9. COMMISSION DES INSTRUMENTS ASTRONOMIQUES

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INTRODUCTION

The great increase in the number of students going into astronomy as a result of current interest in astronomical problems is producing a rapidly growing demand for observational facilities. Present facilities are so inadequate to meet this demand that it is now evident that the rate of progress in many fields of observational astronomy during the present decade will be set primarily by the availability of time at large telescopes. In an effort to meet this need at least eight projects for the construction of new telescopes with apertures of over three meters have either been started or are under serious consideration. Half of these are planned for the northern hemisphere and half for the southern. Unfortunately only a small fraction of these projects have assured financial support at this time.

In making plans for these telescopes serious attention is being given, not only to duplicating present instruments, but to providing telescopes with capabilities well beyond those now in use. Thus several of the projects are making new attacks on the problem of corrector systems for substantially enlarging the field of reflectors of small focal-ratio. If successful this will make possible survey programs of faint objects that are beyond the range of Schmidt cameras with their limited focal length. Consideration is also being given to the selection of focal ratios that make optimum use of the speeds of present day photographic plates. In many cases this will add as much as 0·5 to 1·0 magnitude to the limiting magnitude that can now be photographed by present telescopes of the same aperture.

Recent studies have brought the realization that for most observations both direct and spectrographic, the limiting magnitude attainable with a telescope varies as rapidly with the reciprocal of the angular diameter of the 'seeing' image as it does with the aperture. A number of the projects for new large telescopes have therefore undertaken extended surveys of 'seeing' conditions at many of the possible sites for these instruments. In addition investigations have been started in an effort to understand the basic causes of 'seeing' and their relationship to other meteorological factors.

The effectiveness of all telescopes both present and future has been substantially increased through improvements in radiation detecting, recording, and measuring devices. Especially notable have been the development of infra-red detectors of greatly increased sensitivity and range and the application of computer techniques to the rapid automatic recording of data at the telescope and to the processing of the data. Many of these advances are noted in the following reports from the Observatories.

PROGRESS IN INSTRUMENTATION

National Observatory of Argentina, Cordoba. J. Landi Dessy reports a project for the construction of a 40-inch telescope. In connection with these plans an extensive study of the properties

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of the Ritchey-Chrétien system and distortion free aplanatic telescopes has been made. The results are being published in *Memorie de la Societá Astronomica Italiana.*

La Plata Astronomical Observatory. Carlos Jaschek reports that the following auxiliary equipment has been constructed for the 32-inch La Plata reflector: (1) a photo-electric photometer of conventional design, (2) a Meinel camera giving an equivalent focal ratio of 3·5, (3) an aluminizing equipment for the primary mirror, and (4) a grating spectrograph of the Platzeck-Gaviola type (three-mirror optics), giving a dispersion of 90 Å/mm (λλ 3400–4900). Except for the spectrograph, the equipment is already working satisfactorily. Jorge Sahade reports the project for acquiring a duplicate of the 84-inch Kitt Peak reflector is progressing: The 84-inch mirror blank and the blanks for the secondary optics have been received from Corning. A new building for the optical shop is under construction.

National Standards Laboratory C.S.I.R.O., Sydney. A site has been selected at Culgoora, near Narrabri, in northwest New South Wales, for a new solar observatory. The largest telescope will be a high-resolution instrument designed for the direct photography of the fine structures of the solar chromosphere, particularly those in active regions. It will be basically a 12-inch equatorially-mounted refractor, and careful precautions will be taken to remove all sources of heating within or near the telescope. A solar-seeing monitor will be used to trigger off the exposures at moments of very good seeing in the manner described by Bray and Loughhead (1961).

Another instrument to be installed at Narrabri will be a 'cine-magnetograph' designed by Giovanelli. It will be carried on an equatorial mount with a new flare-patrol telescope, and will permit magnetic fields to be mapped over the entire surface of the Sun with a resolution of about 5″ of arc. The principal innovation will be the use of a series of four Fabry-Pérot interferometers as a tunable monochromator with a pass-band of 1/50 Å; the parallelism and separation of the interferometer plates will be servo-controlled by a method recently developed by Ramsay (1962). Another feature of the new instrument will be the use of television techniques in the recording and reduction of the observations.

Mount Stromlo Observatory, Canberra. T. Dunham, Jr. reports progress on the completion of the large coudé spectrograph for the 74-inch reflector as follows: Three cameras of focal length 8, 32, and 120-inches are now in use. A camera of 10-inch focal length with a double-meniscus corrector of the Arnulf-Lyot type is under construction and cameras of focal length 18 and 60 inches are being designed. The circulating water temperature control system is found to hold the temperature constant to 0·2° during a night without thermostating and to much better than this when thermostating is applied (Dunham, 1962).

Royal Observatory of Belgium, Uccle. E. Vandekerkhove reports the design and construction of a mechanism that permits the graphic transformation and rapid recording of the microphotometry of a stellar spectrum plate (wavelength and transmission) and a corresponding record (wavelength and intensity of incident light) determined from the calibration curve of the plate (Vandekerkhove, 1962 a). Equipment for the photography of artificial satellites (Vandekerkhove, 1962 b) and a comparator (Vandekerkhove, 1962 c) have also been developed.

