Newsletter

Quarterly Newsletter of the Indian Institute of Astrophysics

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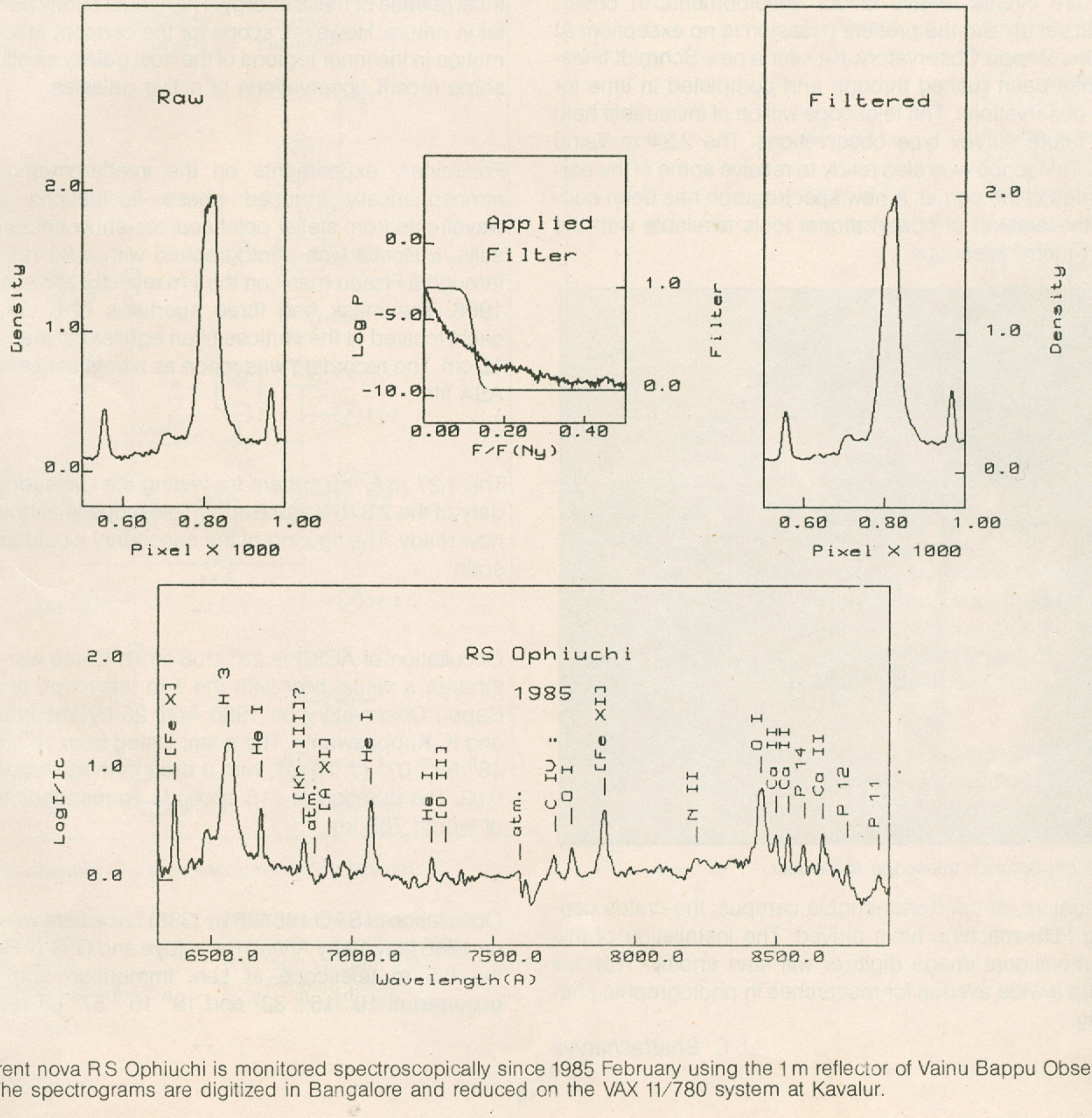


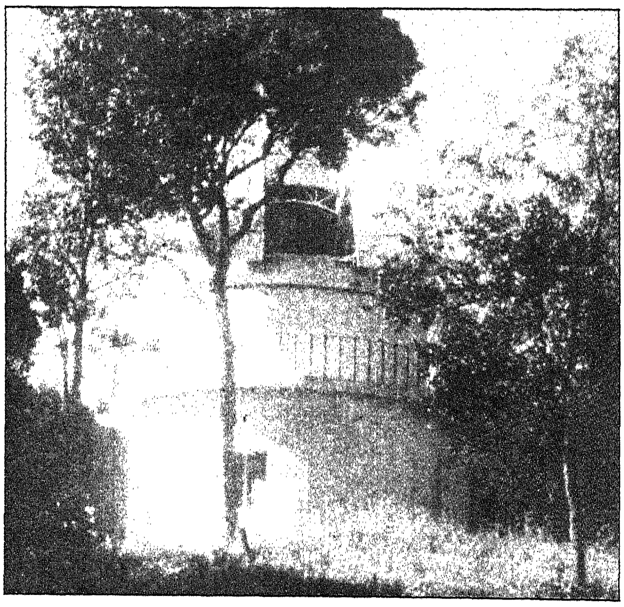
The recurrent nova RS Ophiuchi is monitored spectroscopically since 1985 February using the 1 m reflector of Vainu Bappu Observatory, Kavalur. The spectrograms are digitized in Bangalore and reduced on the VAX 11/780 system at Kavalur.

