It is recommended that the sub-beam prism magnitude-drop is independently calibrated for any sequence of plates, in a given waveband, taken on a given night and, if possible, under the same conditions of seeing.

Users are warned that internal reflections in the prism can cause a tertiary image for the brighter stars - see page 5.5.3.

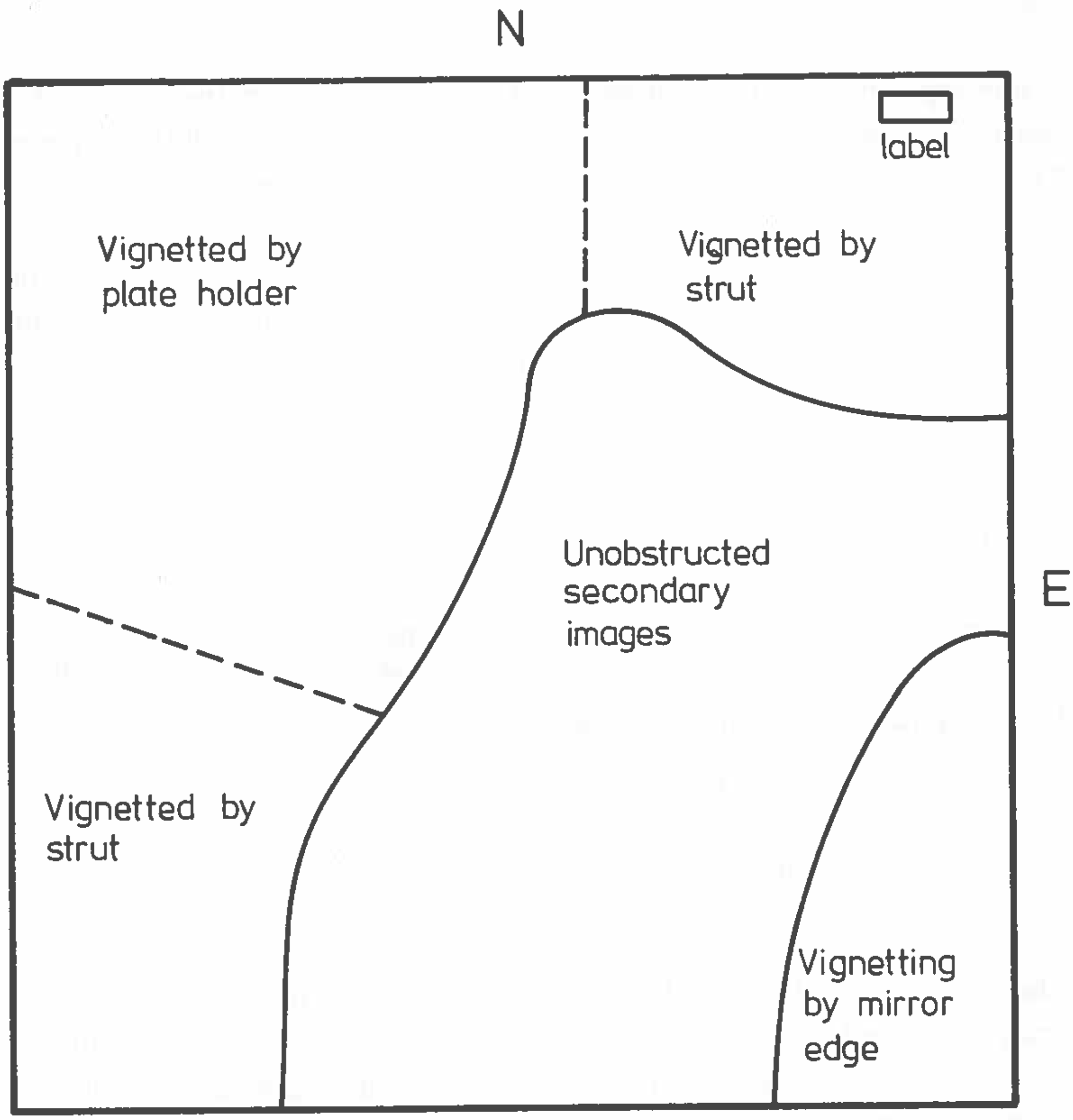


Diagram showing the vignetting profile of a UKST plate with a sub-beam prism mounted.

A full aperture coarse objective grating, designed and built by J.G. Bolton, may be fitted for use with certain photometric or astrometric programmes. It produces a sequence of diffracted side images on either side of each star, with successive drops of about 3 magnitudes in each order.

5.3 FILTERS AND EMULSIONS

Filters

The earth's atmosphere and the telescope optics together produce a short wavelength cut-off at about 320nm. The following uncoated Schott glass broadband filters are available.

Name	Thickness (mm)	Approximate Transmittance	Wavelength at transmittances of 1/10 and 9/10 max. values	
356mm square				
UG1	2	320 to 390nm	315,390	330,375*
WG305	3	longward of 305nm	290	320
GG385	2	" 385nm	360	400
GG395	2	" 395nm	365	415
GG455	2	" 455nm	440	465
GG495	2	" 495nm	480	510
OG590	3	" 590nm	580	600
RG630	3	" 630nm	620	640
RG715	4	" 715nm	690	730
180mm square				
RG830	4	" 830nm	800	860
RG1000	4	" 1000nm	910	980**

The above values are interpolated from graphs given in the Schott Colour Filter Glass Catalogue. Users who need to know the exact values of transmittance are advised to consult this catalogue.

* This filter has a red leak longward of 680nm.

** Maximum transmittance assumed to be 0.34 at 1000nm.

A number of smaller sized narrow band interference filters are sometimes available on loan from the Anglo-Australian Observatory, as follows.

	Approximate size (mm)	central* wavelength (nm)	bandpass* FWHM (nm)
Hα	250 square	656	10
Hα	130 square	656	10
[S II]	"	672	10
[O I]	"	630	9
He I	"	587	9
[O III]	"	501	8
Hβ	"	486	7
He II	"	468	7
Hγ	"	434	6
[O II]	"	373	6
continuum	"	460	20
continuum	"	540	40
continuum	"	643	10

*Please note that these bandpasses and central wavelengths were measured for the f/3.3 beam of the Anglo Australian Telescope, and will be slightly different on the f/2.5 Schmidt.

Selected HN32 polaroid sheets are available as filters for linear polarisation measurements. A 250mm diameter sheet, which is able to be rotated, is held in a special frame together with a fixed sheet for reference purposes. It is not possible to rotate the filter to different position angles while the plateholder is loaded in the telescope.

Several other filters, mainly different interference filters designed and built by individual astronomers are (semi-) permanently stored at Siding Spring. Most of these filters are not available for general use but may be made available on request. Details of these filters can be obtained from UKSTU. In particular, a 15-inch square Hα mosaic filter, designed and built by Dr J. Meaburn is now available for other users. For further details see Elliott, K.H., and Meaburn, J. 1976 (ref 3).

Please note that only one filter may be loaded into a plateholder at a time and that it is not possible to make two exposures on one plate through different filters.

Emulsions

All emulsions are coated on to 356mm square glass, 1mm thick. The principal emulsions available are the following Eastman Kodak types.

Emulsion	Grain type	Spectral sensitivity	Code Letter
IIa-O	medium	UV to 500nm	B
IIIa-J	fine	UV to 540nm	J
IIa-D	medium	UV to 650nm	V
098	coarse	UV to 690nm	R
IIIa-F	fine	UV to 690nm	R
IV-N	fine	UV 400nm to 540nm and 670nm to 900 nm	I
I-Z		UV to 570nm and 830nm to 1120nm	Z

Details of the response curves of these emulsions are available in Kodak publications No. P-315 'Plates and films for scientific photography', P-210 (for the 098 emulsion) and P-316A (for the IIIa-F). Please note that an earlier name for the IIIa-F emulsion was 127. The I-Z emulsion is only available at present on an experimental basis.

All plates are coated with an antihalation backing, with the exception of the IV-N and I-Z. (Although halation is severe with these plates, the backing is not very efficient in the near infrared and will not survive the silver nitrate pre-exposure hypersensitisation treatment.)

The IIIa-J, IIIa-F, IV-N and I-Z emulsions are normally used after hypersensitisation. Brief details of hypersensitisation techniques are given in chapter 4.3 (Hypersensitising Facilities).

Each new batch of plates is subjected to an extensive series of tests to determine the optimum hypersensitising procedure, and the progress of hypersensitising is monitored by the routine exposure of test samples in a laboratory spot sensitometer.

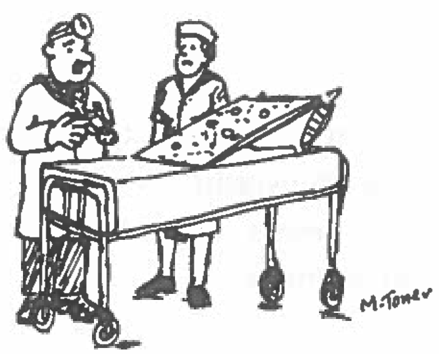
As noted in Chapter 5.1, hypersensitised IIIa-type emulsions lose sensitivity when exposed to air of high humidity. The UKST is now equipped (December 1982) with three plateholders which may be uniformly flushed with dry nitrogen to suppress this desensitisation. In future, it will be regular practice to nitrogen-flush all IIIa-type plates in this way.

Plates are processed according to their emulsion type. All non IIIa-type emulsions are developed in an automatic plate rocking machine, followed by a stop bath, two fixer baths (with nitrogen bubble burst agitation), rinse, hypo clearing agent, wash and photoflo. IIIa-type emulsions, which are prone to gold-spot formation (see below), are processed separately following recommendations of Kodak. The processing sequence is development in the rocking machine, stop bath, one bath of rapid fix with nitrogen bubble burst, wash with bubble burst and, finally, immersion in dilute photoflo. The plates are dried vertically in a laminar flow clean-air station. The complete system is designed to give highly uniform processing to archival standards of permanence.

Microspots on IIIa-J plates (Gold spot disease)

A number of processed IIIa-J plates have developed many small gold spots similar in size to faint star images. They are most likely to occur in areas of relatively high density, such as in bright star images or on the step-wedges, and are sometimes scattered around in non-image areas. An alarmingly high proportion of plates taken in 1974-75 (about 50 per cent or more) have developed gold spots, and the most recent affected plate found so far is less than three years old. Four early IIIa-F plates (taken before mid-1977) have also been found to have gold spots. The spots are gold or yellow when seen in transmission; they look like tiny mirrors in reflected light. Similar spots have been found on plates taken at Palomar and at Kitt Peak. The degree of attack may be slight (a few spots, most likely on a stepwedge), moderate (spots scattered randomly or along the edges of the plate) or severe (spots all over the plate). The affected plates are divided roughly equally between these three categories. It seems that the spots take at least three years to become visible, after the plate has been exposed and processed. This makes it very difficult to establish possible causes of the problem, which is almost certainly not curable. Unfortunately, gold spot formation involves changes in the structure of image silver and some silver migration. Even if it were possible to remove the gold spots, this could only be cosmetic since there is no way to restore the original structure of the image silver.

