25. COMMISSION DE PHOTOMETRIE STELLAIRE

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INTRODUCTION

According to decision of the Hamburg Meeting of Commission 25 its competence is restricted now to photometric and polarimetric instrumentation, observational, extinction and reduction procedures, photometric systems and standards. Extra-terrestrial stellar photometry belongs to its competence too.

The main lines of development of stellar photometry during the last three years were: rapid increase of number and size of photometric telescopes; development of multichannel photoelectric photometers: automation of observational and reduction procedures; further careful studies of the *UBV* photometric system and its extension to the infrared—up to 20 microns (*UBVRIJKLMNQ* system of Johnson); establishment of a common system of the *UBV* photometric standards for northern and southern hemispheres; increasing role of intermediate and narrow band photometric systems.

INSTRUMENTATION AND OBSERVATIONAL METHODS OF STELLAR PHOTOMETRY

Many new photometric telescopes have been designed, constructed and put in operation during the current period.

At the Royal Observatory, Edinburgh, Scotland, a twin photometric telescope has been constructed after a concept by H. Seddon, P. B. Fellgett, W. Matley and W. Jones (**1**). Two 40 cm Ritchey-Chrétien telescopes, one of which can be moved by $\pm$ 5° (with a precision of 6″) orthogonally with respect to the other, are carried by a single mount. Thus, two stars can be compared simultaneously, with consequent virtual cancellation of the effects of variable atmospheric transparency. Photometry is by pulse counting, with a typical limiting exposure of ten minutes for $V = 15^m\!.0$ to a count of 13 binary digits. Measures of adjacent sky brightness are automatically interleaved with those of the stars. Colour filters and focal plane apertures are under remote control, and may be programmed.

A complex of two twin photometric telescopes have been put in operation at the W. Struve Observatory, Tartu, U.S.S.R. Two 48 cm Cassegrain telescopes located in separate domes at a distance of nearly 30 meters are under remote control from the same control panel. This complex permits to carry out simultaneous observations of two stars like the twin telescope of Edinburgh Observatory, just described. The digital technique is used for photoelectric measures (**26, 27, 28**).

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At the Pine Bluff Observatory of the University of Wisconsin, U.S.A., a telescope that automatically sets on programmed stars and then makes multicolour photoelectric measures has been installed. The telescope is a 20 cm reflector under the control of a PDP–8 general purpose computer, with punched tape input.

A 150 cm Ritchey-Chrétien telescope with fused quartz optical parts is to be erected on Palomar Mountain for use as a photometric telescope. It is very short owing to a small primary focal length; this and other features permit rapid shifts from one object to another. The telescope will be equipped with a high speed (about $4 \cdot 10^6$ counts per second) pulse counting multichannel photometer.

Ritchey-Chrétien photometric telescopes of 125 cm aperture are being designed for the Crimean and Abastumani Observatories, U.S.S.R. These telescopes would be under control of a general purpose computer. The setting on the stars to be observed and operation of photometric equipment may be programmed. For input of commands and output of measures (observed colours and magnitudes) punched tapes will be used.

The 2·2 meter (87-inch) telescope, now under construction at the University of Arizona, U.S.A., will be erected at Kitt Peak and will be equipped for multichannel photometry.

A 125 cm automatically controlled telescope with a three-channel photometer is now available at the Kitt Peak Observatory, U.S.A. Other photometric telescopes being under operation at this observatory are: two 40 cm reflectors each with single channel photometer, one with automatic digital read out; two 90 cm reflectors both with automatic digital read out and single channel photometers; a 2·1 meter telescope with a three-channel photometer. Now being designed is a 3·75 meter telescope on which construction should begin the summer of 1967.

The one meter telescope 'The Elisabeth Telescope' used for photoelectric work has been put in operation at the Cape Observatory, South Africa, in 1964 (**2, 3**). Increasing artificial illumination of the sky is reducing the effectiveness of this telescope for photometry, and plans are forming to monitor the sky brightness with a small reflector attached to the main instrument for continual monitoring of the sky.

A 90 cm photometric telescope will be erected in 1967 at the Interamerican Observatory at Cerro Tololo, Chile.

The new 75 cm reflector of the Leushner Observatory, University of California, U.S.A., will be equipped for both conventional photometry and for the spectrum scanning. The instrument consists of a combination spectrograph, scanner, photometer and photography unit. The optical system is so designed that the rapid changes can be made from one mode to another. Photoelectric data will be aquired by a pulse counting system which will have digital output in the form of printed tape and punched cards.

Many other smaller photometric telescopes were put in operation during the last three years. A 70 cm Cassegrain telescope—at Simeis Station of the Crimean Observatory, U.S.S.R. It is equipped with single and three channel photometers and integrating polarimeter. Sixty cm Cassegrain telescopes—at Lund Observatory Station, Sweden, Lick Observatory, U.S.A. and at Kenneth Mees Observatory, U.S.A. Two identical 48 cm Cassegrain telescopes have been installed at Abastumani Observatory and at the Southern Station of Leningrad University Observatory (near Burakan Observatory), U.S.S.R. (**4**). A 45 cm reflecting telescope, having coudé and Cassegrain systems, have been erected at the Sverdlovsk University, U.S.S.R. It will be used for multicolour photometry. The 40 cm reflector, built for the University of Washington, has been installed on Rattlesnake Ridge near Hanford on an elevation near to 1 km. The telescope will be equipped with an ordinary photometer for photometry on *UBVR* system. Another photometric telescope of 40 cm diameter was put in operation at the new Smith College Observatory, U.S.A., and at Mount John Station, New Zealand, by Cook and Flower Observatory. A Cassegrain telescope of the same diameter has been constructed at the

Hamburg-Bergedorf Observatory, West Germany; it would be installed in Greece near Korinth at the height of 800 meters. In midsummer 1967 the Remeis Observatory, Bamberg, West Germany, will have a 40 cm telescope of its own at the Boyden Observatory in South Africa for photoelectric measurements in *UBV* system.

A rotatable telescope of Hiltner type, 60 cm in diameter (**5**) has been ordered for the polarimetric observations at the Bingar Station of Mount Stromlo Observatory, Australia.

Some new telescopes suitable for photographic photometry have been installed too. We like to mention here a one meter Schmidt telescope erected at the Baldone Station of the Astrophysical Laboratory of the Latvian Academy of Sciences, U.S.S.R. and a 60 cm Schmidt telescope at Torun Observatory, Poland (**6**).

Very useful reviews of modern light sensitive devices were published by W. A. Baum (**7**) and R. Smith (**8**).

The problem of thermal dependences of spectral responses of photoelectric apparatus is very actual and should be considered with most care (**12, 13, 14, 15, 16**).

A. T. Young at the University of Texas is revising now the photometric equipment of the Department of Astronomy to eliminate sources of inaccuracy arising from temperature dependence of filter transmission and of photomultiplier characteristics. So, photomultipliers will be cooled by thermoelectric means to provide critical temperature control. Solid state amplifiers are being prepared in order to eliminate the effects on amplifier sensitivity that arises from heating from thermal emission type tubes.

Two types of refrigerating systems for photomultipliers have been tested at Castel Gandolfo Observatory. The first, constructed by Corrido Corridi of Roma employs freon as a refrigerating agent. The second, supplied for experimental tests by Siemens Research Laboratory in Erlangen, is based on the Peltier effect. Both systems reach temperatures of the order of $-40°C$. Such refrigeration lowers the dark current by a factor of 4.10^3. Thermoelectric cooling of an EMI 9558 photomultiplier are being investigated at the University of Michigan too. It is interesting that at the Cape Observatory was found that cooling with the ordinary water ice gives practically adequate results to the dry ice refrigeration.

When using infrared sensitive devices, cooling to much lower temperatures is needed. For this purpose Mrs M. Lunel uses at the Lyon Observatory the following arrangement. Liquid air is evaporated by a heating resistance, and the cold air is circulating around the light sensitive device. The necessary temperature (down to $-150°C$) may be stabilized by regulating the intensity of flow of the cold air. The temperature is measured by a thermocouple (copper-constantan). To prevent condensation of water vapour, all the device is evacuated to the pressure of the order of 10^{-5} mm. The described system gives for a PbS cell a gain of order of 50.

Thermal dependence of spectral transmission of glass filters (**16**) and of brightness of radioactive dye light sources (**17**) raise the question of the necessity of temperature control of these components of photoelectric photometers. Such control for a radioactive dye light source is just described (**18**). But the best way, as it was mentioned in our previous report, is the use of light source of high stability not sensitive to temperature changes. A light source of this kind, based on Čerenkov effect, has been constructed and carefully studied at the Geneva Observatory (**19**). A detailed investigation of another type of light sources—electroluminescent lamps—was undertaken by West and Houck at the Washburn Observatory resulting in a monitored light source capable of variates in intensity over a range of 10^5 with negligible variations in spectral energy distribution.

The question on the dependence of photomultiplier's spectral sensitivity from the high voltage applied has been investigated (**20**).

At the Gottingen Observatory Gomez studied the influence of weak magnetic fields on the behaviour of photomultipliers. The most sensitive were the RCA head on type photomultipliers.

It was found that by a special choice of magnetic field it is possible to improve signal to noise ratio.

Any improvements in the construction of interference filters, widely used now in intermediate and narrow-band photoelectric photometry, are very important. Th. Walraven has been working at the Leiden Observatory on the quartz birefringent filters which produces fringes in the spectrum of rectangular shape, instead of a sinusoidal one. The bright fringes are separated by equally wide dark gaps. Consequently the dark gaps are relatively much wider than in the case of sinusoidal profiles. That permits to have in the well known multichannel photometer of Walraven's type smaller dispersion and therefore a smaller size of the instruments or, alternatively, the use of narrower spectral bands. At the Leiden Observatory such filters are now constructed and in particular a photometer is being built, which is intended for measuring simultaneously in the four Strömgren bands as a small portable instrument which can be carried by a 40 cm telescope.

Now, interference and other types of filters for the wavelength region 3000–1700 Å to be used in extra-terrestrial ultraviolet photometry have been developed (**22**).

Looking forward for the needs of photographic intermediate and narrow-band photometry the development of large, stable and highly uniform interference filters is very much needed.