from the director

Comet Halley has once again passed through our neighbourhood. The unprecedented advancement in instrumentation capability this time has resulted in a rich haul of observational data. The comet has been observed through many telescopes, at many observatories, using an array of focal plane instruments, which are more versatile than anything used before for such observations. All these observations coupled with those obtained from spacecrafts probing close to the comet will no doubt answer many questions accumulated over the ages.

We had arranged for a comprehensive coverage from India. Four regular observatories at Kodaikanal, Kavalur, Japal Rangapur and Naini Tal, all played their roles to record a series of photographic, photometric and spectroscopic observations. Other temporary stations were set up at several places in the country to obtain various records from plain photographs to high-resolution spectrograms. Thousands of amateurs joined the efforts to understand the enigmatic celestial object.

Such rare events always favour developments in observational set up and the present occasion is no exception. At the Vainu Bappu Observatory, Kavalur a new Schmidt telescope has been rushed through and completed in time for Halley observations. The telescope will be of invaluable help for all future survey type observations. The 2.34 m Vainu Bappu Telescope was also ready to receive some of the early pictures of the comet. A new spectrograph has been added to the arsenal of observational tools available with the Zeiss 1-metre telescope.



The 45 cm Schmidt telescope at Kavalur.

In Bangalore, at the Koramangala campus, the crates containing PDS machine have arrived. The installation of this two-dimensional image digitizer will start shortly. This will open up a wide avenue for researches in photographic photometry.

J. C. Bhattacharyya

newsline

Lower Bounds on Axion Rest Mass in a General Cosmological Scenario, a paper submitted by B. Datta and P. S. Joshi (TIFR) to the Gravity Research Foundation (USA) for their 1986 essay competition, has been awarded honourable mention. On the basis of general properties and the large scale structure of spacetime, they derive general lower limits to the rest mass of the axion, assuming that axions make up the dark matter in the universe. These limits on mass are derived in terms of the possible age of the universe.

* *

Similarly, the work entitled *Central Engine or Locomotive?,* by R. C. Kapoor has been awarded honourable mention by the Gravity Research Foundation. This work discusses the astrophysical aspects of proposals of escape of supermassive black holes from galactic nuclei and their implications in relation to quasars. The work concludes that high-velocity recoil of the central engine can at best be considered an exception rather than a rule since it requires a violent asymmetrical release of mass energy. This would surely be spectacular in nature. However, scope for the concept of low velocity motion in the inner regions of the host galaxy exists in view of some recent observations of active galaxies.

* *

Preliminary experiments on the interferometric study of atmospherically induced phase fluctuations in optical wavefronts from stellar point sources show encouraging results. α Bootis was photographed with a 33 ms exposure through a Fizeau mask on the 1 m reflector at Kavalur in May 1986. The mask had three apertures of 6 cm diameter each, located at the vertices of an equilateral triangle of side 15 cm. The recording was made as a time sequence on 320 ASA film.

* *

The 1.27 m F/1.5 sphere for testing the Cassegrain secondary of the 2.3 m Vainu Bappu Telescope is aluminized and now ready. The figuring of the secondary would commence soon.

* *

Occultation of AGK3 + 23° 1108 by (1) Ceres was recorded through a visual filter with the 1 m telescope at the Vainu Bappu Observatory on 1986 April 26 by Vasundhara Raju and K. Kuppuswamy. The event lasted from $16^h\ 56^m\ 12^s$ to $16^h\ 58^m\ 07^s$ ($\pm\ 1^s$) UT, with a drop in magnitude of 0.24 ± 0.03. The duration of 115 seconds corresponds to a chord of length 768 km.