The causes of microspot formation have still not been convincingly established, but the list of primary suspects include pick-up of contaminants in processing solutions, hydrogen peroxide fumes, and fumes from fresh oil-based paints. Preventive measures include using a dedicated processing line for IIIa-type emulsions, to prevent pick-up of iodides and chlorides from other emulsion types (IIIa-J is essentially a pure bromide emulsion) and avoiding sources of hydrogen peroxide and other noxious chemicals. Plates should also be stored away from other possible contaminants; these include recently painted rooms and the soft foam packing that was formerly used to protect plates during shipping. Users are asked to discard all foam packing; the plates should be packed for shipping in yellow boxes fitted with polystyrene sheets. To protect the image silver, Kodak recommend treatment in a post processing batch of Rapid Selenium Toner. At ROE, and at Siding Spring, tests are being done to investigate possible effects of toning existing plates. Early results indicate that the effects of toning on the grain characteristics of the emulsion cannot be detected by microdensitometry. Further tests will be done on COSMOS and results will be given in the UKSTU Newsletter.



I'M AFRAID IT'S GOLD SPOT DISEASE.

Filter and emulsion combinations

Some of the common filter and emulsion combinations are listed below:

Emulsion	Filter	Equivalent photoelectric waveband	Approximate maximum limiting magnitude
IIa-O or IIIa-J	UG1	U	-
IIa-O	GG385	B	21
IIIa-J	GG395	B_J	22.5
IIa-D	GG495	V	21
IIIa-F	OG590	'OR'	22.0
098	RG630	R	21
IIIa-F	RG630	R	22.0
IV-N	RG715	I	19.5

The waveband marked B_J above is not a recognised photoelectric waveband, but UKSTU use the designation 'J' for this particular combination. (It is of course unconnected with the Johnson J band at 1.25μm.) 'OR' is currently used to distinguish red plates taken with the OG 590 filter. If the colour transformation to the photoelectric R band is satisfactory it may become the standard red photographic waveband. The colour transformation to the Cousins photometric passbands have been determined to be (Blair, M. & Gilmore, G. 1982 (ref 16)).

$$
\begin{array}{llll}
U-U' = (0.03 \pm 0.05) \times (U-B) & -0.4 < & (U-B) & < 2.0 \\
B-B' = (0.11 \pm 0.02) \times (B-V) & -0.1 < & (B-V) & < 1.6 \\
B-B_J' = (0.28 \pm 0.04) \times (B-V) & -0.1 < & (B-V) & < 1.6 \\
V-V' = (0.10 \pm 0.02) \times (B-V) & -0.1 < & (B-V) & < 1.6 \\
R-R' = (0.00 \pm 0.05) \times (R-I) & 0.0 < & (R-I) & < 0.9 \\
I-I' = (0.03 \pm 0.02) \times (V-I) & 0.0 < & (V-I) & < 1.9
\end{array}
$$

where unprimed colours are photoelectric, primed values are 'natural' photographic values, and subscript J refers to the (IIIa-J + GG 395) combination. The quoted errors are sample standard deviations from the 22 plates used in the determination.

The effective wavelengths and bandwidths of these filter/emulsion combination are given below as a function of colour temperature, T_{col} for various black body sources and the Sun:

Effective wavelengths and bandwidths of emulsion/filter Combinations in use at the UK Schmidt Telescope

Waveband	T_{col} °K	λ_{eff} nm	$W_{50\%}$** nm	$W_{20\%}$*** nm
U	3000	376	45	68
	6700*	367	58	78
	10000	365	62	80
	25000	360	60	80
B	3000	455	110	140
	6700*	427	100	140
	10000	423	100	140
	25000	417	94	130
B_J	3000	490	90	175
	6700*	450	150	175
	10000	436	110	180
	25000	426	70	165
V	3000	589	95	140
	6700*	570	130	155
	10000	567	135	150
	25000	563	130	150
OR	3000	654	90	115
	6700*	644	90	115
	10000	646	90	110
	25000	641	90	110
R	3000	670	42	70
	6700*	667	50	70
	10000	665	50	70
	25000	665	55	70
I	3000	803	160	190
	6700*	790	160	190
	10000	788	160	190
	25000	784	155	185

* Actually, the solar spectrum
** Width at 50% power level
*** Width at 20% power level

5.4 PLATE GRID

It has been standard practise for a precise grid to be contact printed onto the edges of each plate before exposure in the telescope. This grid has gradations marked at 5mm intervals and a cross in the centre of each side which is used as a fiducial mark for measuring machines such as COSMOS. The grid is imprinted outside the telescope and this has several undesirable consequences of which users need to be aware.

Any exposure to air causes hypersensitised IIIa type emulsions to lose sensitivity (see 5.1.3) and the contact printing can be a cause of this. Recent plates (since R8271 December 1982) have had the grid imprinted after exposure in an attempt to reduce the sensitivity loss.

Although the grid was intended to provide a simple means for calculating approximate positions on the plate, the difficulty of locating the plate in the printer and the problems of maintaining the locating device of the printer in correct adjustment results in a typical error between the grid centre and the physical plate centre of 3 arc minutes. In some cases the error is considerably worse.

The optical axis of the telescope coincides with the relevant field centre of the plate and the physical centre of the plateholder aperture. Because of slight variations in the size of the plates as supplied by Kodak there is some latitude in the positioning of plates in the plateholder. The field centre should coincide with the physical centre of the plate to about 1 arcminute. It is because of the much better correlation between field centre and physical plate centre than between field centre and grid centre that the practise has been developed of indicating positions of objects on the plate relative to the plate edge rather than relative to the grid centre.

It is intended that the grid will eventually be abandoned in order to reduce the amount of time plates spend in air and to remove markings which mislead users as to the position of the field centre. It will be necessary to provide some fiducial markings for use in measuring machines. Information will be given in the UKSTU Newsletters.

5.5 GHOST IMAGES, HALOES AND DIFFRACTION SPIKES

Direct plates

"Location and identification of the EC and FC ghosts."

The geometric arrangement of the components of the telescope (corrector, filter, etc.) causes certain internal reflections such that each real star image gives rise to additional spurious or 'ghost' out-of-focus images. On direct plates the ghosts normally visible are as follows (the magnitudes quoted are B magnitudes for stars on sky-limited IIIa-J plates).

1. Emulsion-corrector (EC) ghosts. The emulsion reflects the light forming the primary image back up the telescope and the corrector reflects it back down again to form the ghost image. The ghost is at the same field radius as the primary but is 180° away in position angle (i.e. diametrically opposite the primary). If the corrector were perfectly plane, the ghost would be perfectly focussed; however the corrector is deliberately figured as a meniscus and so the ghost appears as an oval shape about 50-60mm in diameter. It is visible for the brightest stars ($B < 6.0$) only. It is actually double, with the two components arising from the back and front surfaces of the corrector.

2. Filter-corrector (FC) ghosts. This is formed in the same way as EC but the first reflection is from the filter rather than the emulsion. Very similar to EC in position and appearance, and slightly stronger. Again visible for the brightest stars only, and of course absent on unfiltered plates. Actually quadruple (from the front and back surfaces of the filter and corrector) but the two pairs of components arising from the two filter surfaces are closely superimposed.

3. Corrector (C) ghosts. The incoming light is reflected internally between the two faces of the corrector plate. The ghost therefore appears essentially concentric with the primary image. The light distribution is non-uniform within the ghost but has a fairly sharp outer boundary at a radius of about 5mm. It is visible on stars brighter than $7^{m}.5$ only.

4. Filter (F) ghosts. The incoming light is reflected internally between the two faces of the filter. Like C, the ghost is superimposed on the primary image, but the intensity is uniform and the ghost is slightly displaced towards the field centre (because the plate is curved and the filter is plane). The ghost radius is approximately tA/nF where t, n, A, F are the filter thickness and refractive index and telescope aperture and focal length respectively, leading to a ghost radius of ~ 0.5mm with 2mm filters. It is visible on stars much fainter than C (about $11^{m}.5$), but of course absent on unfiltered plates.

5. Spider (S) ghosts. Scratch-like ghosts can be formed opposite to very bright stars, approximately in line with the diffraction spikes (see illustration on p.5.11). On early UKST plates (up to May 1976 plate B 1489) these are formed principally by grazing incidence reflections on the faces of the spider vanes which support the plateholder, and can be quite prominent. Baffles were then fitted to cut out these reflections, but some small ghosts can still occur, presumably off other surfaces connected with the plateholder mounting, calibrators, etc. (They re-appeared in some strength on plates 7898 to 7993 when the (east) KPNO sensitometer was modified in July 1982. The offending surface, which was only 6 square cms in extent, was subsequently covered with felt.) On high star density fields these ghosts are particularly insidious and have several times led to the reported 'discovery' of new edge-on galaxies, minor planets or comets.

The halo (H) arising from reflections within the plate is not a true ghost but is mentioned here for completeness. Light scattered in the emulsion is reflected from the back of the plate back into the emulsion. The halo is centred on the primary image. The halo has a fairly sharp inner boundary, its intensity falls off radially outwards, and it has an outer boundary which is not usually easily seen. These inner and outer boundaries are defined by the critical angles at the glass-air and emulsion-air interfaces. The radii are (inner) 2t tan (arcsin 1/n) and (outer) 2t tan (arcsin n'/n) where n and n' are the glass and emulsion refractive indices and t is the thickness of the plate. On UK Schmidt plates, the inner radius is about 1½mm. These halation rings are visible on the brighter stars only. All plates, except IV-N and I-Z, are coated with an antihalation backing to reduce the intensity of these haloes. The available backings are relatively ineffective in the near infrared and since the backing can cause problems in the hypersensitisation and processing of IV-N and I-Z plates these emulsions are used unbacked.

The vertical and horizontal spikes superimposed upon star images down to $16^{m}.0$ in the form of a cross are the diffraction spikes (D) formed by the four spider arms supporting the plateholder.

The above effects can all be seen in the illustrations on pages 5.5.5 and 5.5.6.

Sub-beam prism plates

Internal reflections in the prism cause an unwanted tertiary 'ghost' image to be produced for the brighter stars. This image appears stellar and the magnitude drop from the primary is about 10 magnitudes when the prism is used at full aperture. For the old (INT) sub-beam prism the displacement between the 'ghost' and the primary image is about 3.2mm. For the new sub-beam prism (plates taken after U7755S) the displacement is about 2.9mm.