Between the photoelectric photometers constructed during current period we find spectrum scanners suitable for measurements of monochromatic or quasi-monochromatic magnitudes and colours, single and multichannel photometers of different kinds. Different methods for measurement of the photocurrent are being used: DC integrating circuits and pulse counting technique (**23, 24, 25**) are most frequently used at the present time. Digital read out with printing on an ordinary tape or perforated card or tape is very common (**26, 27, 28**).

In their reports many astronomers discussed the problem of the increasing role of multichannel photometry. So, Willstrop emphasizes the importance of simultaneous observations in many colours to eliminate variations in the neutral component of atmospheric absorption and to economize in observing time. He stresses the gain to be derived especially at sites not enjoying the best conditions. Jackisch marks the importance of multicolour photometers for the study of stellar microvariability and for investigations of variables showing very rapid changes in their brightness (flare stars for example).

And now about the new photoelectric photometers.

At the Kodaikanal Astrophysical Observatory two new instruments, a spectrum scanner and a two channel pulse counting photometer are completed and will be in use soon. The scanner employs 1800 lines per mm grating with exit slits that allow the measurements of spectral regions 4 to 80 Å wide. The photometer is designed for use with interference filters on a programme measurement of $H\gamma$ line intensities in early-type stars. The filter selectors will, however, allow simultaneous measurements through many other pairs of filters.

A ten-channel spectrometer designed by Willstrop and Beggs is in an advanced stage of development at University of Cambridge Observatory. It is hoped to commence observations soon at the Cape Observatory.

A four-channel photometer designed by Walker has been built in the Dominion Astrophysical Observatory. A small quartz spectrometer employs a grating for dispersion; four windows at the camera focal plane provide selection of the wavelength. The intensity in each wavelength is measured by each of four separate photomultipliers. The multiplier outputs are integrated by condensers and read out with a digital voltmeter.

At the University of Michigan, as communicates Williams, the slot-photometry scanner is being more highly automated and is being fitted with a second channel to achieve some compensation for changes in atmospheric transparency.

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At the Crimean Observatory a photoelectric scanner has been put in operation by Dimov and Severny in coudé focus of the Shajn's 2·6 meter telescope. The pulse counting technique is being used.

Zarevsky and Guseva constructed at the Sternberg Astronomical Institute a two-channel photoelectric spectrometer for intermediate and narrow-band photometry. It is especially suitable for line photometry (Hα, Hβ or Hγ for example) and was extensively used in 1966 at the Southern Station of Sternberg Institute and at the Crimean Observatory. Pulse counting technique is used.

At Lyon Observatory, Bigay designed a modern two-channel photometer for wide, intermediate and narrow-band photometry. Twelve interference filters may be used in one of the channels and four in the other one. The possibility of rapid changes of field diaphragms is very suitable for photometry of extended objects. Lallemand's photomultipliers are being used and integration of photocurrent is applied. A digital voltmeter gives the possibility to print automatically the results on a punched tape. All reductions are being carried out by an electron computer. This photometer may be used with the 60, 80 and 193 cm telescopes of the Haute-Provence Observatory.

A single-channel photometer has been tested in the coudé focus of the 50 cm telescope of the Crimean Observatory. The integration or pulse counting methods can be used. The results of measurement are registered by a digital voltmeter. All operations with filters and standard light source are being carried out by a remote control system.

The charge integrating photometer, that has been in use for several years with the Steward Observatory of the University of Arizona 90 cm reflector, is being modernized by substitution of a new general purpose data logging system which records on punched paper tape.

A single-channel photometer for six-colour photometry has been modernized at the Observatory of the University of Bordeaux by Mianes. The filters are being changed by remote control and a new, very stable amplifier, using a vibrating condenser, is applied (**30**).

Descriptions of many photoelectric photometers have been published. The photoelectric photometer used for observations in the Golay's multicolour system is described by Rufener (**64**); Argue describes an infrared photometer used for observations of the late type stars at the Kitt Peak Observatory (**212**); Xanfomaliti—a pulse counting photometer of Abastumani Observatory (**31**) and Kubyshkin a photometer with remote control (**32**). Descriptions of photoelectric photometers used at Bosscha (**33**), Pulkovo (**34**), Uppsala (**35**) and Haute-Provence (**36**) observatories have also been published.

Ackermann and Hermann carried out laboratory tests of a photometer designed for the use in 0·8–5·0 microns region (**37**).

A special photoelectric scanner has been constructed at the Lowell Observatory and is being used to carry out exploratory photometric observations of the components of visual double stars too close to be observed by conventional photoelectric technique (**38**). Now a new scanner designed specifically for double star work is being designed. Scans will be produced by a slit of adjustable length and width connected to a motor driven spiral cam. An oscilloscope will be used for monitoring scanner performance during observations. Data will be recorded in machine-readable form for subsequent computer reductions.

At the Arthur J. Dyer Observatory, as communicates Hardie, an interesting experiment in spectral scanning is being performed with an objective grating and a standard photoelectric photometer. The grating gives a dispersion of about 75 Å/mm; slits down to a width of 15 Å can be used, and scanning is done by drifting the telescope in R.A. The method is promising.

The effects of telescopes on the polarization measurements have been discussed by Miller (**39**), and the requirements to telescopes and other polarimetric equipment—by Clarke (**40**). Clarke described also a double-beam polarimeter of new type and discussed the methods of

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reductions, and the results of measures of the instrumental polarization (**41**). Another double beam polarimeter has been constructed by Dombrovsky, Shulov and Vasiliev at the Observatory of Leningrad University and by Xanfomaliti at the Abastumani Observatory.

A polarimeter permitting to measure four Stokes's parameters in the wavelength range 0·19–3·0 microns has been constructed at Sternberg Institute by Pospergelis (**42**).

Polarimeters for multicolour observations were constructed at Harvard (**43**) and Stockholm (**44**) observatories; the last one with the sky background compensation.

A polarimeter for the *UBVR* colour system is being installed at the 80 cm telescope of Haute-Provence Observatory (**45**) and a polarimeter for the near infrared region is being used at one-meter telescope of Meudon Observatory (**46**).

New polarimeters have been tested and put in operation at Pulkovo (**47**), Shemaha (**48**) and Heidelberg (**49**) observatories.

A polarimeter has been designed by Heara for use on the 40 cm telescope at Pine Bluff and Kitt Peak observatories. It is a one-cell instrument using a Glan-Thomson prism, and having a movable shutter on the diaphragm slide to permit rapid switching between the object being observed and the adjacent sky.

Dollfus described a light-modulator for photoelectric polarimeters (**50**) and Rudolf at Gottingen Observatory developed special AC apparatus for the polarimetric measurements in red and infrared.

In the field of photographic photometry the work on improvement and automation of iris-photometers has been continued (**51, 52, 53, 54, 55, 58**). The measurements of stellar magnitudes using a recording microphotometer has been reported (**57**). The isophotometer of the Astronomical Institute of the University of Amsterdam have been described (**58**). And an automated instrument counting the number of stars of different magnitudes on a photographic plate has been constructed (**59**).

Wallenquist has constructed a device for photometric calibration of surface photometric or objective prism measurements by means of Schmidt telescopes. In this device the image from a tube sensitometer, mounted inside the telescope, are projected on the plate during the exposure. This instrument has been tested with the 100/135/300 cm Schmidt telescope of the Uppsala Observatory Kvistaberg Station and it seems to give promising results. At the St Andrews University Observatory, as communicated by Stibbs, a new type of tube sensitometer has been developed making use of an integrating sphere with the interior coated with magnesium oxide. This new sensitometer is expected to be a superior substitute for the use of rhodium plated crossed step wedges.

Some experiments with application of the electronic-image methods to stellar photometry should be mentioned.

Now the electronic camera is in routine operations with the 153 cm (61-inch) astrographic reflector of the Flagstaff Station of the Naval Observatory, communicates Kron. The linear relationship between exposure and density has been verified for electrograms. Hence, the camera should be useful for stellar photometry (experimental use is in progress), and it will certainly be valuable for spectrophotometry, for which it will yield the equivalent of photoelectric scans, but with the advantage of data from all elements of the available spectrum simultaneously. Electronic camera of Kron design is planned to be used with the 75 cm reflector of the Leushner Observatory.

The electronic camera of Lallemand has been applied by Lallemand, Canavaggia and Amiot to the photometry of the faintest stars using Schilt's method of measurements (**60**).

A photometer is being designed by Livingston and Lynds using an image tube which permits to register single photoelectrons (**61**).

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OBSERVATIONAL, EXTINCTION AND REDUCTION PROCEDURES

The problem of establishing the best observational, extinction and reduction procedures for stellar photoelectric photometry is a very important one.

A very interesting and important summary report of the works done on these topics in English-speaking countries and Japan, has been prepared by Dr R. Hardie. He writes as follows:—

'On the whole, observers appear to be adopting similar procedures in observing standard stars frequently interpressed among programme stars, and in exercising considerable care to minimize residual errors due to extinction, filter-leaks, and calibration. It would appear that greater reliability and wider agreement among observers are being achieved, probably by improved and refined application of principles that are already well recognized rather than by the introduction of any basic new concepts. Some observers are successfully observing programme and standard stars simultaneously through the use of dual photometers (**1**), others are adopting rigorous constant-altitude techniques to improve the reliability of their photometry (**213**). The adaptation of automated data-handling systems to photometric installations in many observatories has promoted more efficient use of observing time, with consequent improvement in securing sufficient control measures of extinction and standard stars.

'Cousins (**62**) has described the procedures used at the Cape in the well known and highly accurate photometry done there by him and his colleagues. In general transfer work, stars are observed there at equal altitudes (around 30° or 40° zenith distance), standard stars being observed after every 2 or 4 programme stars, depending on whether magnitudes or colours respectively are being sought. Thus, accurate extinction coefficients are not required, as approximate or seasonal means are fully adequate for the very minor differential corrections.