Dominion Observatory, Victoria. G. M. Sisson reports that the 48-inch reflector constructed by the Grubb Parsons Company is equipped for work at the Cassegrain focus behind the mirror cell (*f*/18) or at two alternative Cassegrain focal stations at faces of the cube located at the upper end of the Polar axis. The telescope also feeds light into a horizontal spectrograph room (*f*/30) adjacent to the dome building. Allowance has been made in the design for work in the future at the prime focus (*f*/4) if desired. Presetting facilities have been supplied by means of which R.A. and Dec. settings can be specified for two selected stars after which the instrument will proceed to either of these chosen positions on command to within one minute of arc.

Ondřejov Observatory, Czechoslovak Academy of Sciences. Boris Valniček reports that the solar department is now equipped with a flare spectrograph working in 8 spectral regions at 1 Å/mm dispersion. The imaging mirror has a focal length of 14 meters, the collimator eight meters, and cameras five to seven meters. The solar department is also equipped with a spectrohelioscope, a Lyot-filter chromospheric telescope and a space velocity coronograph, a new instrument developed for Doppler shift observations in the H alpha line, simultaneously with the recording of direct images of the prominences. To be completed in 1965 is a horizontal solar telescope of 35 meter focal length and with a 10 meter focal length spectrograph, for high dispersion work in connection with a solar magnetograph. Recently a 20/300 centimeter coronograph has been delivered by Zeiss-Jena and installed at the mountain station Lomnicky Štit at an elevation of 2630 meters.

For stellar astronomy the observatory is equipped with a Cassegrain reflector of 65 cm aperture and 11 meters focal length for photo-electric photometry. A second instrument of the same type for stellar spectroscopy is expected to be completed in 1964. A large reflector of 200 cm aperture, equipped with Cassegrain and coudé spectrographs, is under construction at the Zeiss-Jena factory with installation at Ondrejov planned in 1966–67.

Helwan Observatory, Cairo. A. H. Samaha reports that the last consignment of parts for the 74-inch telescope (Newtonian focal ratio $f/4{\cdot}9$, Cassegrain $f/18$, and coudé $f/30$) including the large mirror and the Cassegrain spectrograph arrived in June 1963. Erection of the telescope was completed in September. Since that time erection of the Hilger G51 coudé spectrograph has started and optical and other tests of the telescope have been carried out. The thermostatic controls hold the diurnal variation of the coudé room to 1°C and of the dome to 3° or 4°C in spite of outside variations of 15°C. The new observatory is located in the Kottamia hills RL500 in the desert midway between Cairo and Suez.

A new coudé refractor has been secured from Zeiss and will be erected in Helwan for observations of solar phenomena during the International Quiet Sun Years.

Observatory of Paris. G. Wlérick reports that a new solar telescope has been constructed at Meudon with an aperture of 36 cm and a focal length of 13 meters. Various instruments including a spectrograph with a Bausch and Lomb grating and a monochromater may be attached to it. The instrument was constructed with great care and the spectrograph has provision for the use of photo-electric receivers and of a Lallemand electronic camera. The exposure time for the electronic spectrograph camera will be of the order of $1/50$ second. It is expected that the instrument will be placed in service in the spring of 1964. A vertical solar telescope of aperture 60 cm and focal length 45 meters is planned for completion in 1966. The monochromatic coronameter of Lyot constructed by Pierre Charvin has been used regularly at the Observatory of Meudon since 1961. The principle of discrimination which it uses and the quality of the electronics permits the measurement, with a good ratio of signal to noise, of an intensity of the green coronal line of $1 \times 10^{-6}\,\text{A}\,\text{B}\odot$ against a sky background of intensity $1000 \times 10^{-6}\,\text{B}\odot$. Numerous routine measurements of the green line have been made at the limb and the isophotes have been plotted in certain active regions up to 7′ from the limb. The apparatus will participate during the International Year of the Quiet Sun in observational programs of the green and red lines.

Observatory at Haute-Provence. Ch. Fehrenbach reports that the 1·93 meter telescope was placed in service in 1958 and its coudé spectrograph in 1959. This instrument, with which are associated a number of auxiliary instruments, functions very satisfactorily. It has been possible to obtain several thousands of spectrograms and direct plates. M. C. Courtès has developed a focal length reducer which yields a focal ratio of $f/1$.

Fehrenbach has placed in service a telescope with direct vision objective prism of 40 cm aperture which serves for radial velocity measures and which permits attaining the 12th magnitude.

The telescope of 1·5 meters aperture has been ordered. This telescope has only a coudé

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focus and is to be used exclusively for spectroscopy. It is hoped that a telescope of 3·5 meters may be included in the forthcoming equipment program of France.

European Southern Observatory. Ch. Fehrenbach, as President of the Instrument Committee of ESO, reports that the convention for the organization of the European Southern Observatory (ESO) was signed in 1962 in Paris and the ratification will certainly be obtained before the end of 1963. The choice of site, probably in Chile, has not been definitely fixed.

At the present time a duplicate of the objective prism of 40 cm aperture now in use at the Haute-Provence Observatory has been installed at Zeekoegat in the province of the Cape, 400 km northeast of Capetown. This instrument has made it possible to obtain about 500 plates of which a large number are in the Magellanic Clouds. This instrument, as well as that of Haute-Provence, attains the 12th magnitude.