Objective prism plates

The use of an objective prism gives rise to additional ghost images which will be only briefly described here. Since the faces of the prism are nominally plane, some of these are almost in focus, and could possibly be mistaken for spectra of real objects.

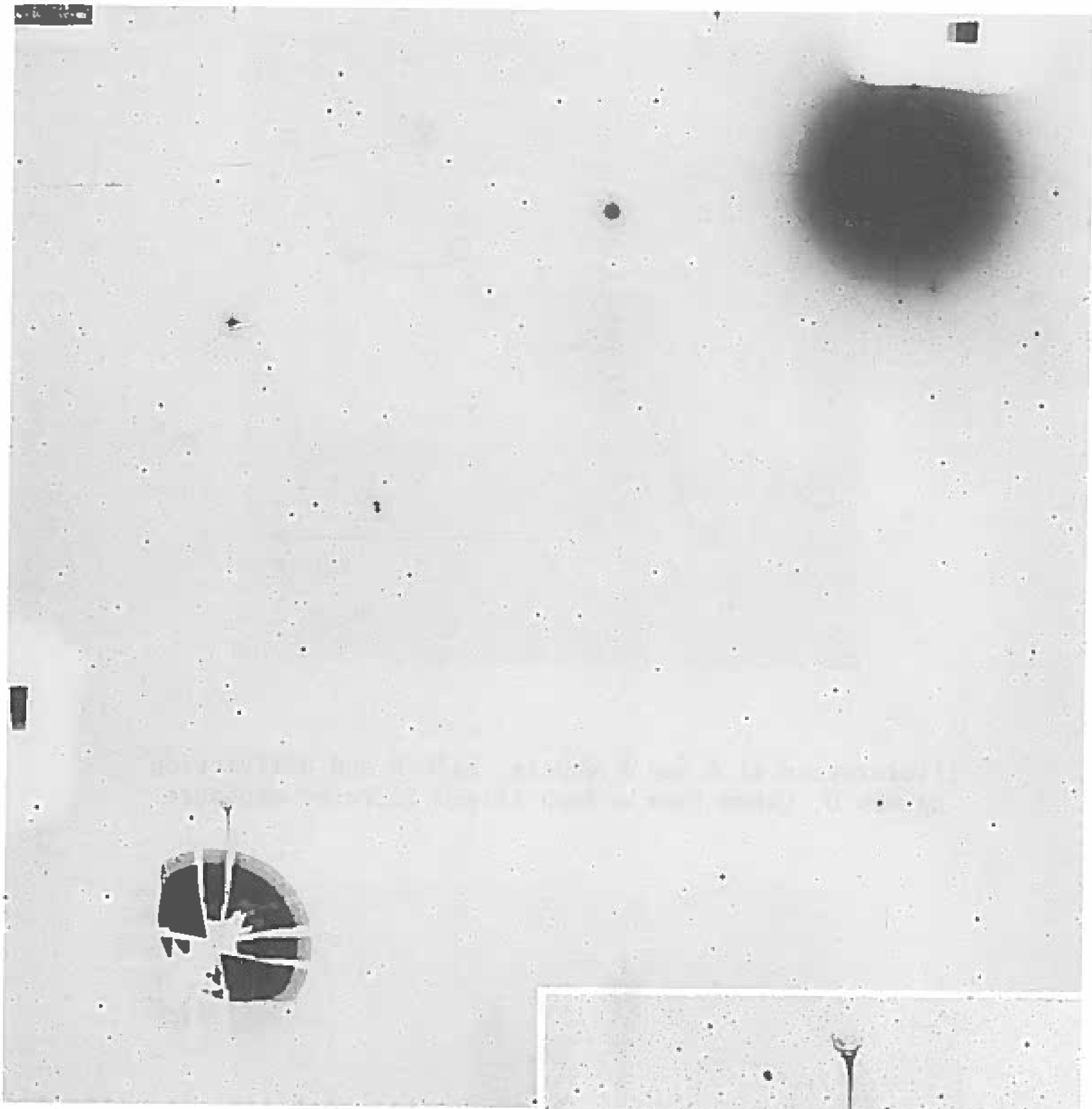
The additional ghosts on an unfiltered prism plate are corrector-prism ghosts (CP), emulsion-prism (EP) ghosts and an internal prism (P) ghost, and they all arise in analogous ways to the ones described earlier. The CP ghosts are similar in appearance to EC and FC and appear for the brightest stars only, but the EP and P ghosts are almost in focus, and appear for many of the brighter stars on a plate. The EP ghosts are usually quite distorted but the P ghost can look something like a planetary nebula (see illustration). The location of these ghosts is indicated in the diagram on the page 5.5.7. It should be noted that the CP and P, but not the EP, ghosts can be formed by stars which are themselves outside the field of view of the telescope.

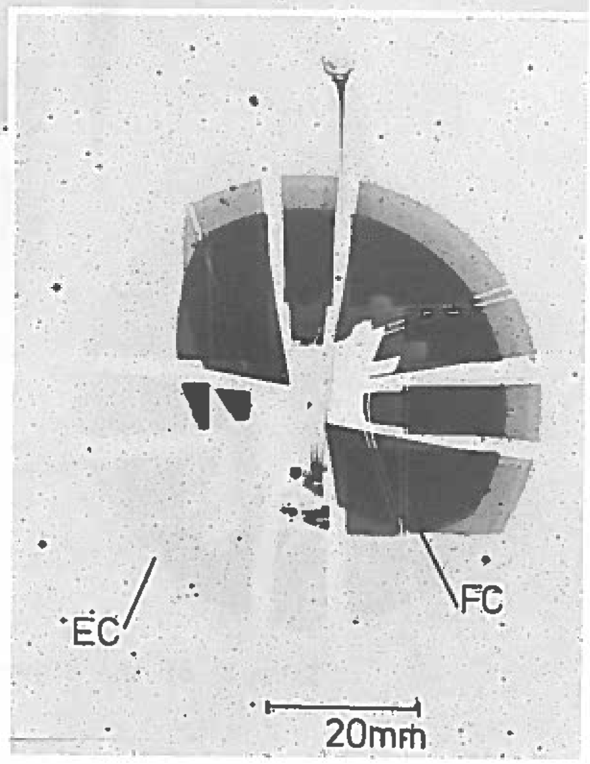
The use of a filter adds filter-prism (FP) ghosts, but these are fairly similar in appearance to the EP ghosts, and located close to them.

The final complication arises when both prisms are mounted together on the telescope (see diagram on page 5.5.8). In that case no fewer than 15 separate ghost images can be formed (excluding filter (F) ghosts which are more or less concentric with the corresponding emulsion (E) ghosts), although again it is impossible to obtain all the ghosts from one star on a single plate. The positions and other information on all these ghosts are tabulated below on page 5.5.9, using an obvious extension of the nomenclature defined above and on page 5.5.7.

Note that there are several ghosts which involve light passing once through the outer prism (P3) and three times through the inner prism (P1). When the two prisms are mounted to give dispersion in opposite directions (i.e. configuration P2), these ghosts are undispersed images and the two which are only slightly out-of-focus (formed by incoming light reflected between the plane surfaces of the prisms) are particularly troublesome since they are small annuli and are formed by quite faint stars.

All ghosts involving the corrector plate 'C' are enormous (about 60mm in diameter) because of the deliberate overall spherical curvature of the corrector, and so can only be detected from bright stars.





Location (above and identification (inset) of the EC and FC ghosts. The whole of survey field 161 (plate J5538) is reproduced above, showing the very bright star Canopus and the resulting ghosts.

The appearance of these ghosts is somewhat different on plates up to number UR3148P, these having been taken through the singlet corrector. On those plates the EC and FC ghosts show a sharp outer boundary.