'Recognition of the critical parameters required before setting up the observing programme has been stressed by Hardie (**63**) in order to make more efficient use of photometric observing time. By adopting standards either locally (as in variable-star or cluster work) or at equal altitudes, extinction determinations may be dispensed entirely. On the other hand, in general transfer work where these techniques are not feasible, much programme work may be rendered inaccurate without critical and judicious timing of extinction measures. Rapid extinction measures can be used with small investment of time, and experience with this technique reveals that the zero-points are indeed virtually constant and subject to little change. Moreover, appreciable improvement in accuracy of the extinction coefficients, as revealed by the greater constancy and repeatability of the zero-points, results from measures made over as great a range in air-mass as possible, even up to 5 and 6 air masses. Thus Hardie finds that limiting the observations of extinction stars to an air-mass of 2 or 3, as is more customary, is not conducive to the most reliable transfer work.

'In an interesting exchange of views, Fernie (**14**) and Young (**15**) have focussed some attention on temperature effects in photomultipliers. That the effects of these in practical photometry, by its nature a closely controlled comparison process among stars, is of little consequence is clear from their converging statements and from the experience of other photometrists. Hardie comments that he is unable to find among the zero-points any evidence of significant or discernable temperature variations, within his refrigerated photomultiplier housings, to the degree stressed by Young.

'Osawa and his colleagues and Cousins (**62**) report difficulty in transforming to $U-B$, in common with many observers. The causes have been discussed widely and are no doubt due to the critical location of the Balmer discontinuity within the U band, the width of the band, and the arbitrary original definition of the U stellar magnitudes in which the $U-B$ extinction was taken to have no colour dependent term. This term is now well recognized as being complex, and Hardie is re-examining all the original U,B,V stars in an attempt to evaluate how serious its neglect may be.

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'Argue (**213**) in a red and infrared photometric survey of G and K stars employed a novel reduction method which, in its initial phases, used all stars to define the systems without special reference to stardard stars. "The reduction was unconventional in that the zero points for the separate nights were brought into mutual consistency by means of every observation (virtually). There were no specially observed 'standard stars' in the early phases of the reduction. Only in the final phases were standards invoked to tie up to the standard system. This procedure made it unnecessary to use up observing time measuring the same standards night after night. It is only necessary to ensure that, at any rate, most stars are measured on more than one night and in such a way that all the nights can be intercompared ultimately, and also that the standards appear somewhere in the final output."

'Cousins (**62**) provides many useful details involved in the measurements and reduction of the photometric data, and the reader is referred to his paper for them.

'A number of observers in private communications have asserted that the reduction of data in strict magnitude form (i.e., U,B,V) is superior to that resulting from one magnitude and several colour-indices (i.e., V, $B-V$, $U-B$). With this assertion Hardie takes strong exception, claiming that the results should be identical, as no variation in arithmetical manipulation can possibly lead to different physical results. Given certain functional relationships involving stellar brightness, temperature, instrumental and physical parameters, equations can be arranged in many convenient forms and necessarily must be equivalent, barring inconsistent definition or determination of the various constants and coefficients.

'Dependence of the extinction coefficients on stellar colour-index is undoubtedly somewhat more complex than is generally represented by a simple linear function of the form $k = k_1 + Ck_2$. However, evidence to date in the $B-V$ colour range is sufficient to establish that this linear relation is substantially adequate, second-order effects being barely, if at all, discernible. On the other hand, it has been well established by several observers that in U or $U-B$ the linear form is entirely inadequate.

'It is emphasized by Hardie that no reduction procedure, however sophisticated, can provide data not inherently contained in observations which are not infinitely precise. Observers have sometimes sought to solve by elaborate simultaneous least-squares solutions for many or all parameters (magnitudes, colours, coefficients, constants, etc.) within a night's or session's observations, without having planned to include critical observations in the programme. For example, transformation constants require a wide range of colour-index simultaneously with no range in air-mass for optimum determination; extinction coefficients (and stable zero-points) require a great range in air-mass, virtually at the same time or within a very short time interval; colour dependent (second-order) extinction terms require very close pairs of wide variety of colour observed repeatedly. If appropriate observations are secured at the telescope during the programme, then the simultaneous reduction for all parameters will indeed provide valuable and reliable data; however, if the needed observations were not secured, the results will be much weakened by the distribution of errors throughout all parameters. Since some parameters (such as transformation constants, and certain second-order extinction coefficients) are inherently more constant and stable than others (such as the principal extinction coefficients) and are thus capable of more precise determination, spurious errors may be associated with them which more properly belong elsewhere. The reduction procedure is merely a convenient mathematical treatment of data of finite accuracy and information content; it cannot take the place of critically and deliberately planned observing procedure.'

Only a few remarks should be added to this general report.

In Europe, where climatic conditions are not so perfect as in western parts of the United States, Chile or South Africa, simultaneous determinations of extinction are necessary to obtain accurate values of extra-atmospheric magnitudes and colours.

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A very elaborate method of this kind has been worked out by Ruefener at the Geneva Observatory (**64**). In the U.S.S.R. Nikonov's extinction procedure is generally used. This procedure, permitting to obtain extra-atmospheric magntiudes and colours with minimum of auxiliary observations, becomes extremely simple when applied to quasi-monochromatic systems (spectrophotometry, narrow-band photometry and also intermediate-band one, if the half band width does not exceed approximately 300 Å).

But even at such perfect site as Cerre Tololo it was found necessary to use mean values of extinction for every night if the highest accuracy should be attained. A special extinction procedure has been developed by Gutierrez-Moreno, Moreno, Stock, Torres and Wroblewski (**220**). Taking account for the dependence of second-order extinction coefficient from the position of the star on the two-colour diagram they could obtain a really extra-atmospheric system of $U-B$ colours.

The anomalous run of extinction in the ultraviolet region for early-type stars has been also considered by Hardie, Heiser and Weedman (**65**) and Ažusienis and Straižys (**66**).

Some other papers dealing with extinction procedures should be mentioned. Gutièrrez-Moreno and Stock discussed the problem of the accuracy of extinction determinations (**67**). Several methods for determination the extinction have been used by Jerzykiewicz and Serkowski during the course of photometrical study in the B,V system of Neptune, Uranus and F–G stars. They led to essentially the same results (**68**). Przybylski worked out some improvements in the extinction procedure (**69**). Uranova improved Hardie's method (**70**). A paper of Dachs, Haug and Pfleiderer is devoted to extinction measurements by photoelectric star photometry (**71**). A review of extinction procedures was given by Edwin and Berg (**72**).

Special observations of extinction have been carried out at several observatories. A photoelectric scanner was used at the Inter-American Observatory at Cerro Tololo by Gutièrrez-Moreno, Moreno, Stock and Sanduleak to study the wavelength dependence of extinction. The results showed exceptional transparency in ultra-violet (**73**). Głeboçki has determined the wavelength dependence of extinction by photographic spectrophotometry at Torun Observatory (Piwnice) for four different types of weather (**74**). Photographic and photovisual extinction for the same place and the same types of weather were determined photographically by Wegner (**75**). Photoelectric measurements of extinction have been carried out in South Africa by a ESO group; the mean extinction coefficients were obtained for Rockdale Mt; Flatehill and Zeekougat. Kivila and Eelsalu carried out such measurements at W. Struve observatory (Tartu) (**76**). Extinction for some other places were studied too (**77, 78**).

At the Remeis Observatory, Bamberg, Kohler made an investigation of colour extinction with six interference filters. Their bandwidths were between 70 and 100 Å and effective wavelengths covered the region from 3530 to 6150 Å. It was shown that the observations cannot be interpreted by the well known formula $k_h \sim \lambda^{-\alpha}$ (magnitudes), and the determination of precise extra-atmosphere colour-indices with narrow band filters should be based on special measurements of colour extinction. Studies of extinction carried out at Mt Elbrus (in visual and infrared) showed that even at high altitudes the wavelength dependence of extinction does not follow the λ^{-4} law (**79**).

It is interesting that the eruption of volcano Mt Agunga in Indonesia caused a large increase of extinction in Chile, Australia and South Africa (**86, 69, 87**).

The very important problem of sky background (geophysical, astronomical and interplanetary) has been considered by Roach (**88**). Fluctuations in the sky background as a limiting factor in the photometry of faintest objects were studied by Miller (**89**).

Some instrumental effects in photoelectric photometry were considered: Red-leak corrections in ultraviolet photometry by Shao Cheng-Yuan and Young (**90**) and filter transmission effects on photoelectric measures of rotationally broadened Hβ line strength by Abt and Osmer (**91**).

The problem of accuracy of photographic photometry has been carefully studied by Vanýsek (**92**). The comparison of photographic photometries made in Hamburg and Edinburgh with photoelectric photometry carried out with the new automated telescope of Edinburgh Observatory were published by Lawrence and Reddish (**93**).

The usually adopted method of calibration of the photographic magnitudes is the observation of photoelectric standards in the same fields. But the problem of the transfer of photometric measurements from one field to another is still actual. This problem was studied at the Bonn University Observatory, as it was reported by H. Schmidt. Two open cluster (NGC 744 and 952) with known *UBV* magnitudes are photographed on different halfs of the same plate by a Schmidt telescope. It will be studied whether the magnitudes derived for one cluster from the other agree sufficiently well with the known magnitudes to permit the use of this method for the determination of magnitudes in a star field where no magnitude standards are given. Furthermore, since NGC 957 is close enough to the field to be photographed on the same plate during a single exposure, the field magnitudes thus derived can be compared with those found by the previous method (Karimie).

The problems arising in the photographic photometry of faintest objects have been considered by Eelsalu and Kalv at the W. Struve Observatory, Tartu (**95, 96**).

A photographic method 'Method of star trails' is being used at Tashkent Observatory for detection of rapid variations in star brightness (**97**).

Methods for separating the polarization of stellar radiation from interstellar polarization have been developed by Shakhovskoi at the Crimean Observatory and Vardanian at the Burakan Observatory (**98, 99, 100**).

Turning now to the reduction procedures, it should be mentioned that at several observatories special programmes for reduction of photometric and polarimetric observations have been developed. So, Bertiau worked out at the Castel Gandolfo Observatory programmes for reduction of the *UBV* measures (**101, 102**) and for reduction of iris-microphotometer measurements too, including corrections for varying sky fog (**103**). At Kitt Peak Observatory computer reduction programmes are available for the photoelectric measurements, either with punched cards or with paper tape produced directly at the telescope. A computer programme for reduction of the photographic measurements of magnitudes by means of standard stars has been prepared by Miss Sundman at Stockholm Observatory.