The present status of the equipment foreseen for the ESO is as follows: A photo-electric telescope of 1·50 meter designed by the Dutch is under construction and should be completed in 1964. A spectrographic telescope similar to that of the Haute-Provence Observatory is being designed by the French astronomers. This instrument has both a coudé and a Cassegrain focus. It is ordered and should be finished in 1965. The spectrographic equipment is under study. A Schmidt telescope of three meters focal length and one meter aperture equipped with prisms is now being studied (the German astronomers are in charge of this design). This instrument should permit the extension of the National Geographic Society — Palomar Sky Survey to the southern hemisphere.

Finally the design of the telescope of 3·5 meters is continuing. The present state of this study is as follows: A combination Ritchey-Chrétien $f/8$ slightly modified should make possible a field of 30′ in diameter with negligible aberrations. No difficulty is presented for the coudé focus $f/30$. At present the calculations for the prime focus $f/3$ have not yet achieved an entirely satisfactory result. The mechanical design of the instrument has not yet commenced.

Observatory of the University of Göttingen. H. H. Voigt reports that the new observatory for solar research (property of the DFG), located in Locarno, Switzerland, has been operating since the summer of 1962. It is equipped with a Gregory-coudé telescope (aperture = 45 cm). In the focus of the main mirror there is an aperture of diameter 1/10 of the solar image at this point. Therefore only one per cent of the light of the Sun reaches the secondary mirrors. In this way the disturbing warming-up of these mirrors has been avoided. The system has proved to be very successful. At the moment there are two spectrographs. One is an échelle-spectrograph of 10 m focal length (0·12 Å/mm at 5000 Å in the 12th order). To this belongs a 1 m-prism-spectrograph used as a pre-disperser. The second spectrograph is a 6·60 m concave grating (2·5 Å/mm in the first order). A third spectrograph for average dispersions is being built at the moment. An additional telescope with an electronic communication system for transferring an Hα solar image into the laboratory was added to the main telescope. (ten Bruggencate and Voigt, 1958; Brückner, 1963).

A microphotometer for scanning photographic plates has been developed. The photometer transforms photographic densities automatically into intensities. The potential drop at the measuring resistor of the recorder is distorted by 20 potentiometers, which are wired parallel to the resistor in such a way that the calibration curve is approximated by a polygon. (Brückner, 1961).

Royal Observatory, Edinburgh. Peter Fellgett reports that following the design study previously reported (Fellgett, 1961), a contract has been placed for the construction of a General Automatic Luminosity and X-Y measuring engine 'Galaxy.' Delivery is scheduled for 1966. The machine is specified to detect the usable star images on a Schmidt photograph, to measure their co-ordinates and a brightness parameter which is a generalization of an iris setting, and to emit these measures in machine-readable form, without manual intervention. The speed of measurement will initially be limited, by the data medium used, to about 10 000 star images per working day, but may be increased later on.

The Becker iris photometer is in full use with digital display and punch-out of the co-ordinates and of the servo-controlled iris setting. During a recent period of eight weeks, repeated UBV measures were made on 3000 stars in the Pleiades with reference to the distribution of color and magnitude in the field stars and to cluster membership of faint stars, and on 1700 stars in the Cygnus two association with the object of determining the distribution of obscuration in depth and its effect on the interpretation of the apparent association. A total of 40 000 star images were examined and the measures reduced on the Edsac-2 and Muse-Atlas computers.

An automatic digital microphotometer has been brought into use. A voltage proportional to the transparency of the area-element of plate being examined is applied to a digital voltmeter, the output of which is stored, recoded, and emitted serially on demand to a paper tape punch. In this way, the digital measurement is overlapped with the punching of the previous result at a speed of up to three measures per sec. An economical register punch-encoder using current-steered ferrite techniques was specially developed for this purpose, and is now being manufactured under license. The signal from the photocell is processed by operational amplifiers in a feedback configuration which closely defines the gain relative to a comparison beam by-passing the photographic plate, and also constitutes an active resistance-capacity filter giving a 4th order Butterworth response. The cut-off frequency is matched to the noise and response spatial spectra of the emulsion so as to yield an effectively band-limited signal which can be sampled by the digital voltmeter without appreciable loss of information. The position of the plate carriage is measured and displayed digitally by a moiré fringe counting system which also triggers the signal-sampling circuit at equal increments of plate travel, currently 12·5 microns.

A twin 16-inch programmatic telescope, specialized towards the provision of photo-electric standards for Schmidt photometry, has been installed and commissioning is in progress. The mounting carries two Ritchey-Chrétien reflectors of 40 cm aperture. One of these can be locked photo-electrically onto a reference star, giving a standard of R.A. and Dec. independent of the accuracy of the drive and mounting. It also increases the photometric accuracy by monitoring changes in sky transparency. The second telescope can be off-set from the first by accurately prescribed amounts up to $\pm 5°$ in each co-ordinate, so as to scan program stars within a Schmidt field enclosing the reference star. The telescope is operated from a console in a warm control room, separated from the dome by double glazing. The primary moiré-fringe digital command and indicating system is backed up by an analog synchro system of lower accuracy potential. After commissioning, the telescope will normally be controlled by a digital program read from punched paper tape, and will emit the photo-electric results in a similar machine-readable form. In a telescope of this kind, the dome and shutter are integral parts of the servo system, and finer control is needed than has been customary hitherto. The dome structure is laminated wood, the low density of which gives a favorable ratio of rigidity to weight and hence low overall cost. It is fibreglass sheathed, with fibreglass laminate shutters. The historical method of dome drive, analogous to early rack-driven railways, has been abandoned in favor of an 'inverted motor-car' configuration whereby the flat lower surface of the dome ring-beam rests on six coned rubber-tired wheels. Three of these are hydraulically driven and define the plane of the ring, the other three are idlers mounted on air springs so that they carry a prescribed proportion of the total weight. Fans in the floor of the dome building give an airflow of 30 cm/sec in the shutter aperture, which is approximately 160 cm square, so as to bathe the telescope in relatively homogeneous air and improve the internal seeing in the manner which is now well established.