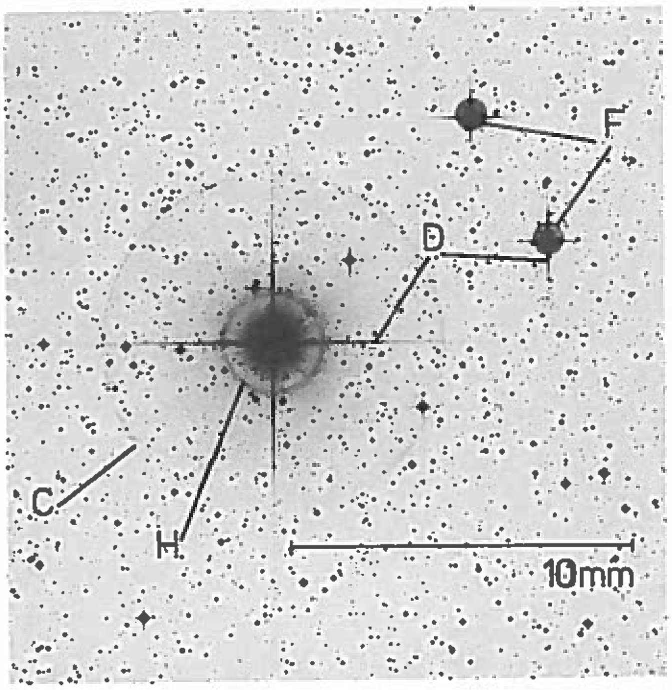
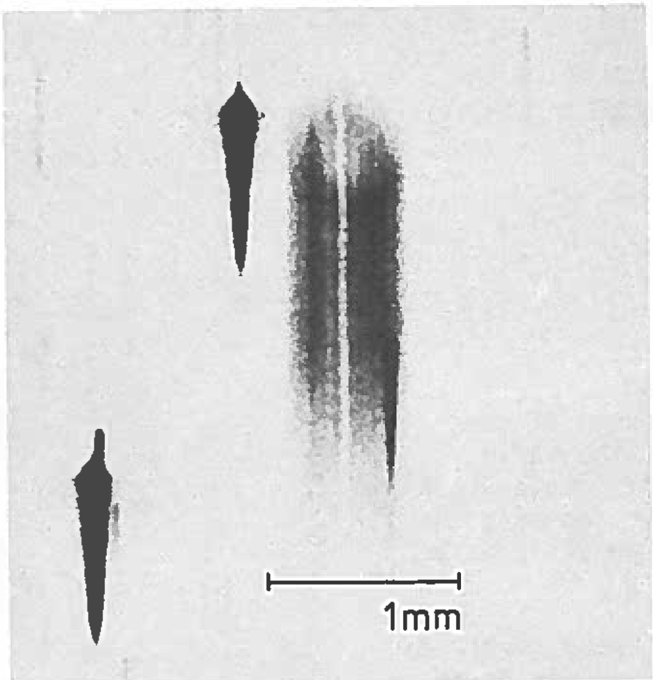
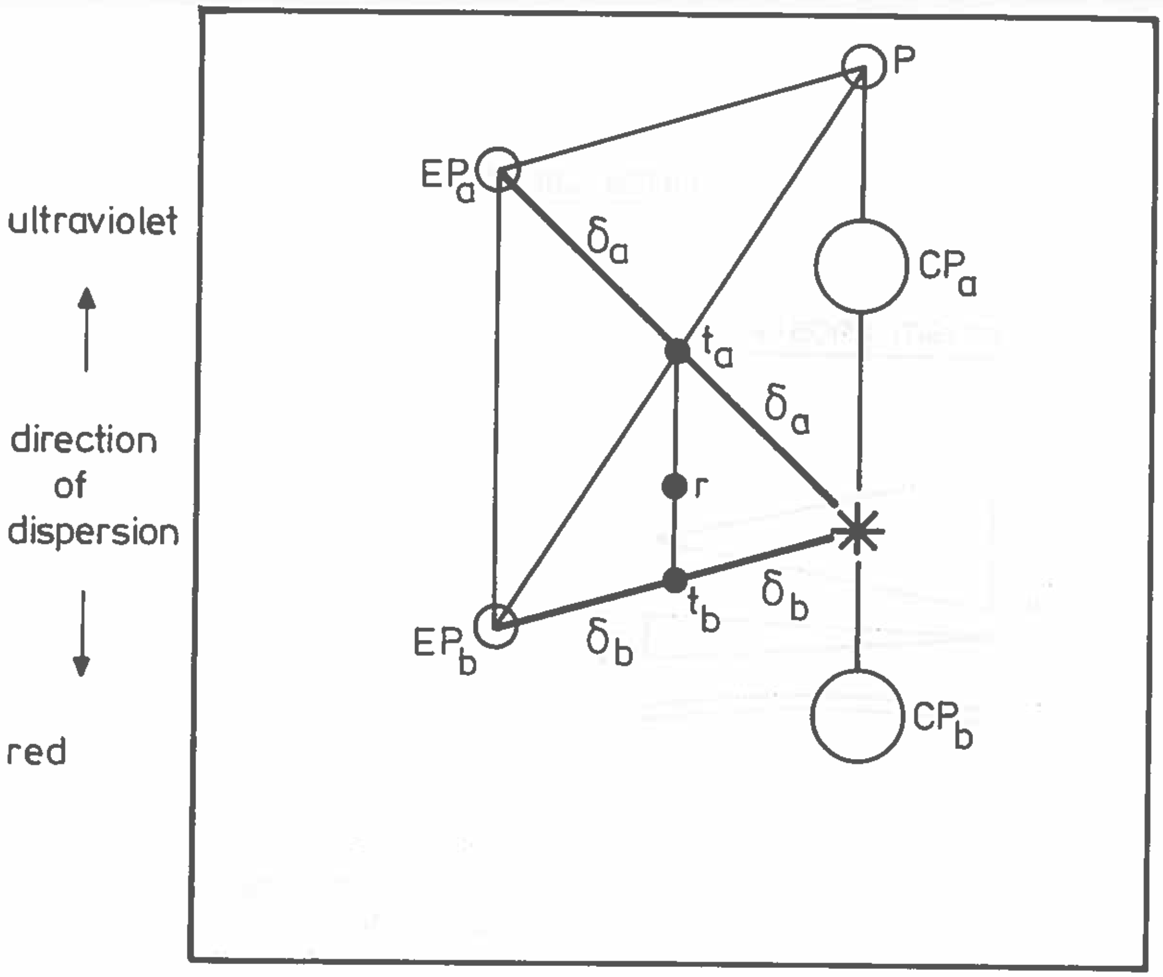


Illustration of C and F ghosts, halo H and diffraction spikes D, taken from a deep IIIa-J filtered exposure.



Example of the objective prism ghost P.



Location of prism ghosts on objective prism plates

In what follows, α is the apex angle of the prism, β is the inclination of the back face of the prism to the optical axis, and n is the refractive index of the glass. Suffices a,b are associated with the prism front and back surfaces respectively.

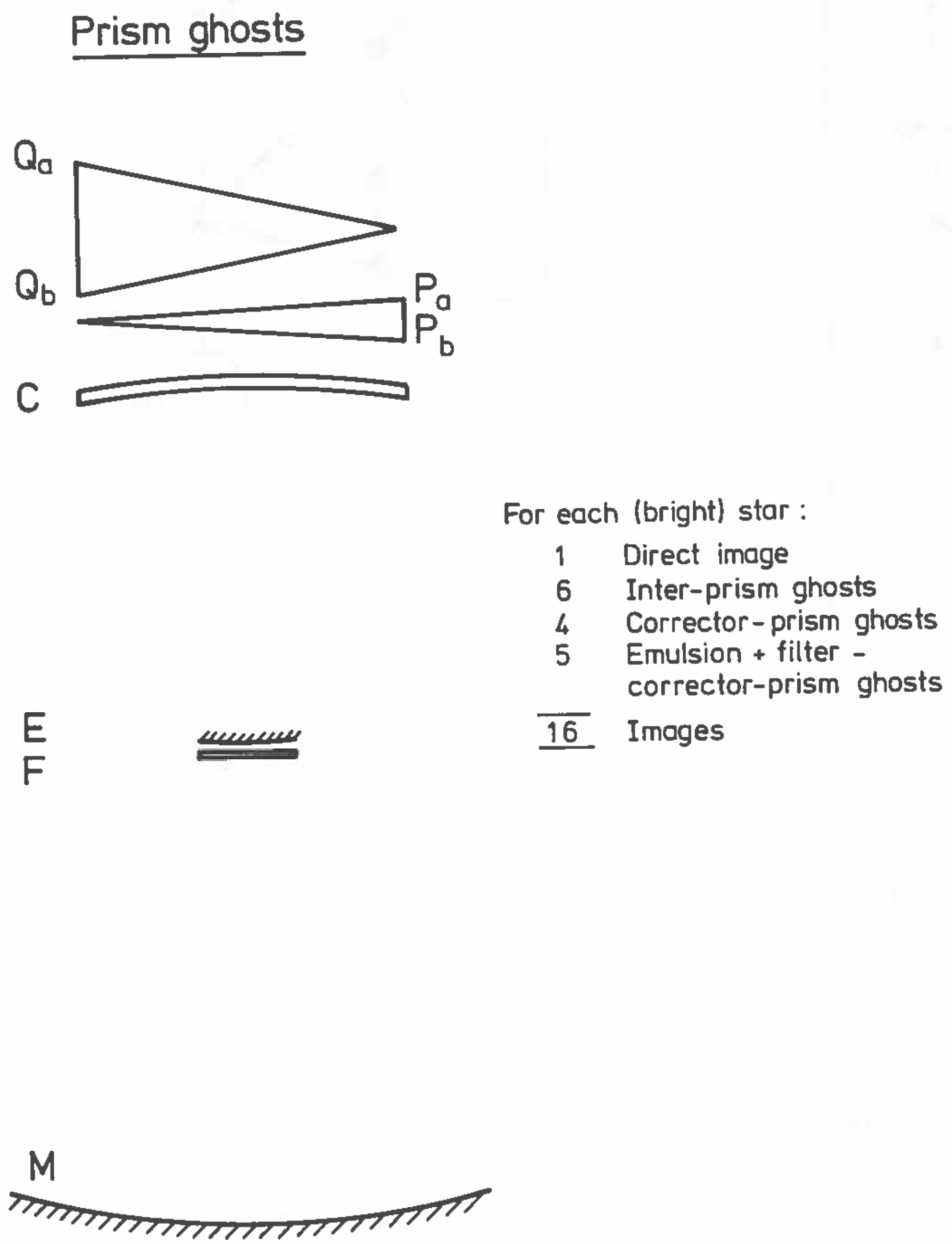
In the diagram, * represents the image of a star on the plate and the five circles show the locations on the plate of its ghost images which arise from the objective prism. The plate centre is at r, and t_a and t_b are points on the plate above and below it such that $rt_b = \beta$ and $t_a t_b = n\alpha$.

If * is at distances δ_a and δ_b from t_a and t_b, then ghosts CP_a and CP_b appear above and below *, EP_a and EP_b appear at points which are reflections of * in t_a and t_b, and P appears above *. The distance CP_b to * is 2β, CP_a to CP_b is $2n\alpha$, EP_a to EP_b is $2n\alpha$ and P to * is $2n\alpha$.

For the 44 arcmin prism, β is about 33 arcmin or 30mm on the plate, and $n\alpha$ is about 67 arcmin or 60mm on the plate.

For the 2 1/4 degree prism, β is about 100 arcmin or 90mm on the plate and $n\alpha$ is about 200 arcmin or 180mm on the plate.

PRISM GHOSTS



To simplify the nomenclature in this diagram and the table on page 5.5.9 the low dispersion prism (P1) has been designated P while the medium dispersion prism (P3) is designated Q. The suffices a and b refer to the front and back surfaces of each prism. C represents the position of the corrector, E the plate emulsion, F the filter and M the mirror.

Positions and dispersions of ghosts formed when the prisms are mounted in parallel (P4) and anti-parallel (P2).

Ghost	P4		P2	
	Position (mm)	Dispersion (P1 = 1)	Position (mm)	Dispersion (P1 = 1)
$C\ P_b$	- 60	4x	+ 60	2x
$C\ P_a$	+ 60	6x	- 60	0
$C\ Q_b$	-140	6x	-220	0
$C\ Q_a$	+220	12x	+140	6x
$P_b\ P_a$	+120	6x	-120	0
$P_b\ Q_b$	- 80	6x	-280	0
$P_b\ Q_a$	+280	12x	+ 80	6x
$P_a\ Q_b$	-200	4x	-160	2x
$P_a\ Q_a$	+160	10x	+200	8x
$Q_b\ Q_a$	+360	10x	+360	8x
EC	0	- 4x	0	- 2x
$E\ P_b$	- 60	- 4x	+ 60	- 2x
$E\ P_a$	+ 60	- 2x	- 60	- 4x
$E\ Q_b$	-140	- 2x	-220	- 4x
$E\ Q_a$	+220	4x	+140	2x

Note that the positions of the ghosts are for when the prisms are mounted at their standard inclinations, chosen to given minimum deviation on-axis when the prisms are used alone. The EP ghost positions are measured relative to the position of the EC ghost, which is diametrically opposite the primary spectrum. The plus sign means in the direction of deviation of the primary spectrum (i.e. towards the UV tail).

Fortunately most of these many ghosts are rare and can be detected from only the brightest stars, while the only ones likely to be mistaken for astronomical objects are P_bP_a and Q_bQ_a since these appear as somewhat defocussed spectra of unusual length. (P_bP_a ghosts are very common and appear as small annuli with the P2 combination.)

5.6 MAGNITUDES ON UKST PLATES

A useful guide to the magnitudes of stars on a deep plate (or copy) can be obtained by noting the points at which the ghosts and/or diffraction spikes are no longer visible. The table shows, for limiting exposures, the approximate (± $0^m.5$) magnitudes at which these effects become no longer detectable under normal visual inspection. See 5.12 for diagram of ghosts.