In connection with the problem under consideration Cousins remarks that the hand processing has been found at the Cape Observatory to give more prompt results than machine processing, but machine data processing has been found convenient when promptness is not important, with the final stages of reductions being done by hand to allow individual attention to the observations.

PHOTOMETRIC SYSTEMS

The development of the work on photometric systems were characterized by extension of *UBV* systems to red and infrared, forming a wide band multicolour system of Johnson *UBVRIJKLMNQ*, covering the wavelength range from 3000 Å to 20μ, and by increasing role of other multicolour systems (wide, intermediate and narrow-band ones) devoted, in general, for solution of special problems, and especially the problems of stellar astronomy.

Summarizing the work on wide band systems Dr A. W. J. Cousins writes:

'The *UBV*-system is one most generally used for wide-band photometry by both photoelectric and photographic observers. The *RGU*, *PV* and S'Pg, S'pv (**202**) systems and $(U-B)_c$ (**197, 196**) are still being used, mainly by those who have used them in the past or in continuation of programmes for which they had previously been adopted. More work has been done in

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the red and infrared; the choice of band depending more on the purpose in view, with less emphasis on standardization than at shorter wavelengths. There has been an increasing tendency to use narrower and more clearly definite bands.

'Several extensive series of *UBV* observations of bright stars have been completed since the last Report (**212, 188, 189, 190, 191, 192, 184, 185, 210, 220**). An important feature of these series is that they include a fair sample of equatorial stars so that there is now, for the first time, a good overlap between the work of observers in the northern and southern hemispheres. These, and earlier series, leave little doubt that V and $B-V$ as observed at the Cape and Cerro Tololo are on essentially the same system as these observed from the northern hemisphere (**200, 184, 185**). There are small local and perhaps seasonal (**15**), differences in zero point between the different series of about the same size as the s.e. of one magnitude or colour index, but there is little correlation between them and it is probable that the zero point errors of the combined series do not reach $0^m.01$ for V and $0^m.005$ for $B-V$ in any part or the equatorial zone, or in the E regions on which the Cape zero points depend. Johnson and associates have shown (**184, 185**) that there are small zero point and colour differences between the Catalina Mountains series and the observations made at Cape, but it is also apparent that there is not complete homogenity between their new observations and earlier measures that are believed to be on the *UBV* system. For most purposes the differences are of no practical importance, but it is now becoming important to discuss whether or not the present definition of the *UBV* system* is adequate.

'The position is less satisfactory for $U-B$ because there is difficulty in reconciling the observations made with different photometers. The transformations from natural to standard system frequently involve both $B-V$ and $U-B$, and the same relation may not be valid for all luminosity classes and different degrees of reddening. There is not much difference between the Cape $U-B$ system and that of the Arizona-Tonantzintla Catalogue (**184, 185**) for main sequence stars earlier than type G and for normal giants of later types, but there are some large discrepancies for high luminosity stars. A natural ultraviolet system depends rather critically on the filters and other components in the photometer and the method of allowing for extinction (**71, 220**). Although no short-wavelength cut-off filter was used for the original U system, it should not be forgotten that the 1P 21 photomultiplier has a glass envelope. The glass must not be too thick, but if the photomultiplier has a quartz window it is important to include glass elsewhere in the optical path. Some observers have pointed out that Schott UG 2 is to be preferred to Corning 9863 glass for the U filter because of the much smaller red leak (**212, 90**).

'The Cape $U-B$ system needs some minor changes (**185**) to make it conform more closely with the system of the Arizona-Tonanzintla Catalogue but after that, and except for the high luminosity stars, there is satisfactory agreement with that catalogue and also with Johnson and Harris, Argue (**212**) and for the later type stars observed at Cerro Tololo (**220**). Stars of the earlier types in this last list are not on the same system. The local zero point errors of these series do not appear to exceed $0^m.01$. There is poor agreement for very red stars between all the lists but the differences appear to be mainly random. Stellar variability and the relatively small amount of ultraviolet light present are certainly contributing factors.

'Young has warned observers using wide-band systems of the danger of seasonal effects due to temperature changes of the filters (**16**) as well as photomultipliers (**13, 15**). Ageing of the aluminium surfaces in reflectors can produce even larger systematic effects, especially in the U band. Ažusienis and Straižys (**104, 105**) have derived corrections to the response curves published by Johnson** to include these and other factors.

*H. L. Johnson, D. L. Harris, 1954, *Astrophys. J.*, **120**, 196.

H. L. Johnson and W. Morgan, 1951, *Astrophys. J.*, **114, 522.
H. L. Johnson, 1955, *Ann Astrophys.*, **18**, 292.

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'Van den Bergh finds that $Q = (U-B) - 0{\cdot}72\ (B-V)$ is a good reddening free metallicity index for globular clusters and that the intrinsic colours of globular clusters in M31 and the galaxy are adequately represented by the relation $(B-V)_0 = Q + 1{\cdot}00$. He has also found that the transformation equation from $P-V$ to $B-V$ for globular clusters is $(B-V) = 0{\cdot}07 + 1{\cdot}07\ (P-V)$, which differs significantly from that given by Kron and Mayall* for single stars because of the very different energy distributions and removes an apparent discrepancy between globular cluster observations by Hiltner and those of Kron and Mayall.'

The properties of the *UBV* system and its two-colour diagram have been carefully discussed. At Vilnius Observatory Straižys, Zdanavičius and Ažusienis considered the response curves, relation between 'winter' and 'summer' *UBV* systems, red leak effect, extinction corrections, systematic differences between different catalogues of Johnson and his associates etc. (**104, 105, 106, 107, 108**). The two-colour diagram was considered by Ažusienis, Straižys, Wampler and Nikolov (**109, 110, 111, 112**). The properties of *UBV* system were discussed also by Karyagina and Kharitonov (**113**) and Osawa (**114**). An effect in modification of the system *UBV* by Fraunhofer lines has been studied by Wilday (**115**).

According to opinion of Walraven the connection of *UBV* photometry between Northern and Southern Hemisphere seems rather weak. The residuals of the difference Cape-Leiden in magnitude *V* show variations with right ascension with total amplitude of about $0^{m}_{\cdot}03$.

The new *UBVRIJKLMNQ* system of Johnson and his associates (**185**)—the extension to longer wavelength of *UBV* system—has been developed. Its response curves are published (**116**), and absolute calibration of this system is carried out (**118**).

A summary of recent infrared astronomical measurements were published by Johnson (**119**). Some very interesting papers dealing with infrared photometry must be mentioned (**120, 121, 122, 123**). In the last paper the first observation in *Q* system ($\lambda_e \sim 20\mu$) is reported.

A theoretical discussion of some problems of wide-band photo-electric photometry has been carried out by Eelsalu (**124**). An investigation of the *RGU* photometric system was published by Straižys (**125**), and the blanketing corrections for this system were considered by Smith and Steinlin (**126**).

Turning to the multicolour systems we like to mention publication of papers presented on the IAU Symposium No. 24: Spectral Classification and Multicolour Photometry (**127**).

The wide-band seven-colour system of Golay has been carefully tested by observations (**128** to **139**).

The intermediate-band systems by Strömgren, Borgman and Walraven are being used now for regular observations.

A four-colour intermediate-band system by Neff (**140**) covering the wavelength region 3330–5500 Å has been applied for discrimination between late-type dwarf and giant stars.

At Vilnius Observatory the work on the Straižy's multicolour system has been continued (**141** to **147**). Successful tests of two versions of this seven-colour system (with glass and interference filters) are being carried out at Vilnius and Crimean Observatories.

The problem of optimal choice of colours for multicolour photometry were considered by Steinlin (**148**).

Several narrow-band photometric systems have been developed, studied and used for practical observations.

The narrow-band photometry of hydrogen lines and especially Hβ is widely used, and in particular for determining luminosities of early-type stars (**149** to **156**).

*G. E. Kron, M. W. Mayall, 1960, *Astr. J.*, **65**, 581.

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Narrow-band photometry of late-type stars is being developed (**157** to **165**). The work on the infrared narrow band photometry is being carried out also (**166**). Bahng at Dearborn Observatory is working with an infrared narrow band system (*XYZ*), using interference filters centered at 1·21, 1·59 and 2·15μ. The corresponding half-width are 77, 86 and 98Å. A lead-sulphide cell is used. The *X* and *Z* bands are very similar to *J* and *K* bands of Johnson, but are much narrower—by a factor 5 or so. The *Y* band has no corresponding band in other infrared systems. Bahng's opinion is that this band is very important in stellar photometry, as it coincides very nearly with the H^- opacity window in the stellar atmospheres.

Some other papers dealing with the photometric systems should be mentioned. Photographic system near to *UBV* (**167, 168, 169**) and *RGU* (**170**) have been described. The properties of different photometric systems from the points of view of influence of absorbtion lines (**171**) or measuring of metal content (**172**) have been compared.

Comparison of different photometric systems is considered in (**173, 174, 175, 176**). V. Shevchenko at Tashkent Observatory proposed to use the observations of a regular variable star, having a well determined light curve in a standard photometric system, for determination of a transformation formula connecting instrumental and standard systems (**177**).

The important problem on the relation between heterochromatic and monochromatic magnitudes in three-colour systems have been considered by Straižys (**178**).

The questions of relations between a wide-band and intermediate band system are being discussed by Walraven. He communicates: 'From the observations with the five-channel photometer of the Leiden Southern Station a large number of bright stars were selected, which are also present in the Photometric Catalogue of the Cape Observatory (*R. Obs. Bull.* no. 64).

'The transformation of magnitude *V* of the Leiden *VBLUW* system to the magnitude of the Cape *UBV* system is not linear but reliable.

'Likewise the transformation for colour $B-V$ is possible with reasonable accuracy, although the relation between the wide band *UBV* and intermediate band *VBLUW* system is strongly non-linear and depends also on reddening and luminosities of the stars.

'The transformation of $U-B$ is unreliable due to the width of band *U* of the *UBV* system.'