Royal Greenwich Observatory, Herstmonceux Castle. R. d'E. Atkinson (1963) reports that design study for the mirror transit circle has been completed. The instrument will incorporate the axis and mirror which have already been made and successfully tested. The two fixed

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telescopes will be inside a rough vacuum (1/100 atm.), and the design is such that no stresses on the vacuum tubes are transmitted to the telescopes inside them. The observing station is well away from the meridian, and neither the circles nor the piers are ever exposed to the sky. The star images are brought to the observing position by optical re-imaging systems, starting after the micrometers, and so arranged that the final image remains stationary, and axial in the repeater system, throughout the transit. Operation of the micrometer is by remote control, and with the exception of the circles (which are photographed), all data for star observations and for all calibrations are punched, either automatically by the instrument itself or from buttons set by the observer. The observing procedure for close polars is the same as that for all other stars, and the optical system for taking levels, autocollimation, etc., is completely identical with that for observing stars.

P. A. Wayman reports that the design for the Isaac Newton Telescope at Herstmonceux with a 98-inch Pyrex mirror provides for a prime focus at *f*/3, a Cassegrain focus at *f*/15, and a coudé focus at *f*/32. The center of the telescope will be 60 feet above ground level. The telescope is being constructed by Grubb Parsons Company and a contract has been placed for the construction of the dome. It is expected that the telescope will become operational in 1966 (Woolley, 1962).

A new Cassegrain spectrograph with mirror optics has been constructed for the Yapp 36-inch reflector. It has a Bausch and Lomb grating and provides for dispersions of 40 Å/mm and 80 Å/mm.

Work on a coudé spectrograph for the 30-inch reflecting telescope at Herstmonceux is continuing and tests on the instrument are currently being carried out.

Astrophysical Observatory, Kodaikanal. Vainu Bappu reports the completion of a 38 cm aperture, 36 meter focal length solar telescope fed with fused-quartz coelostat mirror of 61 cm aperture. The solar telescope yields a solar image 34 cm in diameter. This telescope has an 18 meter Littrow spectrograph which is provided with a Babcock grating with a 203 mm ruled surface blazed in the fifth order green. In its final stages of testing is a 4·3 meter spectroheliograph which will be used on a 30 cm aperture *f*/60 telescope. A 20 cm coronograph is also in operation.

Tokyo Astronomical Observatory. H. Hirose reports that the Observatory has established a station at the top of Mount Dodaira (longitude $9^{h}\ 18^{m}\ 12^{s}.5$ E, latitude $+36^{\circ}\ 00'\ 09''$ elevation 876 m). The new station has a 91 cm reflector made by the Japan Optical Company. The principal features of the telescope are aperture 91 cm, primary focal length 4·6 meters, Cassegrain focal length 16·5 meters. Photographs can be taken at both foci. A photo-electric photometer and a grating spectrograph are available at the Cassegrain focus.

Astronomical Observatory of N. Copernicus University, Toruń. W. Iwanowska reports that a Schmidt-Cassegrain telescope made by C. Zeiss, Jena, was installed in August 1962. The mirror of ZK7 glass has a diameter of 90 cm and a focal length of 180 cm. The corrector plate of UBK7 glass is 60cm in diameter. A 5° objective prism of UBK7 glass gives a dispersion of 570 Å/mm between Hγ and Hα. A 5° objective prism of F2 glass yields a dispersion of 250 Å/mm. In the Cassegrain form a secondary mirror gives an effective focal length of 1350 cm to the direct Cassegrain focus through a hole in the main mirror or with the use of a flat mirror the beam can be reflected along the declination axis. The telescope has a fork type mounting and is driven by the Zeiss mechanism called 'Uhrgan' consisting of an asynchronous motor controlled by one second contacts from a pendulum clock. Four speeds are available for motion in each co-ordinate and are controlled from a desk where the position of the telescope is shown on dials.

The main observing program for this instrument in the Schmidt form consists in covering the whole sky accessible from Toruń with objective prism plates calibrated photo-metrically

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in order to obtain a plate collection for spectrophotometry and spectral classification. In the Cassegrain form the telescope will be used with photo-electric photometers and polarimeters.