Waveband		J	R		I
Exposure (Mins)		60	15	90	90
FC (Filter-Corrector)	60mm	$6^m.0$	$1^m.5$	$4^m.0$	$1^m.0$
C (Corrector)	5mm	7.5	3.5	6.0	-
F (Filter ghost)	½mm	12.0	6.5	9.0	7.5
D (Diffraction spikes)		16.0	12.0	14.5	12.5
Plate limit		22.5	19.5	22.0	19.5

The corrector ghost on I plates is not seen owing to the much more obvious appearance of halation ring H, (most obvious on I plates due to the lack of antihalation backing on the IV-N emulsion). This 'ghost' appears on stars brighter than I ∼ $9^m.5$.

Experience with the plates has shown that for most good quality plates (A and B grades) the magnitude at which ghosts and diffraction spikes are no longer visible gives a good indication of the magnitude limit on the plate.

The diffraction spikes disappear at brighter magnitudes on non-sky limited plates. Hence the cut-off can be used as a check. A reduction from 60 to 40 minute exposure on the J plates lowers this cut-off by over half a magnitude to ∼ $15^m.5$. The same effect is seen on the twelfth magnitude filter ghost which disappears at about $11^m.5$.

The length of the diffraction spike on stars has been found to give a quick and fairly reliable estimate of the magnitude of stars in the 10-16 magnitude range. Estimates to better than half a magnitude are possible even when different plates or films are involved - see diagram on p5.6.2.

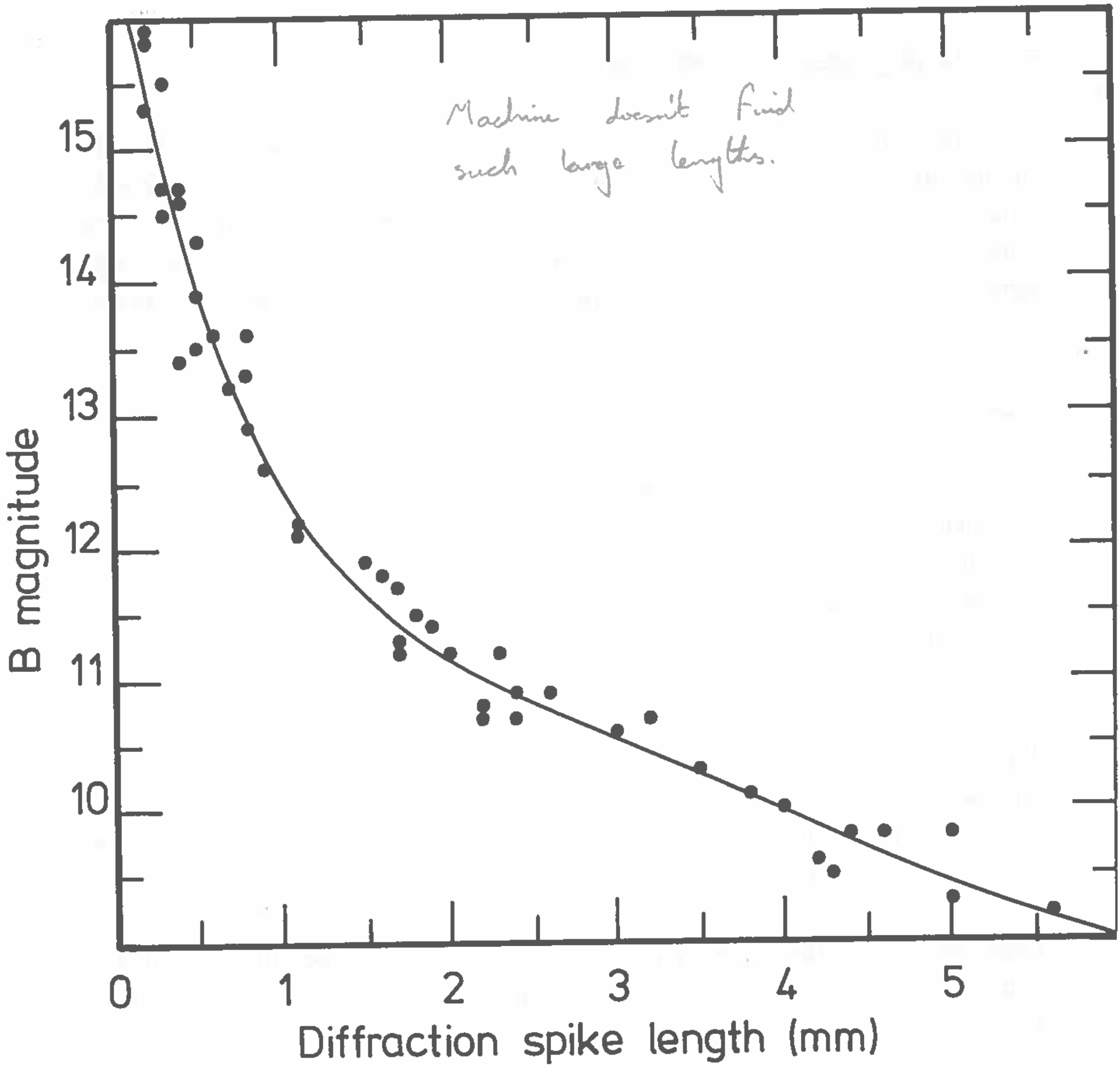


Diagram showing the relationship between diffraction spike length and B magnitude. The data come from seven deep IIIa-J plates.

A detailed discussion of magnitude estimation using the magnitude-image diameter relation has been published by King et al., 1981 (ref 15), with accuracies of order 0.5 magnitudes again being possible.

Limiting magnitudes for some Emulsion/Filter combinations

Equivalent p.e. waveband/ Plate No. prefix	Emulsion	Filter	Sky limit exposure time (nominal mins)	Approx. limiting magnitude
U	IIa-O	UG1	180	
U	IIIa-J	UG1	180	
B	IIa-O	GG385	60	21
J (or B_J)	IIIa-J	GG395	60	22.5
V	IIa-D	GG495	60	21
'OR'	IIIa-F	OG590	60	22
R	098	RG630	60	21
R	IIIa-F	RG630	90	22
I	IV-N	RG715	90	19.5
WZ	I-Z	RG830		

Sky limit refers to a density of about 1.0 above chemical fog (i.e. a total ASA diffuse central sky density in the range 1.2 - 1.5). The exposure time given is only a nominal value. The actual exposure time depends on the speed of plates which varies from batch to batch.

The limits for all the above combinations with the exception of the 'infra-red' emulsion/filter combinations (I-Z, IV-N) refer to exposures taken with a fully dark sky. The infrared photographs are normally taken in some (but not full) moonlight; slightly deeper limits can be obtained with longer exposures on moonless nights, but the gain is not great at infrared wavelengths. Reducing the exposure times to about a third of the quoted times results in a plate with limiting magnitude about 1 magnitude brighter than those quoted. In this case some moon can be tolerated with no further loss of information. The above limiting magnitudes apply when the total seeing is less than 3 arcsec (∿ 45µm images on the plate); in seeing conditions of 4 arcsecs the limiting magnitude will be about 0.5 mag brighter.

Limiting magnitudes using the Objective Prisms

'waveband'	Emulsion	Filter	Prism Dispersion	Sky Limit exposure time (mins)	Approx. Limiting Mag.
UJ	IIIa-J	none	1	45	20
UR	IIIa-F	none	1	20	18.5
UR	IIIa-F	none	3	20	17.5
YR	IIIa-F	GG455	3	35	18.5
UJ	IIIa-J	none	3	45	18
J	IIIa-J	GG395	3	60	18.5

Widening the spectrum on an objective prism plate to about 130μm makes the limiting magnitude about 1.5 mag brighter.

While emission lines can be fairly easily detected near the plate limit, the useful magnitude range for objects which can be studied in detail on prism plates is in the range 1-3 magnitudes above the plate limit. Note that the total usable range is much less than on direct plates, since the spectra of objects more than three magnitudes above the plate limit are saturated.

CHAPTER 6

CALIBRATION

6.1 PROJECTION CALIBRATORS

For relative intensity calibration of direct photographs, two uniformly illuminated step wedges are projected on to each photograph through the filter. The illumination is automatically switched on and off when the telescope shutter is opened and closed, so that the exposures of the step wedges are always the same as that of the main sky photograph, and are made under exactly the same conditions of temperature and humidity. The bodies of the projectors themselves provide a shielded area so that the calibration is put on to clear plate. This is important for two reasons, so that the calibration is well determined to a level below that of the lowest sky density on the plate, and to avoid contamination problems from stars and nebulosity.

The majority of plates taken up to the end of 1979 were calibrated by two projectors each providing seven steps arranged in a strip, one at the north and one at the east edge of the plate. Illumination was by tungsten light bulbs. Since then, the east projector on most plates has been replaced by one of the Kitt Peak design, providing sixteen steps arranged in a square. Illumination is by a quartz-halogen lamp through a BG34 colour correction filter. Two different step wedges have been used and a summary appears below.

Plates	Calibration
1-5391) 5427-5659) 5694-5715)	Two seven-step projectors (north and east edges)
5392-5426) 5660-5693)	One seven-step projector (north edge) and one KPNO projector (southeast corner) with 'KPNO' step wedge 'C'
5716-present	One seven-step projector (north edge) and one KPNO projector (southeast corner with step wedge 'alpha'

Until July 1982 (plate J7864), the intensity of illumination of the KPNO sensitometer spots could not be varied to match the exposure time of

5716 → 6295 (inc.) 16 spot in funny position.

emulsion/filter combination in use. On sky-limited plates, this led to gross overexposure of some spots and scattering of light into adjacent spots. The light source for the sensitometer is now mounted outside the telescope, permitting easy variation of the illumination by means of a rotating aperture disk. The scattered light problem has also been substantially reduced.

The following tables give the values of log relative intensity for the different projector and step wedge combinations and for various wavebands. The values are checked from time to time.