Walraven remarks also that the effective wavelength of the bands *V* and *B* of the *UBV* photometry, which follows from the transformations of the *VBLUW* system and from the accurately determined effective wavelength of the latter, deviate from the values, which are generally adopted.

In conclusion we like to emphasize that the intermediate and narrow-band systems have a great advantage over the wide-band ones to operate with the quasi-monochromatic magnitudes when it is possible to neglect practically all changes of effective wavelength with spectral type, extinction or interstellar reddening (the half width of response curves does not exceed approximately 300Å for a quasi-monochromatic system). In these systems reductions for extinction and transformation to a standard system are very simple; the Forbes effect and curvature of reddening lines on two-colour diagrams are absent. As a consequence, a much higher accuracy can be attained.

PHOTOMETRIC STANDARDS

The problem to establish photometric standards of highest accuracy depends not only on the precision of observations and extinction procedure, but, of course, on the internal stability of stellar radiation (stellar microvariability).

Jackisch (Sonneberg Observatory) returned to this problem during his stay at Kottamia Observatory (United Arab Republic). Using a 25 cm reflector he tested photoelectrically 210

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A-type stars of III and V luminosity classes to study their stability. The preliminary result is that the variability is being found for 20% of stars studied with amplitudes between $0^m.03$ and $0^m.06$ (**179, 180**).

On the other side the photoelectric observations of Neptune, and Uranus carried out by Jerzikiewicz and Serkowski in 1950–66 years (**68, 221**) were used to study the problem of solar and stellar variability. It was shown that the short period variations of solar brightness do not exceed $0^m.003$. The high stability of solar type stars was stated too. The observations of 15 stars of spectral type F and G in the years 1950–66 indicate that for none of these stars does the standard deviation of the yearly mean magnitude exceed $0^m.008$ and for some stars this deviation is even less than $0^m.004$. The V magnitudes and $B-V$ colours of about 50 F and G stars were determined during the course of this work. Their mean errors do not exceed $0^m.003$, so the third digit beyond the decimal is quite significant.

As communicates Feinstein, it was decided to include in the observing programme of La Plata Observatory nearly 30 bright and very red stars ($B-V > 1{\cdot}6$) to check the possibility of using them as standards if they don't show light variation. The measurements are being carried out in the *UBVRI* system.

Cousins (**181**) and McCullogh (**182**) support the point of view on the general constancy of stellar radiation.

As C. Jaschek reports the reference catalogue of all photoelectric measurements is in progress. At the present it contains about twenty thousand stars and six hundred references. It is hoped that it can be published in 1967.

The practical work on the photometric standards is being summarized by Professor E. Rybka:

'Several catalogues containing the standard magnitudes of bright stars have been published during the past three years.

'In 1964 the third edition of the Catalogue of Bright Stars (**183**) appeared, where magnitudes and colours for nearly 50% of stars have been compiled by Klemola and reduced to a common system, for over 1100 stars the HR magnitudes revised by Rybka have been included. For remaining stars, for which neither photoelectric nor revised by Rybka magnitudes were available, the original HR magnitudes have been retained.

Comprehensive catalogues have been published by the Lunar and Planetary Laboratory of the University of Arizona (**184, 185**). The catalogue (**184**) contains magnitudes V and colour $U-V$, $B-V$, $V-R$, $V-I$ for 1325 naked-eye stars determined in Catalina Mountains and at Tonantzintla observatories. For some southern stars, Cape Observatory values are given. Still more comprehensive photometric lists have been published in (**185**), where results of the Arizona multicolour photometric work has been presented. Of the stars listed in (**185**) 1567 were observed in U, B, V, R and I, 653 in J and K and 268 in L. The southern Cape photometry has been transformed into the *UBV* system and a catalogue of *UBV* photometry on 4780 bright stars over the entire sky was given.

'Photoelectric magnitudes and colours of pairs of 6^m stars of A and K spectral types near the Kapteyn's S.A. 1 – 139 have been determined from observations made at the Crimean Observatory in the years 1959–61. The catalogue (**186**) contains magnitudes and colours of 278 stars both in the natural ***ubv*** and in the *UBV* systems. It is planned to extend the determination of fainter photometric standards in S.A. at the Abastumani Observatory.

'Astronomers from Cape Observatory continued the *UBV* photometry of bright stars. The Cape observations of "Stars in the Equatorial Zone" were completed in 1964 and have been published (**187, 188, 189, 190, 191**). Publication (**192**) is a continuation of *Royal Observatory Bulletin* no. 64. Observations of HR stars, south of $-10°$ (V, $B-V$ and $(U-B)_c$) are being continued and several lists have been published by Lake and Corben (**193, 194, 195, 196, 197**).'

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Dr Cousins remarks: 'The completion of four new series observed elsewhere has at last provided the overlaps that were needed to show that the northern and southern *UBV* systems are in good agreement. These are: "The Arizona-Tonantzintla Catalogue" of Johnson and his colleagues (**185**), Stock and Moreno's observations at Cerro Tololo, Argue's observations of F, G and K type stars at Kitt Peak, and Häggkvist and Oja's observations of bright stars from Uppsala (**210**). These observations have now been incorporated in the photometric catalogue of bright stars being compiled at the Cape Observatory, that includes all stars south of + 10° declination with HR magnitude 5·0 or brighter. The standard errors of the mean magnitudes of nonvariable stars are nearly all less than $\pm$ 0^m.01. The s.e.'s of $B-V$ and $U-B$ are usually less than $\pm$ 0^m.005 and $\pm$ 0^m.015 respectively. The northern and southern V and $B-V$ systems have the same colour equations and mean zero points but the new material has shown the need for some small corrections to the Cape $U-B$. After that there is satisfactory agreement between the Arizona and Cape $U-B$ for main sequence stars earlier than type G (of which there was a fair sample in the Johnson and Harris list) and for class III giants of later type, for which the transformation has previously been uncertain.'

Wallenquist reports on the works on photometry made in Sweden:

'1. Lund Observatory.

Roslund has determined magnitudes and colours photoelectrically for 250 stars of early types in Milky Way field in Scorpius in the *UBV* system (**204**).

2. Stockholm Observatory, Saltsjöbaden.

L. Lodén has reported that a list of photometric standard sequences in the Southern Milky Way is under preparation (covering a.o. the Crux region). For the standard sequences 15–20 stars are selected in each region. The stars have been measured photoelectrically in the *UBV* system at the Boyden Observatory. An extensive programme for photographic photometry in two colours of early and very late stars in Centaurus is in progress.

K. Lodén has determined B and V magnitudes and spectral classes for 450 stars in the S.A. 193 on the basis of plates secured at the Boyden Observatory. The catalogue will be published soon in *Stockholm Observatoriums Annaler*.

Sinnerstad reports that Arcling has determined *UBV* magnitudes photoelectrical for about 30 standard stars for the determination of the atmospheric extinction. Sinnerstad is making photoelectric photometry in the *UBV* system (Strömgren photometer) for trying to find luminosity criteria suitable for Schmidt-spectra.

3. Uppsala Observatory.

T. Elvius reports the following photometric investigations which are carried out at Uppsala under his supervision:

Sjögren: The catalogue (**206**) gives V and $B-V$ for 76 stars in S.A. 8.

T. Elvius is determining *UV*-magnitudes in S.A. 19 on the basis of plates secured at Kvistaberg by means of the large Schmidt telescope.

T. Elvius and Lyngå carried out three-colour photometry of 43 stars in S.A. at southern latitudes (**205**).

T. Elvius and Häggkvist: (**207**) contains V and $B-V$ photoelectrically determined for 75 stars.

Ljunggren determined photoelectrically V and $B-V$ for 298 stars (**208**).

Ljunggren and Oja: (**209**) contains photoelectrically determined V and $B-V$ for stars chiefly situated at low galactic latitudes.

Häggkvist and Oja: (**210**) contains V and $B-V$ for all northern stars brighter than m = 5·25, according to Catalogue of Bright Stars.

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Oja: (**211**) contains spectrophotometric data for 2500 stars situated in the region $80° < l^1 < 100°$ and $|b^1| < 3°$.

Oja: **(211a)** contains *UBR* magnitudes for about 2000 stars within a square degree around the cluster M 103 as well as spectrophotometric data for about 1000 stars.

Häggkvist: **(211b)** contains photoelectric magnitudes and colours for 72 visual binaries.

Eriksson is making a spectral classification of about 3000 stars situated in the neighbourhood of the Southern Galactic Pole. Moreover he has determined photographically *B* and *V* magnitudes for about 10 000 stars (will be published soon).

Linden: photoelectric determinations of *B* and *V* magnitudes for stars in S.A. 18 (60 stars) and S.A. 19 (40 stars).

Ekedahl: photographic determination of m_{pg} and m_{pv} for 273 stars in the S.A. 4 (ready for publication).'

Argue draws attention to his two papers (**212, 213**). The paper (**212**) includes magnitudes and colours for about 130 equatorial stars expressed in the northern *UBV* system, which were observed with the intention of strengthening the tie between the northern and southern system. In (**213**) the magnitudes and colours have been derived from measurements made with an RCA 7102 photomultiplier and the following four filters: 6900 Å interference filter (r); Schott RG8; Schott RG9; 1·00 micron interference filter (i) The r magnitudes and $(r - rg8)$ and $(r - rg9)$ colours are similar to Kron's R and $(R-I)$ while $(r - i)$ can be transformed to a colour very similar to the Arizona-Tonantzintla $(R - I)$. The catalogue may thus provide a useful selection of sub-standards for later types. The limiting magnitude is about $R = 8^m$.

Argue remarks: 'It might be worth while for the Commission to consider whether the original definition of the *UBV* system in terms of stars mostly situated in the Northern Hemisphere is still adequate? With the rapid increase in activity in the Southern Hemisphere it would be better to redefine it in terms of equatorial stars. The opportunity should also be taken to advocate the use of the UG2 ultraviolet filter in place of the Corning 9863 which requires a considerably larger correction for red leak on late type stars.'

Some other photometric catalogues are to be mentioned: (**214**) contains seven-colour photometry of 342 stars in the Golay's wide-band photometric system.

The catalogue (**215**) includes *BVRI* photometry in Johnson's system for 275 stars mainly between $-25°$ and $-50°$.