* *

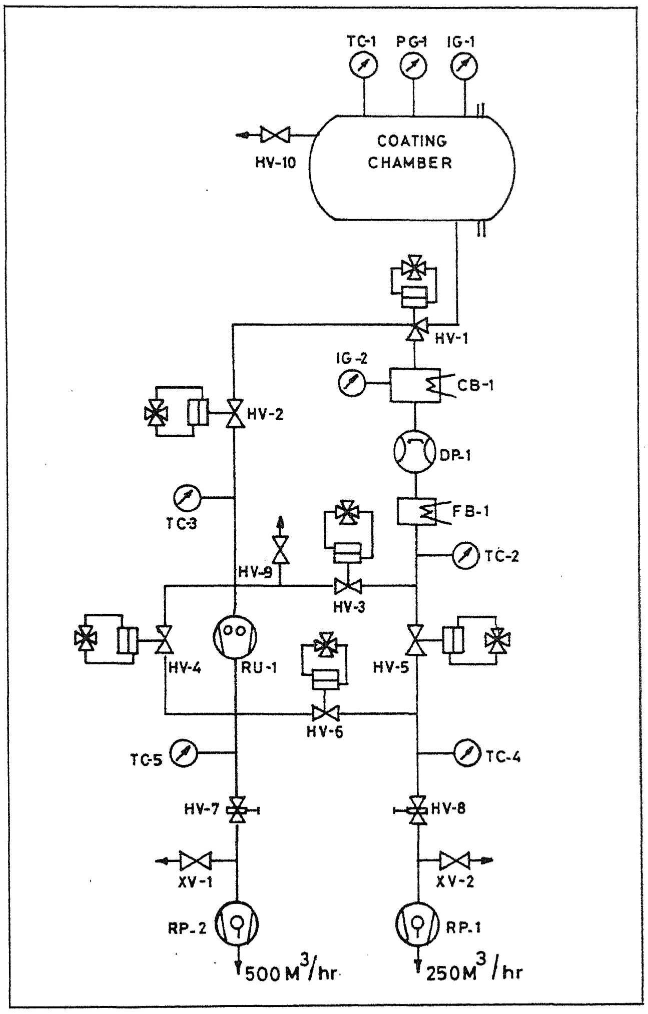
Occultation of SAO 185428 by (336) Lacadiera was recorded on 1986 May 12 by Arvind Paranjpye and G. S. D. Babu using the 0.5 m telescope at Leh. Immersion and emersion occurred at $19^h\ 15^m\ 32^s$ and $19^h\ 15^m\ 57^s$ UT respectively.

* *

Vacuum Coating Facilities

The 2.8 m vacuum coating plant commissioned in 1984 and 1.5 m vacuum coating plant commissioned in 1978 form an in-house facility at the Vainu Bappu Observatory, Kavalur for periodic aluminizing of the telescope mirrors and other optics. High quality surfaces up to 2.4 m diameter can be coated using these plants. Latest methods of system control, automation and measurement have been incorporated in these units. These plants were designed, fabricated and commissioned with the help of the Bhabha Atomic Research Centre (BARC), Bombay.

The 2.8 m vacuum coating plant was used for the first aluminizing of the primary mirror of the 2.34 m Vainu Bappu Telescope in August 1985. It has been used for other applications requiring metal coatings by the vacuum evaporation technique.

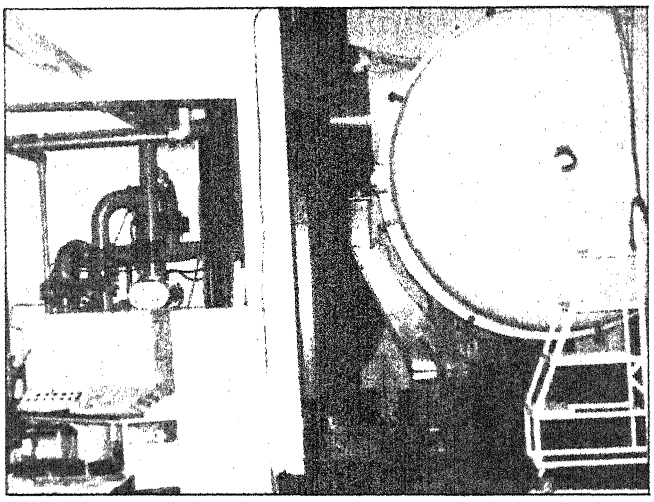


Schematic diagram of 2.8 m vacuum coating system.

Legends:

DP: diffusion pump,
FB: foreline baffle,
RP: rotary pump,
TC: thermocouple gauge,
IG: BA gauge,
AO: air operated.

CB: Chevron baffle,
RV: roots vacuum pump,
HV: high vacuum valve,
PG: Penning gauge,
XV: air admittance gauge,



2.8 m vacuum coating plant.

Typical performance of the 2.8 m vacuum coating plant system.

Time min	Pressure torr	Remarks
0	Atmosphere	Engaging of RP
25	1×10^{-1}	As measured with TC 1. Engaging of roots pump
40	6×10^{-3}	DP connected with RP 1 backing
70	4.2×10^{-5}	Baffle cooling −30°C
90	2×10^{-5}	As measured with discharge guage. DP with roots pump backing. Baffle temp −30°C
135	1.5×10^{-5}	As measured with discharge gauge

(Ionization gauge shows a better vacuum: 6×10^{-6})

RP: rotary pump, TC: thermocouple gauge, DP: 89 cm fractionating oil diffusion pump. Roots pump capacity is 1800 m³/hr.