Royal Observatory, Cape of Good Hope. G. M. Sisson of the Grubb Parsons Company reports that a 40-inch reflector corrector telescope is being installed at the Observatory equipped with facilities for prime focus work at $f/4{\cdot}5$ and Cassegrain work behind the main mirror cell at $f/20$. No coudé focus is provided. A reflector corrector system at $f/3{\cdot}9$ is available comprising a single element correcting plate of 35-inch aperture with central hole $15\frac{1}{2}$-inches in diameter mounted approximately at the focal plane, a correcting lens comprising two components of effective aperture 13-inches mounted in approximately the same plane as the correcting plate, the combination affording a flat field of good definition of $2\frac{1}{2}°$ total width. This type of system makes for a very versatile use of the instrument.

A small spectrograph giving a dispersion of 320 Å/mm has been constructed suitable for use on the new 40-inch telescope and also at the Newtonian focus of the 74-inch Radcliffe reflector.

Stockholm Observatory, Saltsjöbaden. Bertil Lindblad reports that a Schmidt telescope of 65 cm aperture and of 3 meter focal length has been completed and erected. The spherical mirror of diameter 1 meter was ground by the optical engineer E. Aulin at Stockholm and the correcting plate was made by Zeiss in Jena. The mounting of the telescope is of the fork type and has been delivered by the firm Metaalbedrief Rademakers N. V. at Rotterdam. The instrument will have two objective prisms of different dispersions and is designed to be used mainly for spectrophotometric investigation in selected regions. J. M. Ramberg has largely been in charge of the planning and erection of this instrument.

Yngve Öhman reports that the Swedish solar station at Anacapri has equipment partly for solar flare patrol and partly for various solar research. The main patrol instrument is an Hα filter from Halle with a pass-band of 0·7 Å and an improved construction suggested by Öhman, which greatly reduces the intensities of the satellites on each side of the transmission band. Special attention has been paid to the problem of using the Hα filter for photometric measurements of flares, prominences, etc. (Öhman, 1963). A remarkably high accuracy has been achieved in visual measurements with these instruments.

The largest telescope at the Anacapri station has an aperture of 20 cm and a focal length of 20 meters. It has an old Zeiss objective (1914) but the polar heliostat is Swedish. A new building is available for this instrument with heliostat and objective on the roof and two auxiliary flat mirrors in the building. Very satisfactory seeing is obtained with the instrument. Plans are being made for the construction of a special bi-refringent filter for the Hβ line for measurement of magnetic fields in prominences.

At present 12 cm and 8 cm coronographic telescopes are mounted in a dome on the roof of the main building. Photometric measurements are made on prominences and compared with those made with the birefringent Hα filter. In a special laboratory in the basement measurements are made using the thermomagnetic properties of gadolinium (Cahn micro-balance) (Öhman and Rydgren, 1962).

Harvard College Observatory, Cambridge. H. C. Ingrao reports that a new thermal detector, the ceramic ferro-electric bolometer has been developed and manufactured with Curie point between -10°C and $+10$°C and dimensions down to $0{\cdot}5 \times 0{\cdot}5 \times 0{\cdot}05$ mm. The minimum detectable power of such a bolometer $1{\cdot}0 \times 1{\cdot}0 \times 0{\cdot}2$ mm at room temperature with incident signal chopped at 2·5 cps and a band pass $\Delta f = 0{\cdot}25$ cps was $4{\cdot}2 \times 10^{-10}$ watts rms. (Ingrao, and Menzel, 1963; Ingrao, Menzel, and Kahn, 1963).

A radiation pyrometer for lunar work has also been developed with three detectors including an immersed germanium thermister bolometer and a thermister bolometer both $0{\cdot}1 \times 0{\cdot}1$ mm in size with anti-reflection coatings to give maximum transmission from 8μ to 14μ, and a ferro-electric bolometer with a germanium window.

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A new patrol camera has been designed by Ingrao, three units have been manufactured and three more are under construction. They will be used for a three color patrol at Agassiz station and at Boyden Station, Bloemfontain. The optics is a modification of the Dagor objective by James Baker and has the following characteristics: aperture 1·71 inches, focal ratio $f/8·1$, plate scale 583″/mm. For the yellow and red corrected objective 80 per cent of the light falls within a 15μ circle at the center of the plate and a 20μ circle at the edge. The field of view is $40° \times 32°$.

U.S. Naval Observatory. K. Aa. Strand reports the testing of the 61-inch $f/10$ astrometric reflector located at Flagstaff Station was started in November 1963. The optical system consists of quartz mirrors with a parabolic primary and a flat secondary in the Cassegrain arrangement. (Strand, 1963). The telescope is intended primarily for high precision astrometric work such as trigonometric parallaxes of nearby stars fainter than 13·5 apparent magnitude. Besides a multiple exposure camera with automatic exposure and plate transport, the instrumentation will include a spectrograph, a Meinel camera, and a photometer.

The 26-inch refractor at Washington was overhauled and converted to electro-mechanical controls with.synchro read-out of right ascension and declination. (Mikesell, 1964). The digitalization programs for both the six- and seven-inch transit circles at Washington was completed. New synchro-controlled motor drives for the right ascension screws were installed. (Adams, 1963).