The results of *UBV* photometry of 263 stars of B, A0, A1 and A2 spectral types in S.A. 8 ($7^m.8 < m_v < 13^m$ according to BSD) are given in (**216**) and (**217**). And for S.A. 40 in (**218**).

Osawa published the *UBV* photometry for 211 peculiar A stars (**219**).

Van den Bergh informs that at the David Dunlap Observatory McClure is currently carrying out an extensive programme of intermediate band photometry of stars, clusters and galaxies with the 74-inch telescope (λ_{eff} 3800, 4150, 4250, 4500 and 4861 Å); Racine is currently obtaining *UBV* photometry of most of the northern stars which are known to be located in reflection nebulae.

A very precise catalogue for 366 stars have been observed at Cerro Tololo by Gutierrez-Moreno, Moreno, Stock, Torres and Wroblewski in the *UBV* system (**220**).

As it was mentioned above, in the course of photometric observations of the planets Neptune and Uranus, made at the Lowell Observatory for a number of years, 50 stars, mostly of spectral types F and G and situated along the ecliptic, were repeatedly observed in the *B*, *V* system. For the stars observed on about 25 nights the mean errors are about $\pm 0^m.003$ and $\pm 0^m.002$ for V and $B-V$ respectively; for stars observed on about 100 nights these errors are $\pm 0^m.002$ and $\pm 0^m.001$ (**221**). That is, perhaps, the most accurate B,V photometry than any other published until now.

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As communicates Crawford, at the Kitt Peak Observatory *UBV* measurements have been made for all stars B5 or earlier brighter than $V = 6{\cdot}5$, and of declination above $-10°$.

Some other *UBV* photometries should be mentioned, carried out for specially selected groups of stars (**222** to **223**).

Recent observations of stars in the red and infrared photoelectric systems are published in papers (**234, 235, 236, 237, 238, 239**).

Intermediate-band photometric systems: Graham is now carrying out at Kitt Peak Strömgren four-colour photometry for faint high latitude blue stars, as communicates Crawford. Special attention is being paid to stars which have already been studied spectroscopically by Greenstein and others. Crawford and his associates at Kitt Peak are pursuing narrow and intermediate band photometry on the Hβ snd Strömgren four-colour systems for a number of galactic clusters and for the bright field stars. Crawford is preparing a list of standard stars and the discussion of Strömgren four-colour photometry reduction procedures. This work should be in press by the time of the IAU meeting. A catalogue of Strömgren's *ubvy* and Hβ photometry of 749 B5–Fo stars observed by Cameron, will appear in a *Georgetown College Observatory Monograph* in late 1966. This catalogue includes data for approximately 300 Ap stars and 100 Am stars. Seven-colour photometric observations on Strömgren's *ubv* and Crawford's *abc* systems have been continued. Bigay communicates that it is expected to carry out observations in Strömgren's system of stars in S.A. near galactic plane and of Luminous Stars. Some considerations concerning his system were published by Strömgren (**241**).

Borgman applied his seven-colour system for observations of 102 stars belonging to spectral types from A to M, and located nearer than at 20 pcs. Mean errors of colours were found to be from $\pm$ 0^m.008 to $\pm$ 0^m.002 (**242**).

The Walraven's system has been used for observations of high velocity stars by Ponsen and Oosterhoff (**243, 244**) and by Graham and Lyngå for observations of 454 OB stars in Carina (to be published in a recent Mt Stromlo Memoir).

Hydrogen lines photometry: Crawford and Mancler published a list of standard stars for photoelectric Hβ photometry (**245**). β-indexes have been observed by Crawford for 93 stars in the region of 'Orion belt' (**246**). Hα photometry of late-type stars has been carried out by Peat (**247, 248**).

A summary of all photoelectric observations for stars O9–B3 (III and V luminosity classes) having Hα in emission were compiled by Schmidt-Kaler (**249**)

Very important successes were attained in quasi-monochromatic and monochromatic photoelectric photometry (spectrophotometry).

Narrow-band photoelectric colour-indices for 25 bright stars O9–F5 have been observed in 16 bands ($\Delta\lambda \cong 54$Å) in the region 3200–6400Å) by Bahner (**250**). Observations of α Lyrae have been calibrated using a lamp.

Absolute measures of energy distribution in stellar spectra have been carried out by Willstrop (**251**), Oke and Conti (**252**), Kharitonov, Karjagina and Neljubin (**253, 254, 255, 256, 257**).

Photoelectric spectrophotometry of selected bright southern stars has been carried out by Aller, Falkner and Norton (**258, 259**), and for F2–K7 stars by Van den Bergh and Sackman (**260**).

Irvin communicates that a programme of photoelectric scanning of all stars south of declination +20° and brighter than visual magnitude 5·0 with spectral type later than A9 has been initiated at Inter-American Observatory at Cerro Tololo and is 45% complete. The scans are from 3100 to 6000Å with a bandpass of 80Å. The region shortward of 4000Å is especially interesting and the Tololo sky is excellent for this purpose.

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Standard stars for infrared region have been recommended by D'Agati (**261**).

As Heddle has mentioned (**262**), accurate absolute calibration of photometric data in the visual region are very needed to obtain precise relation between this region and the ultraviolet observed from outside the atmosphere.

At the present time we have no photometric systems for the ultraviolet region with $\lambda < 3000$ Å. But very important photometric observations have been carried out in this region from rockets and satellites (**263, 264, 265, 266, 267, 268, 269**). As an example of a very interesting astronomical result we like to mention here the determination of the law of interstellar extinction for the wavelength down to 2200 Å obtained by Boggess III and Borgman (**270**).

Almar proposed to use a slowly moving satellite with known photometric parameters for calibrating the scale of stellar magnitudes (**271**).

Among several polarimetric measures of stellar radiation we will mention the *UBV* (and for some stars *UBVRI*) observations carried out by Krzeminski and Serkowski at the Lowell Observatory (**272**), the *UBV* Stepien's measures in the polar region (**273**), observations of Kruszewski (**274**) and Serkowski (**275**) at Belgrad Observatory and polarimetric investigations of L. Lodén in the Milky Way (**276**).

Many papers dealing with photographic photometry of different stellar fields, which could not be regarded as sources of photometric standards and belongs to competence of other IAU Commissions were not included in the present report.

President of Commission is very grateful to all members of Commission who kindly sent their reports to him or to members of the Organizing Committee, and he is especially grateful to the members of Organizing Committee for their great work in preparing special parts of the report.

V. B. NIKONOV
President of the Commission

BIBLIOGRAPHY

Instrumentation and observational methods

1. Reddish, V. C. 1966, Twin 16-inch photometric reflectors at Edinburgh. *Sky Telesc*, **32**, 124.
2. Evans, D. S. 1964, The new Cape reflector. *Observatory*, **84**, 222.
3. Stoy, R. H. 1964, The Elizabeth telescope. *Mon. Notes astr. Soc. Sth. Afr.*, **23**, 56.
4. Dombrovsky, V., Gagentorn, V., Gutkevich, S., Poljakova, T., Sveshnikov, M., Shulov, O. A. 1965, A 20-inch reflecting telescope with photometer for photoelectric, colourimetric and polarimetric observations (in Russian). *Uchenye Zapiski Leningrad. Univ.*, no. 328, 83.
5. Hiltner, W. A. 1965, A rotable telescope for polarization studies. *Sky and Telesc.*, **30**, 144.
6. Iwanowska, W. 1963, Telescop Schmidta-Cassegraina w Polsce. *Nauka Polsca*, **11**, no. 2, 95.
7. Baum, W. A. 1964, Photosensitive detectors. *A. Rev. Astr. Astrophys.*, **2**, 165.
8. Smith, R. 1965, Detectors for ultraviolet, visible and infrared radiation. *Appl. Opt.*, **4**, 631.
9. Fain, D. L. 1965, Photomultiplier sensitivity limitations. *J. opt. Soc. Am.*, **55**, 206.
10 Shulov, O. 1965, General parameters of photomultipliers FEU-31 and FEU-64. (In Russian.) *Uchenye Zapiski Leningrad. Univ.*, no. 328, 95.
11. Blackwell, D., Petford, A., McCrea, S. 1965, An image-scrambler for use with a photomultiplier. *Observatory*, **85**, 21.
12. Schmeidler, F. 1965, Temperatureffekte bei Multipliern. *Sterne*, **41**, 211.
13. Young, A. T. 1965, Effects of photomultiplier temperature variations in astronomical photometry. *Mon. Not. R. astr. Soc.*, **129**, 215.

https://doi.org/10.1017/S0251107X00030546 Published online by Cambridge University Press