The 1.5 m vacuum coating plant has been in continuous use since June 1978. Satisfactory aluminizing of many astronomical mirrors including periodic aluminizing of 1.2 m primary mirror of Japal Rangapur observatory and 1.02 m primary mirror of the Kavalur 1 m telescope have been done using this plant.

A 12 inch coating plant for small individual jobs is available for periodic needs of the Institute at Bangalore. This plant is used also for experiments on different types of coating and coating materials, besides aluminizing small mirrors.

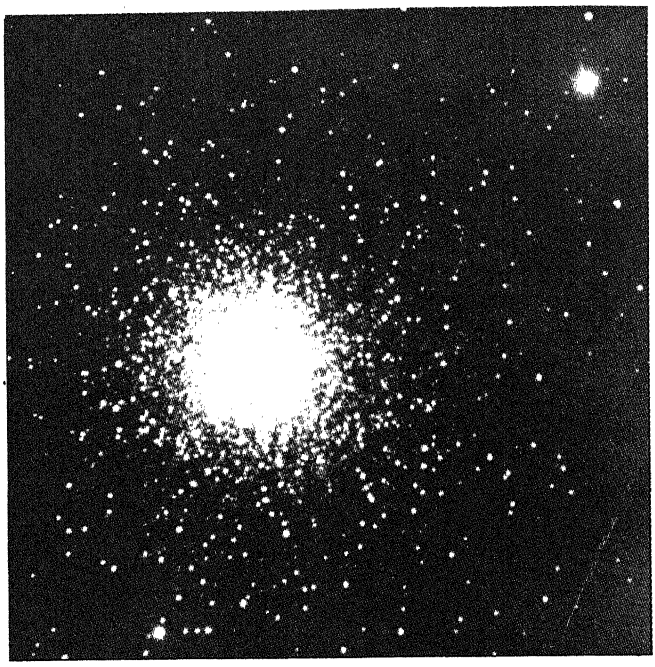
A. K. Saxena

instrumentation

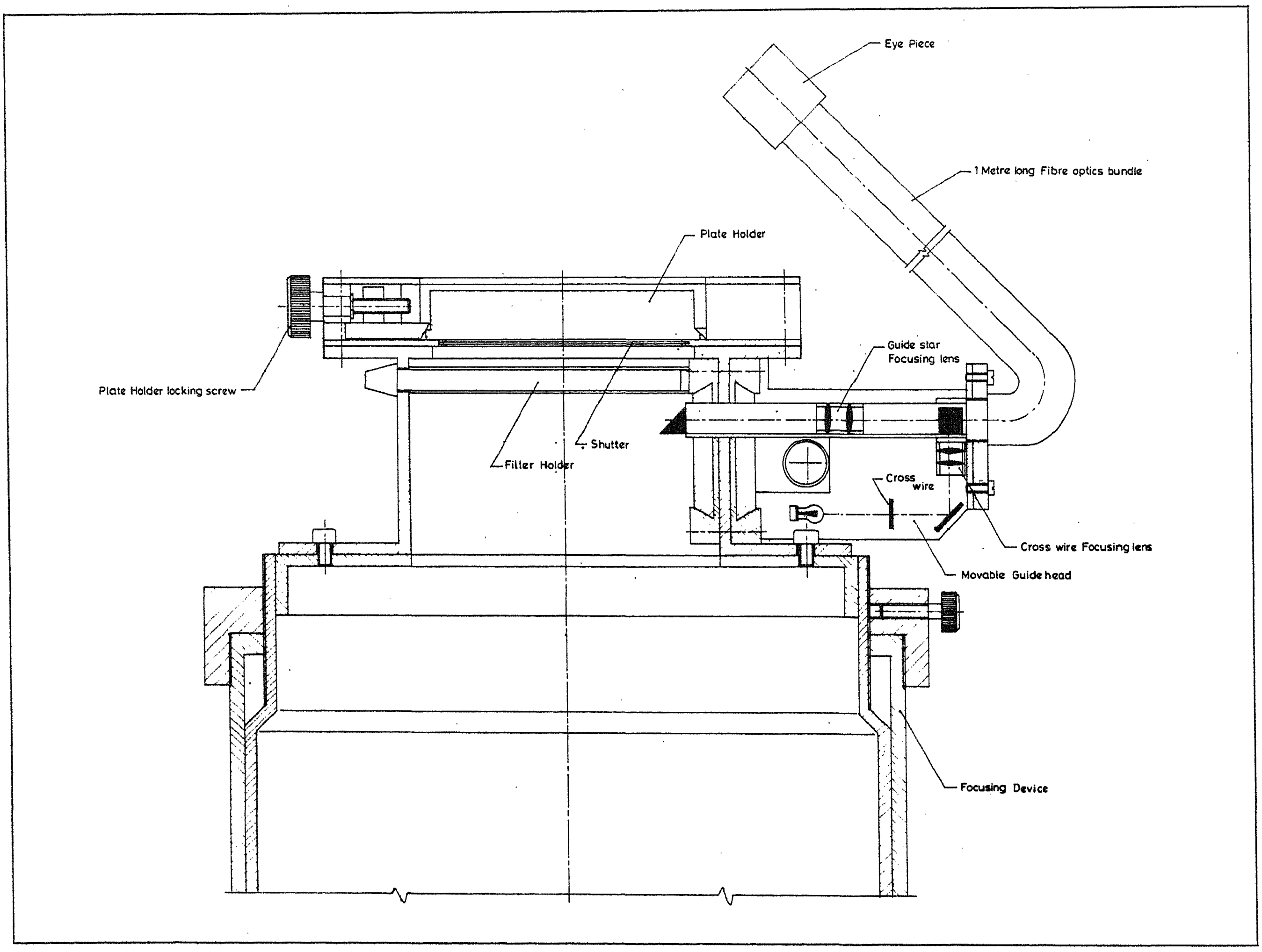
Prime-Focus Camera for the 2.3 m Telescope