A two-stage thermo-electric camera has been developed by A. A. Hoag for photographic reciprocity modification experiments (Hoag, 1961). The temperature of the platen of the camera can be maintained anywhere between ambient and $-68°$ by means of a simple power supply. A Muller type bi-refringent crystal micrometer with a 30mm crystal was constructed. A Clark filar-micrometer was digitized with read-out of circle and drum on paper tape, doubling the number of stars observed in a session. Two new cameras with automatic timing and plate transports designed by A. H. Mikesell were constructed for photographic double star observations with the 26-inch refractor at Washington, and the 24-inch Lowell Observatory refractor at Flagstaff. A dual purpose photometer designed by K. C. Chou was constructed for observing eclipsing variables and for determining the magnitude differences between the components of visual binaries. The photometer is furnished with interchangeable photocell units permitting the use of the standard 1P21 photomultiplier as well as multistage phototubes of the Lallemand type.

A servo-controlled iris diaphragm photometer with digital readout of co-ordinates and iris setting on punched cards and paper tape designed by A. A. Hoag was constructed and put into use at the Flagstaff station. A contract was awarded in May 1963 for the construction of a high precision automatic measuring machine designed for measuring the plates of the parallax series obtained with the new reflector. Specifications for the machine incorporate several new features such as air bearings and solid state Ferranti co-ordinate measuring system with automatic read-in and read-out of the star positions.

Steward Observatory, Tucson. A. B. Meinel reports that the 36-inch Steward telescope has been moved from Tucson to Kitt Peak adjacent to the Kitt Peak National Observatory. The telescope mirror support system has been replaced making it possible to work at either the Newtonian, Cassegrain, or coudé focus positions. New instrumentation includes a nebular spectrograph with a flat field $f/0·8$ camera producing a dispersion of 250Å/mm. A Cassegrain spectrograph with an $f/2$ camera has also been constructed to give dispersions between 60 and 160Å/mm. An automatic punch card photometer is also in operation.

Kitt Peak National Observatory, Tucson. Keith Pierce reports that the $f/7·5$ Cassegrain form of the 84-inch telescope has been installed at Kitt Peak. The system is figured following the Ritchey-Chrétien design and gives a flat coma free-field when used in conjunction with a quartz plano-concave lens just before the focal plane. Preliminary Hartmann tests show 100 per cent of the light concentrated within one sec of arc and 50 per cent within $\frac{1}{3}$ sec of arc. Further

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adjustments of the mirror support system is needed. Optical shop work continues on the *f*/30·5-mirror, coudé system. The coudé spectrograph follows the basic design of the Lick 120-inch and the McDonald 82-inch spectrographs. Four Schmidt cameras whose axes are parallel to a large shaft allow each one to be indexed into position by rotation of the shaft; two fixed cameras have other axes. The collimation beam of 9-inch aperture feeds light to any one of several gratings in a turret. The cameras provide dispersions from 22 to 2 Å/mm in the second order blue-violet region.

The McMath Solar Telescope is in operation feeding a 33-inch solar image to a vertical spectrograph. The spectrograph is supported on an oil pressure pad bearing permitting slow motions and a 24 hour/rotation drive. The optics are of the Ebert type with provision for photo-electric recording in double-pass or photographic recording on 4×10 inch plates in single pass. The dispersive element is a 10-inch grating of 610 grooves/mm blazed in the 5th order green ruled by Horace Babcock. The mirrors of the McMath telescope consist of a 63-inch quartz flat (later to be replaced with an 80-inch), a 63-inch Kanigen coated cast aluminum mirror of 289 feet focal length and a 48-inch quartz flat, all of which perform well. Tests of the internal seeing of the telescope are being conducted as it relates to the cooling system of the telescope.

The remotely controlled telescope system is comprised of a 50-inch *f*/13 telescope controlled from the Tucson Headquarters through a digital communication system by a digital computer. The telescope, of coma-free design, utilizes an *f*/2 primary of Kanigen coated aluminum. It will be housed in a 35-foot dome attached to the Administration Building on Kitt Peak. Figuring of the optics is to begin late in 1963, whereas the mounting, dome, communication system, and control console are completed and are currently being tested. The mounting with a 16-inch test telescope will be moved to the dome during the first quarter of 1964. The 50-inch telescope is expected to be installed by the end of 1964.

Lowell Observatory, Flagstaff. John S. Hall reports that an interferometric spectrometer has been constructed for astronomical use. This instrument may be thought of as a single element Lyot filter in which the thickness of the plate of the birefringent material may be varied. The interferograms are recorded by digital techniques and compensation is provided for fluctuations of seeing and atmospheric transparency. It is further compensated for noise arising from sky emission. The interferogram is then converted to the spectrum of the object by processing with a large digital computer. P. Fellgett has shown that in the infra-red, where the sensitivity of the detector is limited by intrinsic detector noise, a considerable gain in signal to noise ratio can be obtained in spectrum analysis by using a Michelson or other type of two beam interferometer.

The instrument, at present, operates between two and four microns. Thus far interferograms of 30 stars have been obtained mostly with the 69-inch Perkins telescope.

High Altitude Observatory, Boulder. Gordon Newkirk, Jr. reports on an investigation of optical systems to improve the performance of coronographs by reducing scattered light, eliminating chromatic aberration, etc. The properties of reflecting and of externally occulted systems were studied as well as a number of lens materials. (Newkirk and Bohlin, 1963; and Zirin and Newkirk, 1963).