Seven step

North	U	1.46	1.30	1.17	1.00	0.76	0.46	0.27
	B	1.55	1.34	1.17	1.00	0.78	0.57	0.35
	J	1.52	1.35	1.19	1.00	0.78	0.57	0.36
	V	1.57	1.35	1.18	1.00	0.80	0.58	0.35
	R	1.54	1.35	1.18	1.00	0.80	0.60	0.35
unfiltered		1.57	1.39	1.20	1.00	0.78	0.57	0.36
East	U	1.41	1.30	1.17	1.00	0.76	0.43	0.17
	B	1.49	1.35	1.19	1.00	0.79	0.56	0.31
	V	1.50	1.36	1.20	1.00	0.79	0.55	0.28
unfiltered		1.50	1.36	1.20	1.00	0.79	0.55	0.31
errors		0.04	0.03	0.02		0.02	0.04	0.07

Recommended calibration values for the wedge "C"

Waveband	U		J		R		I	
Step			Log (Relative Intensity)					
1	0.85 ±	.03	0.74 ±	.01	0.70 ±	.01	-	
2	0.66	.02	0.58	.01	0.56	.01	0.63	.02
3	0.42	.02	0.40	.01	0.38	.01	0.39	.01
4	0.06	.01	0.19	.01	0.18	.01	0.17	.01
5	0.00	.01	0.00	.01	0.00	.01	0.00	.01
6	-0.22	.01	-0.20	.01	-0.17	.01	-0.16	.01
7	-0.55	.01	-0.40	.01	-0.34	.01	-0.35	.01
8	-0.94	.01	-0.60	.02	-0.52	.02	-0.56	.02
9	-1.20:		-0.85	.02	-0.73	.02	-0.72	.02
10	-1.38:		-1.02	.01	-0.87	.01	-0.87	.02
11	-		-1.17	.03	-1.00	.01	-1.00	.03
12	-		-1.35	.03	-1.20	.02	-1.12	.02
13	-		-1.71	.20	-1.44	.03	-1.33	.03
14	-		-2.01	.20	-1.59	.02	-1.45	.06
15	-		-		-1.71	.03	-1.52	.11
16	-		-		-2.07	.10	-1.58	.10

Recommended calibration values for wedge-"α"

Waveband	U	B	J	V	R	I
Step			Log (Relative Intensity)			
1	0.76±.02	0.75±.02	0.76±.02	0.75±.02	0.75±.02	0.77±.04
2	0.55 .02	0.54 .02	0.53 .02	0.53 .02	0.53 .02	0.56 .03
3	0.40 .02	0.38 .02	0.40 .02	0.39 .02	0.39.02	0.46 .02
4	0.11 .02	0.13 .01	0.15 .01	0.15 .01	0.15 .01	0.17 .02
5	0.00 .02	0.00 .01	0.00 .01	0.00 .01	0.00 .01	0.00 .02
6	-0.16 .02	-0.14 .02	-0.15 .02	-0.12 .02	-0.11.01	-0.10 .03
7	-0.32 .02	-0.28 .02	-0.30 .02	-0.25 .03	-0.21 .01	-0.22 .02
8	-0.56 .02	-0.53 .02	-0.55 .02	-0.44 .03	-0.42 .02	-0.40 .02
9	-0.91 .03	-0.86 .04	-0.85 .03	-0.73 .04	-0.62 .02	-0.64 .02
10	-1.06 .03	-1.00 .04	-0.97 .04	-0.84 .05	-0.72 .03	-0.71 .02
11	-1.27 .03	-1.18 .05	-1.14 .05	-0.96 .05	-0.84 .03	-0.88 .03
12	-1.63 .05	-1.45 .06	-1.38 .05	-1.21 .05	-1.07 .03	-1.05 .04
13	(-1.78 .06)	-1.65 .06	-1.58 .05	-1.44 .06	-1.22 .04	-1.29 .05
14	(-1.92 .06)	-1.76 .06	-1.74 .05	-1.54 .06	-1.35 .04	-1.37 .05
15	(-2.06 .06)	-1.94 .06	-1.90 .06	-1.69 .06	-1.47 .05	-1.47 .05
16	(-2.30 .06)	-2.20 .06	-2.14 .06	-1.89 .06	-1.66 .05	-1.63 .05

6.2 NIGHT SKY PHOTOMETER

The step wedges provide only relative intensity calibration of the plates, and there remains the problem of determination of a zero point, if desired. One method is to use the background sky density in star-free regions of the photograph; when used with care this method can yield photometry accurate to $0^{m}.1$ or $0^{m}.2$, although probably no better.

During most long exposures, the sky brightness is measured using a small night sky photometer with an EMI type 9502/B (S11) photomultiplier tube. Observations during such exposures are obtained in the U,B and V wave-bands and calibrated with reference to a beta-light (tritium/ phosphor) source. A nominal value for the sky brightness, in B only, was provided on the observing records up to plate J8750. The 'corrected night sky brightness' as given by the Smyth calibration (see below) is given on all observing records since 1983 August 11, plate V8751.

Up until 1979 March 8/9, measurements were taken of the night sky brightness in a region, 1.27 degrees in diameter, close to the south celestial pole. The reason for working at the south celestial pole was that it was always the same piece of sky which was measured, so that the corrections for the stars falling within the measured area were constant and had to be calculated only once. Also, the small auxiliary telescope could be permanently mounted in a fixed position. However, the mounting of the photometer was such that the measured area was probably never accurately centred on the pole. Furthermore, there are very considerable variations in background luminosity across the sky, so that the photometer readings could never have provided accurate calibration for fields well away from the south pole. These background variations arise from three main causes: airglow and other terrestial atmospheric effects, zodiacal light, and unresolved background light from the Milky Way. Thus the background varies both in time and position across the sky. The last plate calibrated in this way was R4838.

In an attempt to obtain more useful sky brightness readings the night sky photometer was remounted on the telescope with the effective centre of the photocathode aligned with the main optical axis. Readings are taken at the field centre immediately before and after an exposure, and sometimes at mid exposure (for long exposure plates).

Naturally, in this mode of operation, the contribution of stars still included in the 1.27 degree measuring aperture must be subtracted out, and this is quite a difficult procedure. Applicants may request sky brightness readings on other centres within the field, if they specify cordinates. For example, it is possible to use the Sky Atlas to select a suitable 'clear sky' spot beforehand, in order to minimise the correction work.

Users working from original or copied observing records should be aware that the B values noted therein are nominal values only. Zero point and drift corrections due to secular changes of the beta-light must be allowed for. The approximate correction is

$$+ 0\overset{m}{.}38 + 0\overset{m}{.}09t$$

where t is the time in years after 1974.0 (i.e. the recorded value is too bright). At the south celestial pole, the correction for stars falling in the measuring aperture is approximately $+ 0\overset{m}{.}2$.

The colour of the night sky remains reasonably constant in dark-time. Average values for SSO are:

$$\langle B-V \rangle = 1.0 \pm 0.1$$
$$\langle U-B \rangle = -0.7 \pm 0.1$$

Full details of the calibration of the Night Sky Photometer in the U,B and V wavebands are given by Smyth, R.J., 1982 refs (20,21). Night sky brightnesses in the U and V wavebands, are available for most plates on direct application to UKST at Siding Spring.

When using the sky brightness on a photograph to calibrate the stars, a correction must be made for the atmospheric extinction of the stars at the time of the exposure. Working values for Siding Spring Observatory, appropriate for completely clear nights when there is little dust or bushfire smoke in the atmosphere, are as follows:

V	$0\overset{m}{.}16$	x sec z	)
B-V	0.11	x sec z	) where z is the zenith-distance
U-B	0.36	x sec z	)

However it should be noted that these corrections indicate a fundamental limitation of this method of establishing a photometric zero point. Essentially two quantities are required: the night sky emissivity and the absorption, and a single night sky photometer reading cannot provide both. For high precision photometry the only viable method seems to be to relate the photographic measurements to known photoelectric measures of stars or galaxies on the plates.

6.3 CALIBRATION SPECTROGRAPH

Another calibration problem at the UK Schmidt arises for plates taken using the objective prism. Emulsion response and contrast is far from uniform with wavelength, particularly for red-sensitive emulsions, and the characteristics of a given emulsion type are likely to vary depending on the hypersensitisation and processing methods used, see Clowes, R.G., 1983 (ref 22). For this reason test plates taken from the same emulsion batches as the main plates, are normally exposed during each observing run with the prism. These are exposed in a conventional calibration spectrograph, and can subsequently be measured in the same micro-photometer as the objective prism plates themselves.

A grating spectrograph is used with a 12-stepped aperture slit perpendicular to the dispersion. The grating is used in the first order, giving 6.5nm mm^{-1}. A range of approximately 400nm is recorded on the plate, and the central wavelength is selected by the grating angle. A quartz-halogen lamp forms the continuous spectrum, and a mercury discharge lamp provides wavelength calibration.

The 70 x 25mm plates have to be exposed in the laboratory rather than under observing conditions.

Widths and intensities of the stepped aperture slit, and wavelengths of the principal mercury lines are given in the following tables.

Step no.	Width(μ)	$-\log_{10} I$
1	32	1.579
2	44	1.441
3	66	1.264
4	91	1.125
5	132	0.963
6	177	0.836
7	254	0.679
8	348	0.542
9	470	0.412
10	634	0.282
11	875	0.142
12	1212	0.000

Mercury line wavelengths (nm)

365.0
404.7
435.8
546.1
577.0
579.1

The wavelength calibration in the red region of the spectrum may be augmented by the addition of a neon source.

Data for any particular batch of emulsion are available from Siding Spring Observatory; most data are also available from ROE.

Appendix 1

NOTES ON "APPLICATION FOR PHOTOGRAPHIC MATERIAL"

The rate at which material is provided by the Unit is often very dependent on certain critical parameters. UKSTU staff will assist applicants to optimise their requests; however, it is a great help if the original application is well-designed. The following notes apply when new non-Survey plates are required. However, please note that many requests can now be met by the provision of copies of Survey plates, and also that we strongly encourage applicants to use standard Survey plate centres whenever possible.

(a) Seeing Criteria

Wherever possible avoid specifying the standard Survey-quality combination of good seeing (< 3 arcsec)and full-depth exposures in dark time. The surveys already utilise 80% of this time but for about half of the clear time at Siding Spring the seeing is 3 arcsec or worse. The selection of seeing limits is accordingly a critical factor in planning a programme involving a significant number of deep plates.

The table below gives a rough indication of the effects of a seeing change from 2" to 4" on programmes using IIIa-J, IIIa-F or IV-N emulsions, based on the experience of a number of users. Note in particular items (i) and (ii).

	Parameter	Effect of change from 2" to 4"
i)	Limiting magnitude: detection of images	$\sim 0\overset{m}{.}8$ brighter
ii)	Limiting magnitude: star-galaxy separation	$\gtrsim 1\overset{m}{.}0$ brighter
iii)	Galaxy Classification	Weight declines by 2 on de Vaucouleur's system (RC2)
iv)	Photometry of uncrowded in-focus images	$\sqrt{2}$ better in precision (s.d. $0\overset{m}{.}07$ instead of $0\overset{m}{.}10$) for images > 2^m above limit.
v)	Photometry of extended objects	Limiting magnitude unaffected Spatial resolution degraded.

vi)	Detection of emission-line objects on low-dispersion prism plates	Severe. Approx. 4X equivalent width required for detection in 4" seeing.