There is a sustained interest in prime-focus photography since it combines the advantages of a fast *F* ratio and large light-gathering power of large-aperture telescopes, enabling one to obtain deep sky photographs at good resolution. The 3-element Wynne corrector at the *F*/3.25 prime focus of the 2.3 m Vainu Bappu telescope provides 40 arcmin field at an image scale of 29 arcsec/mm. The plate-holder using 10 cm × 10 cm filter and 8 cm × 8 cm plate allows capturing the entire field.

The small area available at the prime focus of the 2.3 m telescope posed problems in designing a guiding system. This was solved by using a fibre-optic image transfer bundle of 10 mm × 8 mm cross-section and 1 m length. A small mirror fixed on to a moveable arm enables the selection of a guide star from the edge of the field. The arm can move in only one direction, but the plateholder can be rotated to access any star located in an annular area at the periphery of the field. The guide-star is reimaged with slight magnification on the input of the fibre-optic bundle. The output end can be positioned by the observer in any convenient location.



The globular cluster M3 in Canes Venatici photographed at the prime focus of 2.3 m telescope on 1986 April 4. Kodak 103aO emulsion, exposure time of 30 min.



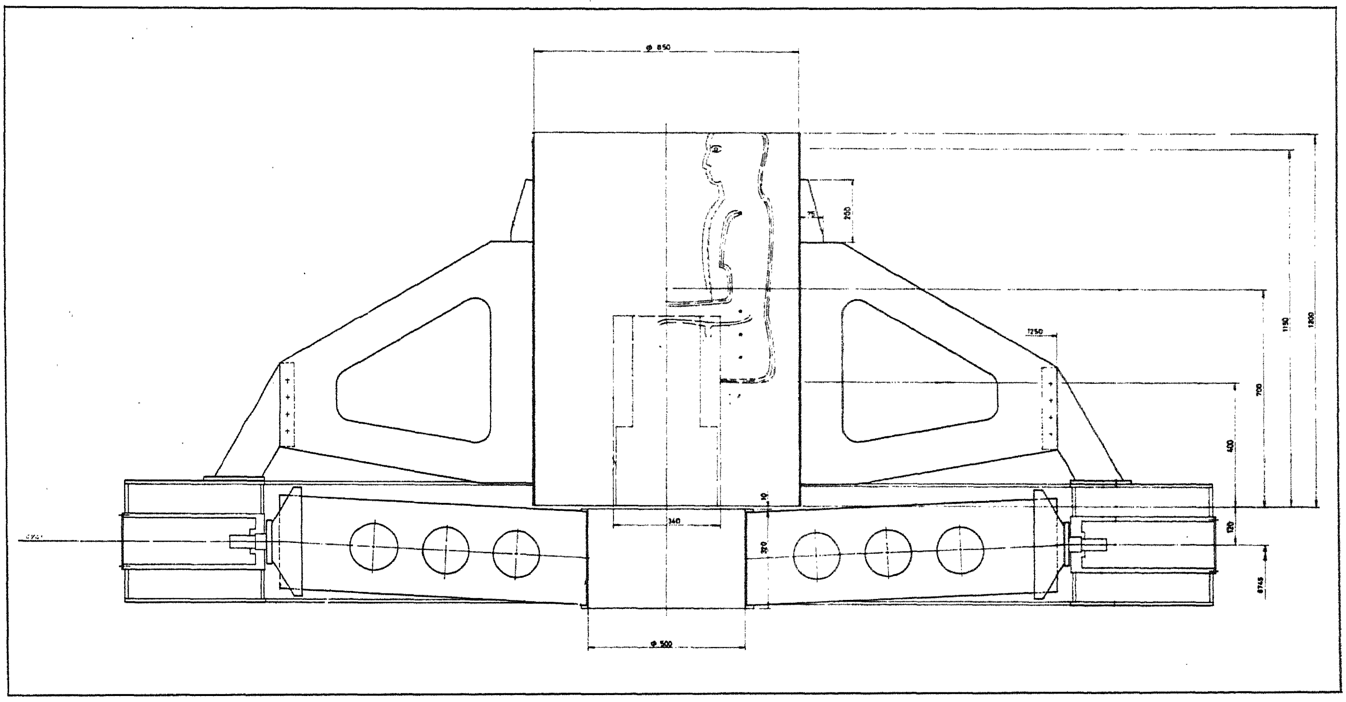
Design of the prime-focus plateholder.