Sacramento Peak Observatory, Sunspot. John W. Evans reports that in 1963 E. Dennison constructed an electronic analog to digital converter, and assembled a system which records the digital signal to three places on IBM cards at a rate of 5 points per second. So far this system has been used with the micro-densitometer for the reduction of 150 eclipse spectra (approximately 5×10^5 data points each) and with the recording Doppler comparator for studies of Fraunhofer line wiggles. It will also be used for recording direct photo-electric measurements of line profiles and with the magnetograph. A new system handling 20 points per second is under construction.

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The recording Doppler comparator, finished early in 1963, traces a line on a spectrogram perpendicular to the dispersion. Its output signal is proportional to the displacement of the line from an arbitrary straight line defined by the motion of the plate carriage. The instrument defines the position of the line midway between points of equal optical density on either side of the line profile. The separation of the points, $2\Delta\lambda$, is adjustable for studies of the dependence of the Doppler shifts on $\Delta\lambda$.

A new Doppler-Zeeman analyzer is in the last stages of adjustment. This is a device for direct use on the Sun with a telescope and spectrograph. Its sensing device is identical to that of the Babcock magnetograph. It differs in that a servo system, actuating two plane parallel line shifters, nulls out the line displacements due to radial velocity and longitudinal magnetic field, and produces a separate signal proportional to each. Since it is non-saturating and independent of light intensity, it can be used for studies of velocities and magnetic activity in solar active regions. A 16-inch coronograph-type telescope and a compact grating spectrograph for use exclusively with the Doppler-Zeeman analyser are approaching completion. The whole system will be mounted on the 28-foot spar and will point directly at the Sun to minimize scattered light and instrumental polarization.

The Observatory is well along in the design of an evacuated tower telescope of 30-inch aperture and 180-foot focal length. It will be an altazimuth reflecting system with appropriate compensation for image rotation. The three reflecting surfaces will be contained in the vacuum chamber away from scattering dust. There will be two large spectrographs, one for photographic and image tube observation, and one (double pass) for photo-electric line profile measurement, at five points simultaneously between center and limb. There will also be a spectroheliograph, as yet undesigned.

Yerkes Observatory, Williams Bay. W. A. Hiltner reports that a 24-inch Cassegrain telescope is now under construction and will be installed in September 1963. The telescope is unique in that the tube can be rotated on its optical axis for the elimination of systematic errors in polarization measurements. A rising platform has been installed for convenience of operation. The output from the two photomultipliers that will be used for polarization measurements will be digitized, either by pulse counting or voltage to frequency converters, and together with all other pertinent data, printed on a Hewlett-Packard printer. The telescope is financed by the National Science Foundation.

The reducing camera originally described by Meinel (1956) has been rebuilt and is now in general use with the 40-inch refractor for the photography of galaxies with interference filters. A camera with a focal ratio of 0·95 has been added which gives an equivalent focal length of 60 inches.

Observatories in the U.S.S.R. The following instrumental advances are reported by N. N. Mikhelson.

The 2·6 m reflector (chief designer B. K. Ioannisianny) was put into operation at the Crimean Astrophysical Observatory and the work on testing and adjusting the instrument was carried on. At present regular observations are carried out at the prime focus only. A correcting system is in use and the image converter is also widely used. The extra-galactic nebulae are under observation.

The main characteristics of the instrument are: (Ioannisianny, 1963): Diameter and focal ratio of the main mirror: 2·6 m and 1:4; prime focus with three correcting systems: focal ratios 1:39 (field $2W = 12'$), 1:4 ($2W = 28'$), 1:2·6 ($2W = 45'$); Cassegrain and Nesmit system 1:16; coudé system with one flat mirror (for $-30° < \delta < +45°$) 1:40 and with four flat mirrors (for $\delta > 45°$) 1:40. A fork type mounting is used. The tube is of Palomar type. The control system provides the automatic and semi-automatic setting for a desired position, a driving mechanism for observations of the Moon or planets, a correcting system for mean atmospheric refraction and flexure of the tube, a photo-electric guiding device and automatic control of the dome with wind screen to follow the telescope. The main mirror (Oshurko, 1963) was cast of Pyrex which has a coefficient of thermal expansion of $32{\cdot}7 \times 10^{-7}$ per °C. The central hole has a diameter of 0·5 m. The mirror is mounted on a 24 support mechanism. The test of the mirror was made by a Maksutov compensation method (Maksutov, 1957).

A reflecting telescope with aperture 0·7 m and with original corrector lens for coma correction was built at the Astronomical Observatory of the Academy of Sciences of the U.S.S.R. in Pulkovo. The focal ratio at the prime focus is 1:3, the Cassegrain system 1:12, and in the coudé system 1:30. The telescope is provided with a semi-automatic and automatic control system (Belyaev, Gerasimova, Dravskikh, Mikhelson, Sumin, Shutova, and Shumakher, 1963; Belyaev, 1961). The semi-automatic control system includes the indicating synchros which transfer the position of the telescope to the control desks. The system is adjusted and put into operation. The automatic control system contains the electronic digital computing device which performs the control of the telescope. The device is in operation. Connection of this device to the telescope is being completed. The complete control system contains the computing device for correction for mean atmospheric refraction (Mikhelson, 1958), the driving mechanism for observation of the Moon or planets (Konshin, and Mikhelson, 1958), and a special indicating device 'planisphere.' The testing of the telescope has started and showed that the steel main parabolic mirror with a ribbed structure which has a diameter of 700 mm, 1:3 fully complies with the requirements for the operation in the prime focus but requires final figuring for the operation in the Cassegrain and coudé foci.