14. Fernie, J. D. 1965, Temperature effects in photomultipliers. *Observatory*, **85**, 169.
15. Young, A. T. 1966, Temperature effects in photomultipliers. *Observatory*, **86**, 71.
16. Young, A. T. 1965, Glass-filter temperature effects in astronomical photometry. *Astr. J.*, **70**, 697.
17. Vitrichenko, E. A. 1966, An investigation of the dependence between the radiation of sources of constant action and temperature (in Russian). *Izv. Krym. astrofiz. Obs.*, **35**, 274.
18. Kutusov, P. S., Mench, K. L. 1966, Use of a luminescent standard of brightness for the sensitivity control of photoelectric photometers (in Russian). *Astr. Zu.*, **43**, 878.
19. Peytremann, E. 1964, Etude et réalisation d'une lampe à effet Čerenkov. *Publ. Obs. Genève*. Ser. A. no. 69, 84.
20. Irvine, W., Picoes C., Charm, J., Lecomte, G. 1964, Effect of high voltage on spectral sensitivity for two photomultipliers. *Astrophys. J.*, **140**, 1629.
21. Korolev, F. A., Klementjeva, A. J., Meshcerjakova, T. F., Shcheglov, P. V. 1963, Multilayer interference filters of high contrast (in Russian). *Astr. Cirk.* no. 272, 1.
22. Ultraviolet interference spectroscopy (Roy. Holloway Coll. London). Space Res. U.K. Rep. 1964–65, 23, 1966.
23. Growes, J. 1966, Amplifier and pulse-counter for fast, low level photometry. *J. scient. Instrum.*, **42**, 430.
24. Artemiev, V. V., Rojnova, I. P. 1963, Photon counting in low level photometry (in Russian). *Izv. Krym. astrofiz. Obs.*, **30**, 297.
25. Dimov, N. A. 1963, Comparison of DC amplification and pulse counting when measuring very weak light fluxes (in Russian). *Izv. Krym. astrofiz. Obs.*, **30**, 308.
26. Veismann, U. 1965, A digitalized printing photoelectric photometer (in Russian), *Novaja Technika v Astronomii*, **2**, 40.
27. Veismann, U., Kübar, T. A photoelectric photometer with the remote control (in Russian). *Publ. Tartu Obs.*, **36** (in press).
28. Veismann, U. Digitalization of photometer's readings (in Russian). *Publ. Tartu Obs.*, **36** (in press).
29. Willstrop, R. V. 1965, A wide-field coma-free all-reflection plane grating spectrometer. *Mon. Not. R. astr. Soc.*, **130**, 233.
30. Mianes, P. 1965, Photométrie en 6 couleurs. Méthode mixte de mesure d'étoiles faibles. *J. Observateurs*, **48**, 103.
31. Xanfomaliti, L. V. 1965, Photometer with pulse counting system 'Volna' PS–5M (in Russian). *Abastumanskaja astrofiz. Obs. Bjull.*, no. 32, 197.
32. Kubyshkin, V. V. 1964, A photoelectric photometer with remote control (in Russian). *Astr. Zu.*, **41**, 738.
33. Nitisastro, S. 1964, The photoelectric instrument at the Bosscha Observatory. *Madjelah inst. Techn. Bandung Proc.*, **2**, 185.
34. Kokhan, E. K. 1966, Photometer AFM–6. Testing observations (in Russian). *Izv. glav. Obs. Pulkove*, **24**, 96.
35. Elvius, T., Eriksson, P., Linden, H., Ljunggren, B. 1964, The new photoelectric photometer of the Uppsala Observatory. Preliminary results for a field in Cassiopeia (S.A. 19). *Ark. Astr.*, **3**, 317.
36. Bigay, J. H. 1963, Mesures photoélectriques en 3 couleurs (*UBV*) d'étoiles O–B et Ao dans les selected areas du plan galactique S.A. 9, 19 et 24. *J. Observateurs*, **46**, 319.
37. Ackermann, C., Hermann, W. 1965, Experimentelle Arbeiten zur lichtelektrische Photometrie im nahen und mittleren Infrarot (0·8 m–5 m). *Mitt. astr. Ges.*, 95.
38. Franz, O. G. 1966, Photometry and astrometry of close double stars by a photoelectric scanning technique. *Lowell Obs. Bull.*, no. 134.
39. Miller, R. H. 1963, The effects of telescopes on astronomical polarization measurements. *Appl. Opt.*, **2**, 61.
40. Clarke, D. 1965, Theoretical considerations in the design of an astronomical polarimeter. *Mon. Not. R. astr. Soc.*, **129**, 71.
41. Clarke, D. 1965, Studies in astronomical polarimeter. II. A double beam polarimeter. *Mon. Not. R. astr. Soc.*, **130**, 75.

42. Pospergelis, M. M. 1965, Electronic polarimeter 'Taimyr' (in Russian). *Astr. Zu.*, **42**, 398.
43. Harvard Observatory Report. 1964, *Astr. J.*, **69**, 660.
44. Loden, L. O. 1964, A photoelectric starlight polarimeter with sky background compensation. *Stockh. Obs. Ann.*, **22**, no. 7.
45. Martel, L., Martel, M-Th. 1964, Polarisation de la lumière des étoiles dans le système *UBVR*, *Ann. Astrophys.*, **27**, 203.
46. Marin, M. 1965, Mesures photoélectriques de polarisation à l'aide d'un télescope coudé de 1 m. *Rev. Opt.*, **44**, 115.
47. Kokhan, E. K. 1964, Testing of the polarimeter of Pulkovo Observatory and of the camera ACU–4 (in Russian). *Izv. glav. astr. Obs. Pulkove*, **23**, 86.
48. Omarov, S., Gadjiev, M. 1966, Polarimetric tests of the 200 mm reflecting telescope of the Shemaha Observatory of the Academy of Sciences of the Azerbajdjan S.S.R. (in Russian). *Soobšč. Shemahinskoj Astrofiz. Obs.*, **5** (in press).
49. Lehnert, Ch., Schmidt, Th. 1965, Ein neues lichtelectrischen Polarisationsphotometer. *Mitt. astr. Ges.*, 81.
50. Dollfus, A. 1963, Un modulateur de lumière polarisée pour polarimètre photoélectrique. *C. r. Acad. Sci. Paris*, **256**, 1920.
51. Seddon, H., Jones, W. 1965, A semi-automatic iris photometer. *Publ. R. Obs. Edinb.*, **5**, 99.
52. Olivier, J. P., Kinman, T. D. 1964, A null indicating meter and other modifications of the Sartorius iris photometer. *Publ. astr. Soc. Pacif.*, **76**, 88.
53. Van Chuan-Zin, Lu dun-Chgen 1965, Improvement in the Sartorius iris photometer and investigation of its errors. *Acta astr. Sinica*, **13**, 57.
54. Urasin, L. A., Urmatsky, A. I. 1965, An iris-type microphotometer (in Russian). *Bjull. astr. Obs. Engelgardta*, no. 38, 101.
55. Urasin, L. A. 1965, An iris photometer on the base of MF–2 microphotometer (in Russian). *Novaja Tekhnika v Astronomii*, **2**, 46.
56. Friedemann, Ch., Schoneich, W. 1963, Uber eine Zusatzeinrichtung zur schleiermessung mit der Irisphotometer. *Astr. Nachr.*, **287**, 187.
57. Wamer, B. 1964, The measurements of stellar magnitudes using a recording microphotometer. *J. Brit. astr. Ass.*, **74**, 99.
58. Koelbloed, D. 1965, The isophotometer of the Astronomical Institute of the University of Amsterdam. *Bull. astr. Inst. Netherl.*, **18**, 62.
59. Kuschbert, D. 1965, Ein Lichtpunktabtastgerat zur automatische Auswertung von Himmelsaufnahmen. *Astr. Nachr.*, **288**, 125.
60. Lallemand, A., Canavaggia, R., Amiot, F. 1966, Détermination des magnitudes d'objets très peu lumineux au moyen de la caméra électronique. *C. r. Acad. Sci. Paris*, **262**, 838.
61. Livingston, W., Lynds, C. 1963, Recent experiments with image-tubes at Kitt Peak National Observatory. *Astr. J.*, **68**, 284.

Observational, extinction and reduction procedures

62. Cousins, A. W. J. 1966, Methods of observation and reduction of photometric observations at the Cape Observatory. MNASSA, **25**, 100.
63. Hardie, R. H. 1966, European Southern Observatory (E.S.O.) colloquium on photometry. Groningen.
64. Rufener, F. 1964, Technique et rèduction des mesures dans un nouveau système de photométrie stellaire. *Publ. Obs. Genève*, no. 66, 413.
65. Hardie, R. H., Heiser, A. M., Weedman, D. W. 1964, Study of anomalous ultraviolet extinction. *Astr. J.*, **69**, 543.
66. Ažusienis, A., Straižys, V. 1964, On the reduction of colour-indices $U-B$ outside the atmosphere (in Russian). *Astr. Circ.*, no. 304, 4.
67. Gutièrrez-Moreno, A., Stock, J. The accuracy of extinction determinations. *Publ. Dep. Astr. Univ. Chile*, no. 1 (in press).
68. Jerzykiewicz, M., Serkowski, K. The Sun as a variable star. III. Photometric observations of Uranus, Neptune, and F and G type stars. *Lowell Obs. Bull.* (in press).