K. K. Scaria, S. C. Tapde & J. C. Bhattacharyya

The Prime Focus of the 2.3 m Telescope

Though the prime focus is a regular feature of large-size telescopes, the telescopes of intermediate size do not offer sufficient space for an observer to sit and observe comfortably without obstructing more than 15% of the incoming beam. In the case of the 2.3 m Vainu Bappu Telescope it was just possible to design an optimized prime focus.

The top ring of the telescope tube supports two systems of spiders, one for the observer's cage, and the other for the Wynne corrector and the instrument. This allows the observer to move about without disturbing the instrument. The observer's cage obstructs no more than 15.5% of the incoming beam. Although the space in the cage is constricted the swivel chair in it allows the observer to take fairly comfortable positions in all the orientations of the telescope tube. An automated version of the prime-focus cage is planned for remotely operated instruments. Since the observer is not riding in it, it will become possible to mount larger instruments.



Design of the prime-focus cage..

S. C. Tapde

The Computer-controlled Zeiss Microdensitometer

The Carl-Zeiss microdensitometers (Mark G II and G III) are available at the Institute for analysis of photographic plates. A need for digital data for more objective and efficient reductions led to the automation of one of these. The first attempt resulted in interfacing the microdensitometer with a desktop programmable calculator HCL Micro-2200 (Viswanath 1980 : *Kodaikanal Obs. Bull. Ser. A* **3**,57). The deflections could be digitized at fixed 8 μ m intervals in blocks of 100 values at a time and stored on minifloppy discs. The chart-recorder output of 0-10V was digitized between numbers 0-1024. Certain amount of reductions like smoothing by weighted averages, averaging of spectra, line identification and wavelength scale determination, 'scrunching' to uniform wavelength scale etc. could be carried out on the same programmable calculator (see *e.g.* Giridhar 1983 : *J. Astrophys. Astr.* **4**,75).

Subsequently, a new system was developed as a peripheral of the ECIL TDC-316 minicomputer (Ananth 1985 : *Kodaikanal Obs. Bull. Ser.* A **5**,37). This facilitated the logging of data on 9-track magnetic tapes for subsequent analysis either on the TDC-316 or at any other computer system, *e.g.* VAX 11/780 at Vainu Bappu Observatory, Kavalur.

The system hardware consists of (a) TDC-316 cpu, (b) 28 KW memory, (c) One magnetic tape unit, (d) One teletypewriter, (e) the real-time subsystem consisting of the real-time clock, analog input subsystem, digital input/output subsystem with functional modules consisting of contact interrupt and monoshot driver.

The table is driven by a stepper motor through gears. Each step of the motor corresponds to 4 μ m displacement. The digitization interval can be set to a multiple of this value. The stretch of plate that can be scanned at one go is 1-120 mm, in integral number of millimetres. The limit switches on either side of the clear 120 mm length of the platform help in stopping digitization and warning the user of the limit. The microdensitometer is capable of digitizing only in one dimension.

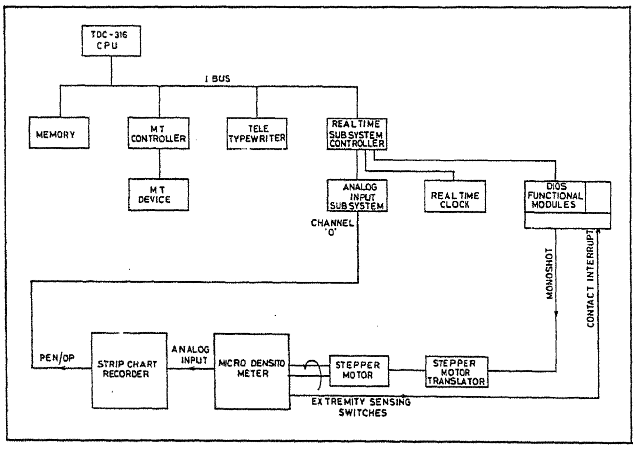
The 0 to 10 V signal of the stripchart recorder is digitized to integers between 0 and 2048 using a 12 bit (binary two's complement output) successive approximation type analog-to-digital converter with a conversion time of 40 μ s. This enables a digitization speed in the range of 4 - 400 μ m/s in steps of 4 μm/s. The analog chart output is available parallel to the digital output to facilitate a hard-copy record.

The digital data consist of a header of 36 card images, provided by the user. The data are arranged in records of 1000 points (2 K Bytes) or less in the case of last record. The numbers are stored in binary form while the digitization is in progress.