The mounting of the horizontal transit circle of a Sukharev's system is being completed in Pulkovo. The specifications of the instrument are: the mirror diameter 300 mm, the lens aperture 190 mm, the focal length of the tubes 4 m. The reading of the circle and the observations will be performed photo-electrically.

In 1961 the experimental television telescope with electronic system for synchronous recording of the light flux and the shape of the stellar image during its atmospheric scintillation was completed in Pulkovo (Kuprevitch, 1961). The correlation between these phenomena has not yet been found.

In 1962 Kuprevitch in Pulkovo obtained with the use of the television telescope the photographs of the different regions of the Moon in the infra-red region of spectrum ($0{\cdot}9 - 2{\cdot}3\,\mu$). (Kuprevitch, 1962, 1963). Details which had not been seen before on the usual direct photographs were found.

In 1960 at the Abastumani Astrophysical Observatory of the Academy of Sciences of the Georgian S.S.R. the automatic electronic polarimeter in combination with a 400 mm refractor was put into action by Ksanfomaliti (1962) operating within the range of -4^{m} to $+11^{m}$. The accuracy of determination of the degree of polarization is about 0·1 per cent and of the angle is 2° (stellar magnitude $+7^{m}$). The instrument is used for studying the Moon, planets, asteroids, and other objects. The polarovisor scanning frame with a definition of 210 lines for 1·5 minutes was built (Ksanfomaliti and Dzhapiashvili, 1962). With the help of the polarovisor a number of interesting objects on the surface of the Moon and the effect of polarization inversion near the full Moon were found. Work in the field of construction of improved polarimeters is in progress. A similar work is done also at the Astrophysical Institute of the Academy of Sciences of the Kazakh S.S.R. by Rozhkovsky (Rozhkovsky and Dzhakusheva, 1962). His polarimeter is used for polarimetry of the diffuse nebulae of low surface brightness. This instrument uses the principal of accumulation of discontinuous exposure. An automatic electro-polarimeter was also constructed at the Kharkov Astronomical Observatory (Dudinov, Bugaenko, 1962). Work on automatization of the astronomical telescopes is carried out, new systems for photo-electric guiding and for synchronization of the dome and a telescope are constructed and put into action (Zhurkin, and others, 1963; Sabinina, Egorova, and others, 1963). These found wide application at the Crimean Astrophysical Observatory.

At the Enghelgardt Astronomical Observatory in Kazan modernized Markowitz cameras were designed. An automatic instrument for measuring the photographs of the Moon which are obtained with the help of a Markowitz camera was constructed by N. F. Bystrov in Pulkovo. The instrument permits the measurement of 70 radii in 12–15 minutes with an accuracy of up to 0·5 microns and automatic readout on punched cards (Bystrov, 1962).

At many U.S.S.R. observatories (Pulkovo, Abastumany, Sternberg State Astronomical Institute, etc.) new automatic microphotometers were designed which allowed the registration of the intensity (or logarithms of intensity) during the studying of photographs (Kotlyar, 1960; Kononovitch, 1963).

In almost all places work aimed at improving the equipment and methods for observations of the artificial Earth satellites was carried out. New cameras using a movable film (Panaiotov camera—Pulkovo, Abel-Lapushka—Riga State University, satellite tracking telescopes by Einasto (1960) Tiit (1960), etc.—Tartu Observatory of the Academy of Sciences of the Estonian S.S.R., etc.) were constructed and put into practice.

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President of the Commission

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REPORT TO COMMISSION 9 FROM THE WORKING GROUP ON IMAGE TUBES

This report is divided into three main sections dealing with the following different methods of photo-electronic image detection:

I. Electronographic methods.
II. Multistage image intensifiers.
III. Scanning or television type techniques.

I. *Electronography*

1. From the Paris Observatory, Lallemand and his colleagues, Duchesne *et al.*, report on progress of their work as follows.

The development and study done on the electronic camera have mostly been concerned with the reduction of noise, the conservation of the sensitivity of the photocathode for as long as possible, the increase of resolution, the linearity of the response and the improvement of the technique of use in order to facilitate and increase the reliability of the preparation of the tube.

The reduction of the noise and the increase of the life of the photocathode depend, in particular, on the quality of the vacuum obtained in the tube during its use.

We have been able to eliminate the barium getters, the use of which creates several difficulties, in particular the necessity of dismantling and thorough cleaning of the electronic lenses. By systematic study (1) of the various parameters that determine the rate of degassing of the walls, we could diminish the latter sufficiently to be able to maintain for several days—by means of activated carbon suitably disposed and cooled—a vacuum better than 10^{-7} torr. Our study has also touched on the employment of the molecular sieves. These substances have a porous structure with pores a few angstroms in diameter and for equal volumes the absorbing surface is much larger than the surface of the activated carbon. Moreover, fabricated under perfectly controlled methods, they have the advantage over the activated carbon of having a regular and reproducible structure, and consequently more uniform properties. The use of the activated carbon as an absorbing substance has enabled us during a recent visit to the Haute-Provence Observatory to make five nights of observation with a more photosensitive layer without measurable deterioration of the sensitivity. We have also continued our study of the

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