(b) Exposure time

The probability that an exposure will be completed successfully is an inverse function of exposure time. Exposures of two hours duration or longer are difficult to schedule and are often spoiled by changes in weather conditions. It is therefore generally impractical to request large numbers of very long exposure plates, and plates obtained for such programmes are often of very variable quality.

Conversely, short exposure requests (< 15 minutes) are usually easily accommodated, and it is realistic to request quite large numbers of such plates. Furthermore, the loss in limiting magnitude will only be 1-2 mag. compared with the deepest Survey plates. Long exposures using narrow-band interference filters can be taken in grey conditions and are also relatively easy to accommodate.

(c) Complicating Factors

There are various other factors which complicate the process of securing plates for a programme.

Technical complications include special hypersensitising requirements, e.g. the use of IV-N plates, which have to be specially hypered one at a time, or the fitting of special equipment. For example, the small Pickering prism can be easily fitted or removed by the observer, whereas using the objective grating is more difficult and increases the effective duration of an exposure considerably. Mounting the full-aperture objective prism is a major day-time engineering exercise, so that it is normally fitted for several nights at a time.

Temporal factors can also slow down production, for example when a matched set of plates must be taken on the same night, or a series is requested in a defined way over a longer priod of time. The chances of completing such sets of exposures successfully is much lower than the chances for an equivalent number of isolated exposures. Therefore such programmes (e.g. polarization studies or searches for variable stars) must always be specified with as much flexibility as possible, and planned in such a way that good science can be done even from incomplete sets of plates.

(d) Variations in demand

Experience has shown that some regions of the sky are much more popular than others, notably the two galactic caps centred near 0^h and 12^h. The Magellanic Clouds at 1^h and 5^h are also much in demand, and the combined peak from 0^h to 6^h is made worse by the shorter summer nights. Applicants with programmes which do not demand specific RA's are strongly recommended to try to avoid the regions of peak demand.

SCIENCE and ENGINEERING RESEARCH COUNCIL

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UKSTU

APPLICATION FOR RESEARCH MATERIAL REF. NO. T /

Before filling in the form please refer to the UKSTU Handbook and to UKSTU Newsletter No. 3 (June 1981).

Applications may be sent to the above address or (for Australian applications only) to:
UKSTU, Private Bag, Coonabarabran, NSW 2857, Australia

1. A copy of this page will be returned to you after your application has been processed by UKSTU. Please note the reference number which will be added to this form (the T number). Please quote this number in all correspondence relating to this proposal. This copy will be the only formal acknowledgement of your application.

2. NAME(S) AND INSTITUTION(S):

ADDRESS OF PRINCIPAL (FIRST) APPLICANT:
(all correspondence will be directed to this person and address)

Telephone: Telex:

3. a) TITLE OF PROGRAMME:
(< 60 characters)

b) Is this a continuation of an existing programme YES/NO
If so please give the reference number (if known) T /

4. Your signature here is taken to signify that you accept the conditions under which material is supplied by UKSTU.

SIGNATURE..

DATE...

If you are a student (including graduate student) please ask your supervisor to sign as well.

SIGNATURE OF SUPERVISOR...

DATE.......................................

UKSTU USE ONLY
Ref. No. T /
Date received ROE/SSO
Date sent SSO/ROE
Date received SSO/ROE
Ack. sent Date

REF. NO. T /

NAMES

5. DESCRIPTION OF PROGRAMME

UKSTU does not "referee" applications but attempts to fulfil all requests. The Unit does, however, try to ensure that directly competing programmes are not active at any one time, without all applicants being aware of the situation. Give a full scientific justification for your request, even if you only require the loan of existing plates. Particular attention should be given to the following points:

(a) Any special Observing constraints should be given here in full (with justification) and noted in §6 comments.

(b) The latest date on which the plate(s) will be of use (give reasons).

(c) UKSTU reserves the right to supply film or glass copies of plates. Give full justification if the original plate is required (e.g. for use in a measuring machine). Original plates will normally be fitted with a cover glass. Reasons should be given if you cannot work with a cover glass.

REF. NO. T /

NAMES

6. PLATE (OR FILM) MATERIAL REQUIRED (NEW AND EXISTING)

FIELD NUMBER or OBJECT NAME (a)	RA (1950) DEC (of plate centre) or PLATE NUMBER (if known) (b)	EMUL (c)	FILT (c)	EXP or LIM MAG (d)	SEE-ING (max) arc sec (e)	AREA to be used	AUX. EQUIP. (f)	COPIES FILM/ GLASS (g)	NOTES

COMMENTS

NOTES:

(a) Use standard ESO/SRC survey field centres if possible. Otherwise give name of object (e.g. NGC 200). Give reasons in §5 for non-standard centre.

(b) Position required only for non-survey centres.

(c) If your request can be fulfilled by a standard survey-type request please indicate by writing e.g. "Survey R".

(d) Indicate clearly whether you are giving magnitude limit or time limit (i.e. not 20m which is ambiguous). For sky limited plates write "lim".

(e) The normal "seeing" limit for taking survey plates is 3 arc sec (45μ on the plate).

(f) Auxiliary equipment. If prism required write "P" and give full details of dispersion, orientation and wideing required in "COMMENTS". If sub-beam prism required write "SBP" - special area of interest should be given in "COMMENTS" as the plate centre may have to be moved to avoid special vignetting problems. (For other details refer to Handbook and Newsletter which will also give details of additional equipment as it becomes available).

(g) If you particularly wish to receive the original plate put "NO" and give reasons (refer to § 5). If you prefer a film or glass copy write "FILM" or "GLASS" as appropriate. (Note: film is much easier for handling and dispatch. The normal density of all copies is 0.5).

REF. NO. T /

NAMES

7. PHOTOGRAPHIC PRINTS AND ENLARGEMENTS

OBJECT NAME	RA (1950) DEC (of object)	FIELD NO. (a)	PLATE NO. (b)	FIND CHART (c)	PRINT SIZE (d)	MAGN (e)	CONTRAST (normal) (f)	PAPER (glossy) (g)	CO

COMMENTS

NOTE Orientation of N up and E left is assumed unless specified otherwise.
Negative prints (black stars on grey background) will be supplied unless otherwise indicated.

NOTES

(a) Give field number if known.

(b) Give plate number if it is essential that print is made from a particular plate.
Otherwise indicate waveband and allow UKSTU to select the most suitable plate. Indicate depth required to aid in this choice.

(c) Please tick if Finding Chart is supplied. Small objects nearly always require a finding chart or overlay.

(d) Indicate size of final print. Available sizes are:
(A) 100 x 125mm (4 x 5in)
(B) 200 x 250mm (8 x 10in)
(C) 400 x 500mm (16 x 20in) max

(e) Indicate magnification required. Choose from one of the following:
1x, 2x, 5x, 10x, 20x, 30x, 40x, (UKSTU plate scale is 67.1 arc sec/mm)

(f) CONTRAST Choose from: Low, Normal, High, Ultrahigh*, Special* (e.g. unsharp masking)
(normal assumed if no indication given).
*These techniques are laborious to apply and requests for them should be kept to a minimum and the requirement explained in § 5.

(g) PAPER Choose from Glossy or Matt (glossy assumed).

Appendix 2

RECOMMENDATIONS FOR HANDLING AND STORING UKSTU PHOTOGRAPHIC PLATES

The original photographs taken by the UK 1.2m Schmidt Telescope each represent irreplaceable scientific data and a financial investment of several hundred pounds. They are glass plates, 356mm square and 1mm thick, and are therefore very fragile. Furthermore, the photographic emulsions used are particularly sensitive to surface abrasion. Original plates may be supplied with a 2mm plain cover glass attached.

1. Any cover glass fitted should not be removed unless this is absolutely essential. The cover glasses are put on after special cleaning, and using a special type of adhesive tape. If a cover glass is removed, it should be replaced as soon as possible, taking great care that no dust or grit is trapped.

2. The emulsion side of a photographic plate (recognisable by its duller appearance under reflected light) MUST NOT be cleaned or brushed in any way except by using a blower or clean nitrogen gas jet.

3. NEVER put any ink, felt tip pen, or any other type of mark on the emulsion side of a plate. Fingerprints also cause irreparable damage; you should NEVER touch the emulsion side of a plate except at the extreme edges.

4. If an uncovered original plate is broken, it can often be temporarily repaired and made relatively safe to handle by joining the pieces with transparent adhesive tape. This must be used ON THE GLASS SIDE ONLY. If in doubt, please contact UKSTU staff for advice.

5. As a result of experience, we have devised some reasonably safe ways of handling plates and for getting them in and out of Tyvek envelopes. There are also some ways which are definitely NOT safe. Users who have not previously handled these plates should contact UKSTU for advice.

6. When plates are being inspected, they should be supported on all sides in suitable frames such as the perspex frames in use at ROE. (Please contact us for advice on the manufacture or purchase of such frames.) Light boxes should be comfortably larger than the supporting frames.

7. Uncovered plates should ALWAYS be placed EMULSION DOWNWARDS IN FRAMES. Airborne dust and dirt particles adhere to the emulsion surface and often cannot be removed without causing damage. Hand-held magnifiers and incautious fingers can also cause irreparable emulsion damage.

8. The fragile plates require safe storage when they are not in use. For most users with only a few plates the simplest method is probably to use the large yellow Kodak boxes in which plates are normally delivered. Users with many plates should arrange to have a suitable rack constructed. Plates should be stored vertically, in pigeonholes comfortably larger than the plates themselves. A plate storage area should be free from dust and not subject to extremes of temperature and humidity.

9. NEVER leave plates lying on a desk, shelf or any other flat surface. NEVER place books or papers on plates, and conversely DO NOT balance plates on piles of other miscellaneous items. These warnings may seem self-evident, but nevertheless such simple rules are broken far too frequently. So are the plates.