The speed and intervals of digitization, the length of the plate to be scanned, the direction of scan, the header details and such other information is fed to the computer in the initial dialogue phase. The conversion is halted under the following conditions: (1) after the specified length of the table is scanned, (2) interrupt by the user, (3) encounter with the limit switches.

```
MODE OF SCANNING ? LIN
TABLE SIZE IN X DIRECTION IN MM :5
RESOLUTION IN MICRONS :4
SCANNING RATE IN X DIRECTION :10
TABLE POSITION O.K ? Y
HEADER DETAILS ? Y
D 3206 : 57 SER, STANDARD FOR RS OPH, CLEAR
END
MOUNT MAGNETIC TAPE ON UNIT ? Y
ANY FILES TO BE SKIPPED BEFORE CONVERSION ? N
FORWARD SCAN ? Y
START CONVERSION ? Y
TOTAL NO. OF SAMPLES—1250
TOTAL NO. OF RECORDS—2
CONVERSION OVER
EXIT ? N
TABLE SIZE IN X DIRECTION IN MM :
```

An independent MACRO assembly language program helps the conversion of ASCII header and binary data into standard EBCDIC characters and their storage on the magnetic tape in a standard disc operating system format. The output files are organized as unlabelled tape files and records are stored as 80 character card images. Each record begins with the number of points in the record (1000 for all records except the last one for which it may be less.)



A. V. Ananth

software

Reductions of Photographic Spectra

The capability of digitizing photographic data at IIA, coupled with the installation of VAX 11/780 system with graphic terminals at Kavalur, has induced the development of software incorporating standard techniques of digital reduction. A set of programmes are now available for handling the spectroscopic data and for reducing them interactively.

During the digitization, the data are stored in different files corresponding to the calibration plate, the spectrum of interest, and the standard star if photographic spectrophotometry is desired. For each plate, the clear and dark scans are stored in separate files. If an image-tube is employed in spectroscopy, the background adjacent to the spectrum is also digitized. All these data are stored on the magnetic tape in EBCDIC code at a density of 800 bpi.

First, a simple routine helps in converting the data into ASCII card images and in storing on a labelled tape at higher densities (1600/6250 bpi). A second routine helps in copying from tape to the disc all the files related to a particular plate number (which should be in the header).

A Fortran program helps in averaging clear and dark scans and in fitting a polynomial of desired degree to the image tube background.

The calibration trace is initially smoothed by weighted running averages and steps are identified interactively. This helps in choosing the 'clean' parts of the steps, avoiding blemishes. The characteristic curve is determined as a polynomial of low degree in Baker transformed densities (log ω) and log E, where E is the relative exposure. The same routine also helps in averaging a set of characteristic curves interactively, if desired.

The averaged clear and dark, and the polynomial fits to the tube background are appended to the data of the spectrum. The characteristic curve stays as a separate file, but is identified.

The main reduction of the spectrum is begun by activating the routine SPECTRUM. The first step is to convert the deflections into densities and to obtain a smooth power spectrum of the data. Smoothing of power spectrum is achieved by segmental averaging. The entire length of data ($\leq$ 4096 points) is divided into a desired number of segments, the power spectra of all segments are averaged and displayed on the screen. One may then choose a low-pass filter, or alternatively an optimum filter based on modelling of the signal and noise. At present, the optimum filter assumes Gaussian profiles. The spectrum is smoothed by applying the filter in the Fourier domain, the densities are converted into relative intensities, background is subtracted if desired, and the smoothed spectrum as log I values against pixel number may be examined on the monitor.

The next step involves reduction to the continuum intensity (or "regularization"). A choice of methods are provided in the main routine:

(1) automatic determination of pseudocontinuum (with a choice of emission/absorption spectrum),

(2) examining the histograms of segments of spectra and determining by an automatic/interactive method the mean level of continuum in the segment,

(3) determining the continuum by extreme low-pass filtering of the smoothed spectrum.

The bad points can be discarded in methods (1) and (2) and polynomial fit obtained for the continuum, if so desired. Alternatively, one may spline-interpolate between the continuum points.

The wavelength scale is determined either from the comparison scan (with/without smoothing and intensity conversion), or by identifying the lines in the spectrum itself. Note that with the present microdensitometer, it is not possible to fix the zero-point of the scan accurately. Hence, if the wavelength scale is determined using the comparison spectrum, a few lines of the star spectrum are identified and the zero point is determined. The present microdensitometer is not suitable for radial-velocity measurements and hence the wavelength scale is determined only to facilitate other kinds of spectrophotometric reductions.

The determination of the wavelength scale is centred on a peak-and-dip finding routine. The wavelengths of the emission/absorption lines so determined may either be fed interactively, or taken from a line-list. In the latter case two wavelengths and pixel numbers at either ends of the spectrum are provided to facilitate automatic identification of lines. The wavelength scale is determined as a polynomial fit both in wavelength as a function of position and the position as a function of wavelength.

The continuum is then added back to the spectrum if desired, and the spectrum 'scrunched' to a linear wavelength scale using cubic spline interpolation. If the spectrum corresponds to the standard star, corrections for the instrumental response are obtained by comparing with absolute fluxes/magnitudes stored in a separate file. If it is the programme object, the corrections are applied by spline interpolation. Thus the final spectrum is obtained either as regularized intensities, or relative fluxes as a function of wavelength. The routine uses extensively the Digital ReGIS graphic library (RGL) for the display of high resolution data and the run-time library to put characters on the screen for low-resolution plots (20 × 80 characters).

The final spectrum can be examined on a Tektronix 4115 terminal using the routine FIGS. This routine employs the Tektronix interactive graphic library (IGL) and enables preparation of final figures even as a superposition of different spectra and helps writing wavelength identification labels for lines listed in a separate file. These figures can be printed on the colour copier. If working plots are desired, one may employ the routine based on PLXY software for a plot on the Printronix printer/plotter.

T. P. Prabhu

new sites

Leh : A High Altitude Site Survey Observatory

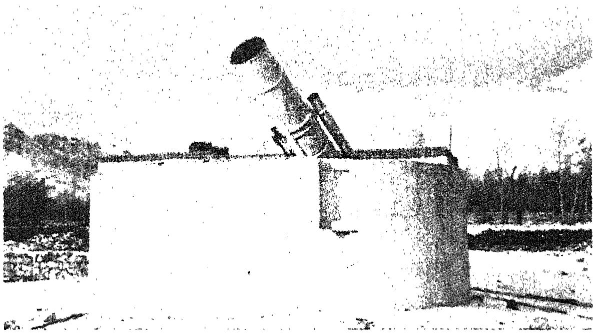
Situated in the state of Jammu and Kashmir in the Ladakh region, at an altitude of about 3300 m above sea level, the High Altitude Site Survey Observatory at Leh functions under the auspices of the Department of Science and Technology (DST). The following reasons favoured the choice of this site. (1) It is a high altitude desert with low atmospheric moisture content resulting in low infrared absorption. (2) The monsoon never reaches this part of the Himalayan ranges resulting in clear skies when rest of the country is cloudy. (3) Air travel to Leh is possible during the winter months when the roads may be closed. (4) There are several peaks in the region, ranging up to heights over 4000 m, from which the final site may be chosen in future for a full-fledged observatory.

The possibility of an astronomical site at Leh was first envisaged by M. K. V. Bappu and Homi J. Bhabha. A national committee was formed by DST and the station inaugurated in October 1984. IIA is among the institutions which have shown a keen interest in the project. It has provided a 50 cm reflector equipped with a photoelectric photometer and has been sending observers regularly both for site survey observations and serious astronomical observations.

A major problem faced in photoelectric observations was the malfunctioning of the electronics due to low ambient temperature (–28°C in winter). Incorporating heater elements in the system, it is now possible to observe at ambient temperatures reaching –10°C.

Bhavnagar Telescope

The 50 cm (20-inch) reflector at Leh has an interesting history. It is a Grubb telescope purchased during the last decade of the nineteenth century for an observatory in Poona, partially funded by, and named after, Maharaja Takhtasinghji of Bhavnagar. After the demise of K. D. Naegamvala, the director, the observatory was closed in 1912 and the instruments transferred to Kodaikanal observatory through a government order.



Due to various reasons the telescope was not commissioned at Kodaikanal until A. K. Das took keen interest in it in 1951. During the subsequent years, it was used for observing Mars. M. K. V. Bappu equipped it with a spectrograph in the sixties, and the 'Bhavnagar telescope' served as a major facility in the country for stellar spectroscopy for nearly a decade.

of human elements

Data storage and retrieval

His [Kepler's] early days at Benatsky Castle were spent in a state of intellectual shock. For the past six years he had worked in isolation – a loner, working with inadequate data. Suddenly, he had data by the cartload. And it led to problems that were so great 'that I nearly went out of my mind'. But he saw at once that Tycho lacked the organizing intellect to make proper use of all this material, and that he, Kepler, was destined to be the architect of the grand design.

Tycho himself realized this, and it made his attitude to Kepler highly ambivalent. He clung to his data like a miser, releasing it in dribs and drabs, sometimes in a casual remark made at meal times. Kepler was desperate but determined; his mind locked onto the problem, and bulldog-like he tugged grimly.

Colin Wilson in 'Starseekers'

Hodder and Stoughton, London, 1980

out of context

...It is useful to construct a model for the run of density and velocity between the Sun and Earth that is model independent and based solely upon observations.

Space Sci. Rev. (1986) **43,** 108.

* *

Theoretical models computed by...predicted observed fluxes...

Astr. J. (1986) **91,** 130.

* *

...and by using the actual spectra themselves, nearly all the stars could be accurately typed.

Thanks also to...for her excellent typing abilities...

Astr. J. (1986) **91,** 173, 176.

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