10. When plates have to be shipped from place to place, they must be firmly packed between sheets of polystyrene in large yellow Kodak boxes, so that the plates are not free to move if the box is shaken. If such a box is to be sent by commerical carrier, additional protection must also be provided, preferably a wooden crate with polystyrene lining, such as those used to airfreight plates from Australia. When possible and practicable, plates should be sent by personal carrier, provided the carriers are well aware of the value of the package entrusted to them. In general, the

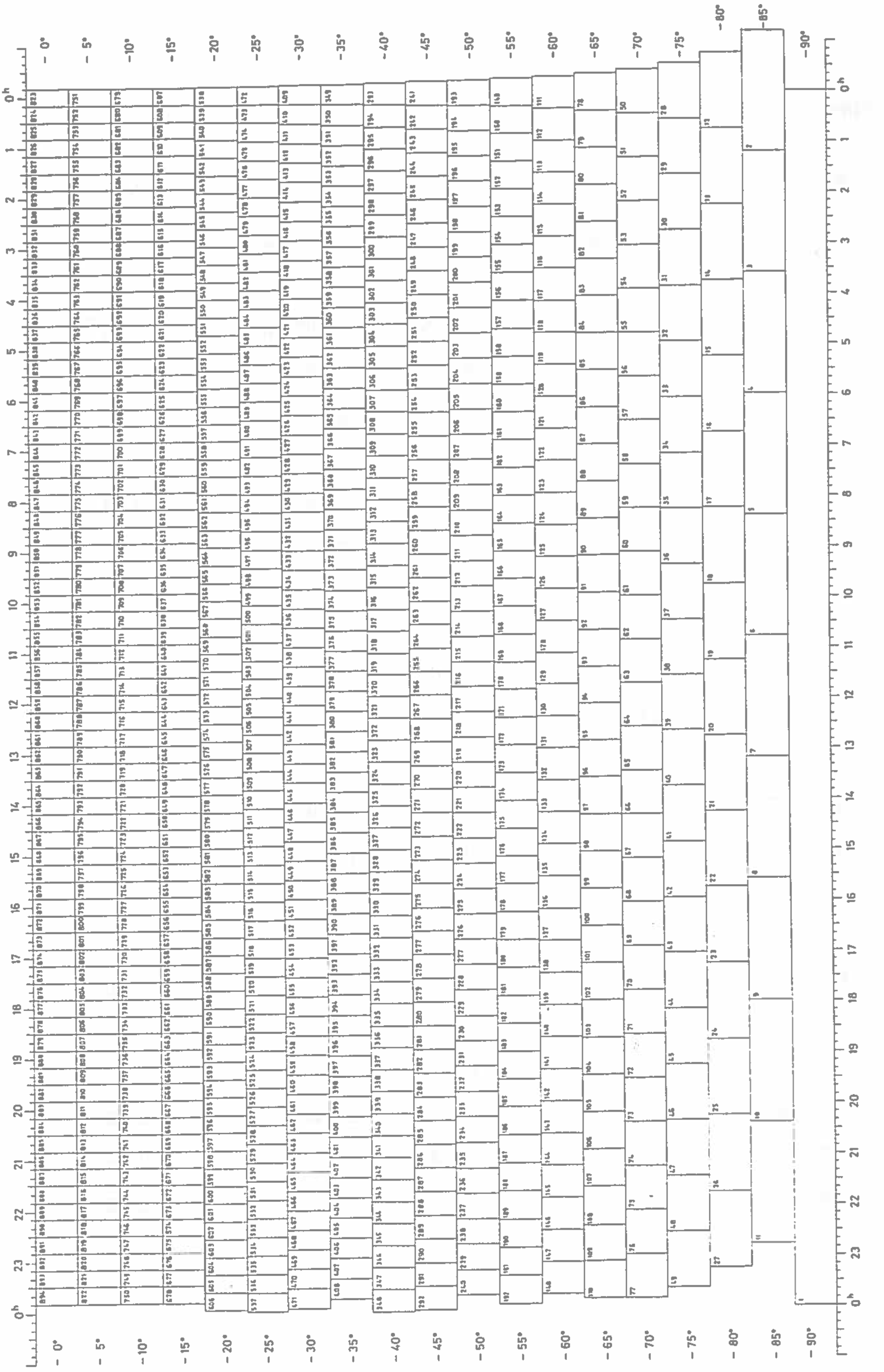
packaging in which you receive plates from UKSTU will be adequate for onward or return shipping by the same method as you received them.

11. Until mid-1981 two or more sheets of thin soft plastic foam were used as additional protection for the plates. This foam is now suspected of being a possible cause of 'gold spot' disease which is found on many IIIa-J (and some IIIa-F) plates. This foam is no longer used and users are asked to discard any foam found in the vicinity of their plates. Expanded polystyrene sheets are allowed packing material and have proved to provide sufficient protection for the plates during transport. Oil-based paints (and cooking oils!) are also suspected as being possible causes of gold spot and users are asked to ensure that their plates are not stored in recently painted areas or areas subject to cooking smells!

Appendix 3

STANDARD FIELD CENTRES

Field numbers	Declination	Right Ascensions		
1	-90°	00^h00^m		
2- 11	-85	from 00^h00^m	to 21^h36^m	in steps of 2^h24^m
12- 27	-80	00 00	22 30	1 30
28- 49	-75	00 00	23 06	1 06
50- 77	-70	00 00	23 24	0 52
78- 110	-65	00 00	23 28	0 44
111- 148	-60	00 00	23 26	0 38
149- 192	-55	00 00	23 39	0 33
193- 240	-50	00 00	23 30	0 30
241- 292	-45	00 00	23 48	0 28
293- 348	-40	00 00	23 50	0 26
349- 408	-35	00 00	23 36	0 24
409- 471	-30	00 00	23 46	0 23
472- 537	-25	00 00	23 50	0 22
538- 606	-20	00 00	23 48	0 21
607- 678	-15	00 00	23 40	0 20
679- 750	-10	00 00	23 40	0 20
751- 822	- 5	00 00	23 40	0 20
823- 894	0	00 00	23 40	0 20
895- 966	+ 5	00 00	23 40	0 20
967-1038	+10	00 00	23 40	0 20
1039-1110	+15	00 00	23 40	0 20



Standard field centres 1-894

Appendix 4

SOME KEY DATES IN THE DEVELOPMENT OF THE UKST

Date	Corresponding Plate Number	Event
1973 Jul 10	UR 15	First guided plate taken.
1973 Aug 17	-	Formal opening by Prof. Bengt Strömgren, President of the IAU.
1973 Sept 3	J 149	First fully successful deep IIIa-J plate. Telescope commissioning completed.
1974 Jun 17	J 637	First plate eventually to be used in SERC(J) Survey.
1974 Nov 4	B 987	Plate holder adjusted. On all previous plates the field was rotated by about ½° relative to a NS-EW grid.
1974 Nov 28	HA 1025	First plate with Meaburn mosaic H-alpha filter.
1975 Apr 28	J 1436	Introduction of optically worked filters.
1975 May 17	B 1489	Plate holder support spiders baffled to minimise ghosts.
1975 Jun 3	J 1541	First hydrogen hypersensitised IIIa-J plate.
1976 Jul 7	J 2420P	First use of low dispersion objective prism (P1).
1977 Apr 28	J 3153	Achromatic corrector plate fitted.
1977 Oct 7	J 3646	Motorised adjustment of polar axis elevation.
1978 Aug 30	B 4482S	First use of (INT) sub-beam prism.
1979 Mar 8	I 4839	Night sky photometer mounted on telescope.
1980 Feb 28	S2 5716	New 16-step calibration step wedge fitted permanently. (see section 6 for details).
1982 Mar 11	UR 7557P	First use of intermediate-dispersion prism (P3).
1982 May 17	U 7755S	First use of 'new' sub-beam prism
1982 Jun 11	R 7794	New dedicated processing line for IIIa type survey plates (attempt to prevent gold spot)
1982 Dec 3	R 8271	Nitrogen flushing of IIIa plates routinely used during exposure (also grid printed post-exposure).
1983 Aug 11	V 8751	'Corrected night sky brightness' given on observing card

Appendix 5

LIST OF USEFUL TECHNICAL REFERENCES

This list includes all references referred to in the text together with a few additional ones. If necessary, copies can be provided on request.

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14) Hartley, M. and Dawe, J.A., 1981, Proc.ASA 4, (2), 251, The SRC Near-Infrared Survey of the Galactic Plane.

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16) Blair, M. & Gilmore, G., 1982, Pub.A.S.P., 94, 742, Colour equations for the United Kingdom Schmidt Telescope.

17) Campbell, A.W., 1982, The Observatory 102, 195, Field Effects in UK Schmidt Telescope Plates.

18) Cannon, R.D., Dawe, J.A., Morgan, D.H., Savage, A. & Smith, M.G., 1982, Proc.A.S.A. 4 (4), 468, The Medium Dispersion Prism of the UK Schmidt Telescope.

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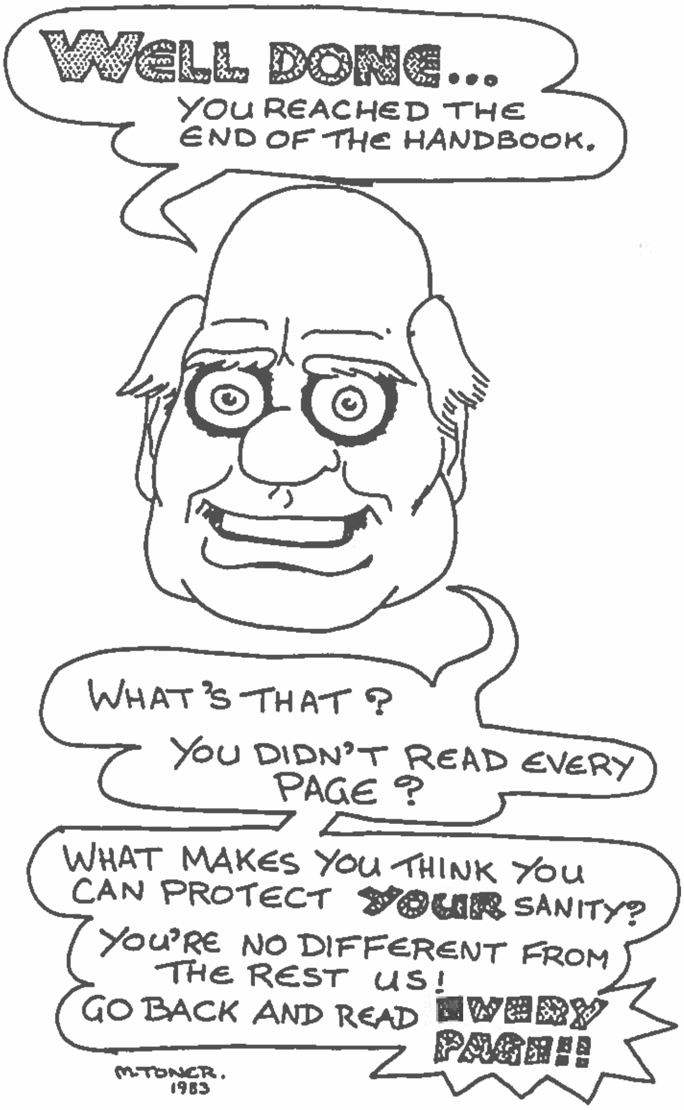
WELL DONE...
YOU REACHED THE END OF THE HANDBOOK.
WHAT'S THAT ? YOU DIDN'T READ EVERY PAGE ?
WHAT MAKES YOU THINK YOU CAN PROTECT YOUR SANITY? YOU'RE NO DIFFERENT FROM THE REST US! GO BACK AND READ EVERY PAGE!!
M. TONER. 1983