69. Przybylski, A. 1964, The reduction of photometric observations affected by variable extinction (with an application to the effect of the volcanic dust). *Acta astr.*, **14**, 285.
70. Uranova, T. 1966, *Soobšč. gos. astr. Inst. Sternberga* (in Russian), no. 149.
71. Dachs, J., Haug, U., Pfleiderer, J. 1966, Atmospheric extinction measurements by photoelectric star photometry. *J. atmos. terr. Phys.*, **28**, 637.
72. Edwin, A., Berg, R. 1964, Stellar magnitudes and atmospheric extinction. *Astr. J.*, **69**, 557.
73. Gutièrrez-Moreno, A., Moreno, H., Stock, J. 1967, The atmospheric extinction on Cerro Tololo. *Publ. Dep. Astr. Univ. Chile*, no. 1.
74. Głeboçki, R. 1965, Spectrophotometric investigations of atmospheric extinction at Pivnice. *Bull. Obs. Torun*, no. 34, 29.
75. Wegner, W. 1965, The atmospheric extinction in photographic and photovisual ranges at the Astronomical Observatory in Pivnice-Torun. *Bull. Obs. Torun*, no. 34, 21.
76. Kivila, A., Eelsalu, H. An attempt to estimate atmospheric extinction for the *BV* photometry at the new Tartu Observatory (in Russian). *Publ. Obs. Tartu*, **36**, (in press).
77. De Vaucouleurs, G. 1965, Atmospheric absorption at McDonald Observatory, 1960–64. *Publ. astr. Soc. Pacif.*, **77**, 5.
78. Sharov, A. S. 1965, Some characteristics of the atmospheric transparency in the region of the high altitude expedition of Sternberg Astronomical Institute (in Russian). *Soobšč. gos. astr. Inst. Sternberga*, no. 139, 3.
79. Kondratyev, K. Y., Andreev, S. D., Badinov, I. Y., Grishechkin, V. S., Popova, L. V. 1965, Atmospheric optics investigations on Mt Elbrus. *Appl. Opt.*, **4**, 1069.
80. Johnson, H. L. 1965, Atmospheric extinction in the infrared. *Comm. Lunar Planet. Lab.*, **3**, 67.
81. Westphal, Y. 1964, New observations of atmospheric emission and absorption in the 9–14 micron region. *Mém. R. Soc. Liège*, **9**, 357.
82. Kondratyev, K. Y., Naylisk, Kh. J. 1963, On the heat emission of the 9·6 μ ozone absorption band in the atmosphere (in Russian). *Problemy Fisiki Atmosfery*, no. 2, 3.
83. Rasool, S. 1964, Intensities of 9·4 μ and 10·4 μ CO_2 Bands. *Mém. R. Soc. Liège*, **9**, 55.
84. Bignell, K., Saiedy, F., Sheppard, P. 1963, On the atmospheric infrared continuum. *J. opt. Soc. Am.*, **53**, 466.
85. Curcio, J., Drummeter, L., Knestrick, G. 1964, An atlas of the absorption spectrum of the lower atmosphere from 5400 Å to 8520 Å. *Appl. Opt.*, **3**, 1401.
86. Moreno, H., Stock, J. 1964, The atmospheric extinction on Cerro Tolelo during 1963. *Publ. astr. Soc. Pacif.*, **76**, 56.
87. Hill, P. W. 1964, Atmospheric extinction and volcanic ash in the upper atmosphere. *Mon. Notes astr. Soc. Sth Afr.*, **23**, 148.
88. Roach, H. 1964, The light of the night sky: astronomical, interplanetary, and geophysical. *Space Sci. Rev.*, **3**, 512.
89. Miller, R. H. 1963, A limitation on the photometry of faint objects. *Astrophys. J.*, **137**, 1049.
90. Shao, C.-Y., Young, A. T. 1965, Red-leak corrections in ultraviolet photometry. *Astr. J.*, **70**, 726.
91. Abt, H., Osmer, P. 1965, Filter transmission effects on photoelectric measures of rotationally broadened Hβ line strength. *Astrophys. J.*, **141**, 949.
92. Vanýsek, V. 1964, A note on the accuracy of photographic photometry with Schmidt telescope. *Acta Univers. Carolinae, Math. Phys.*, no. 1, 19.
93. Lawrence, L., Reddish, V. 1965, The Cygnus II association. I. Intercomparison of photometries with the Edinburgh and Hamburg Schmidt telescopes. *Publ. R. Obs. Edinb.*, **3**, 279.
94. Bresterhus, E. 1963, Zur Automatisierung photographischer Dreifarbenphotometrie mit Anvendung auf M 37. *Astr. Abhand. Hamburg. Sternw.*, **7**, 15.
95. Eelsalu, H. 1963, On the treatment of stellar-photometrical equations in the case of extremely weak darkenings (in Russian). *Publ. Obs. Tartu*, no. 8, 1.
96. Kalv, P., Eelsalu, H. 1966, An attempt to investigate photometrical properties of faint stellar images on the nonsensibilized photographic plates (in Russian). *Publ. Obs. Turtu*, **35**, 69.

https://doi.org/10.1017/S0251107X00030546 Published online by Cambridge University Press

97. Ishcenko, I. M. 1964, Photographic photometry of star trails (in Russian). *Astr. Zu.*, **41**, 138.
98. Shakhovskoi, N. M. 1963, Investigation of the polarization of variable stars. I. (in Russian). *Astr., Zu.*, **40**, 1055.
99. Shakhovskoi, N. M. 1964, An investigation of the polarization of variable stars. II. (in Russian). *Astr. Zu.*, **41**, 1042.
100. Vardanian, R. 1964, The polarization of T and RY Tau. (in Russian). *Soobšč. Bjurak. Obs.*, no. 35, 3.
101. Bertiau, F. C. 1963, A programme for the reduction of three-colour photoelectric observations. *Ric. astr. Spec. Vatic.*, **6**, 443.
102. Bertiau, F. C. 1965, A programme to establish primary standards in independent three-colour stellar photometric systems. *Ric. astr. Spec. Vatic.*, **6**, 611.
103. McCarthy, M., Treanor, P. M. 1964, Stars in the region of Pleiades. *Ric. astr. Spec. Vatic.*, **6**, 535.

Photometric systems

104. Ažusienis, A., Straižys, V. 1966, On the response curves of the *U,B,V*, system (in Russian). *Astr. Circ.* no. 352, 1.
105. Ažusienis, A., Straižys, V. 1966, The corrections of response curves and parameters of the *U,B,V*, system. I. Response curves (in Russian). *Bull. Vilnius Obs.*, no. 16, 3.
106. Ažusienis, A., Straižys, V. 1966, The corrections of response curves and parameters of the *U,B,V*, system. II. Colour-indices (in Russian). *Bull. Vilnius Obs.*, no. 17, 3.
107. Straižys, V., Zdanavičius, K. 1963, The band width effect and the parameters of system *U,B,V*, (in Russian). *Astr. Cirk.*, no. 254, 5.
108. Straižys, V., Zdanavičius, K. 1964, The influence of the band-width effect on the parameters of the *U,B,V*, system (in Russian). *Astr. Zu.*, **41**, 519.
109. Straižys, V. 1963, On the slope of reddening-lines in two-colour diagrams (in Russian). *Astr. Cirk.*, no. 254, 1.
110. Ažusienis, A., Straižys, V. 1964, On the slope of reddening-lines in $U-B$, $B-V$ diagram (in Russian). *Astr. Circ.*, no. 304, 1.
111. Wampler, E. 1964, The curvature of the reddening-line in the *U,B,V*, colour-colour plot. *Astrophys. J.*, **140**, 1615.
112. Nikolov, N. 1964, On the curvature of the reddening-line in the diagram $U-B$, $B-V$ (in Russian). *Astr. Cirk.*, no. 309, 3.
113. Karyagina, Z. V., Kharitonov, A. V. 1965, Some investigations of the *U,B,V*, photometric system (in Russian). *Astr. Zu.*, **42**, 377.
114. Osawa, K. 1963, An experiment concerning the width of the transmission band of the *U* filter. *Contr. Bosscha Obs.*, no. 21, 25.
115. Wilday, R. L. 1965, On line-blanketing normalization of subdwarf photometry. *Astrophys. J.*, **141**, 943.
116. Johnson, H. L. 1965, Interstellar extinction in the galaxy. *Astrophys. J.*, **141**, 923.
117. Johnson, H. L. 1964, The colors, bolometric corrections and effective temperatures of the Bright Stars. *Bol. Obs. Tonantz.*, **3**, 305.
118. Johnson, H. L. 1965, The absolute calibration of the Arizona photometry. *Comm. Lunar Planet. Lab.*, **3**, 73.
119. Johnson, H. L. 1966, Astronomical measurements in the infrared. *A. Rev. Astr. Astrophys.*, **4**, 193.
120. Wilday, R., Murray, B. 1964, Ten micron stellar photometry. First results and future prospects. *Mém. R. Soc. Liège*, **9**, 460.
121. Low, F. J., Johnson, H. L. 1964, Stellar photometry at 10μ. *Astrophys. J.*, **139**, 1130.
122. Johnson, H. L., Mendoza, E., Wisniewski, W. 1965, Observations of 'infrared stars'. *Astrophys. J.*, **142**, 1249.
123. Johnson, H. L., Low, F. J., Steinmetz, D. 1965, Infrared observations of the Neugebauer-Martz-Leighton 'Infrared Star' in Cygnus. *Astrophys. J.*, **142**, 808.
124. Eelsalu, H. Stellar-statistical approach to the wide-band photoelectric photometry (in Russian). *Publ. Obs. Tartu*, **36** (in press).

125. Straižys, V. 1964, An investigation of the *R,G,U* photometric system (in Russian). I. *Astr. Zu.*, **41**, 406; II. *Astr. Zu.*, **41**, 979.
126. Smith, L., Steinlin, U. 1964, Blanketing corrections for the *R,G,U* system. *Z. Astrophys.*, **58**, 253.
127. Spectral Classification and multicolour photometry. *IAU Symposium No.* 24. Eds. K. Lodén, L. Lodén, U. Sinnerstad, p. 383, 1966.
128. Golay, M. 1964, Photométrie en 5 couleurs et propriétés du diagramme △, *g* (Note 2). *Publ. Obs. Genève*, no. 66, 19.
129. Golay, M. 1964, Position des étoiles métalliques et des sous-naines dans le diagramme △, *g*. *Publ. Obs. Genève*, no. 66, 27.
130. Golay, M. 1964, Etude de quelques étoiles des Pleiades en cinq et sept couleurs. *Publ. Obs. Genève*, no. 68, 29.
131. Golay, M. 1964, Etude de quelques étoiles de Coma Berenices en cinq et sept couleurs. *Publ. Obs. Genève*, no. 68, 64.
132. Golay, M. 1964, Etude de quelques étoiles des Hyades en cinq et sept couleurs. *Publ. Obs. Genève*, no. 70, 179.
133. Golay, M. 1964, Etude de quelques étoiles de Praesepe en cinq et sept couleurs. *Publ. Obs. Genève*, no. 70, 148.
134. Golay, M. 1964, Cas des étoiles doubles dans les diagrammes en plusieurs couleurs. *Publ. Obs. Genève*, no. 68, 1.
135. Golay, M. 1964, Photométrie en cinq et sept couleurs et position des étoiles doubles dans le diagramme △, *g*. *Publ. Obs. Genève*, no. 68, 15.
136. Golay, M., Goy, G. 1965, Photométrie en 5 et 7 couleurs d'étoiles proches. *Publ. Obs. Genève*, no. 71, 19.
137. Hauck, B. 1964, Couleurs des divers corps noirs dans le système de l'Observatoire de Genève. *Publ. Obs. Genève*, no. 70, 3.
138. Hauck, B. 1964, Note sur la sous-naine σ Boo dans le système photométrique de l'Observatoire de Genève. *Publ. Obs. Genève*, no. 70, 45.
139. Hauck, B. 1966, Un critère de luminosité dans le système photométrique de l'Observatoire de Genève. *Bull. Soc. Sci. Nat.*, **69**, 181.
140. Neff, J. S. 1966, A sensitive photometric discriminant for late-type dwarf and giant stars. *Astr. J.*, **71**, 203.
141. Straižys, V. 1964, A three-colour system for the determination of interstellar absorption (in Russian). *Astr. Zu.*, **41**, 750.
142. Zdanavičius, K., Straižys, V. 1964, The selection of spectral regions for heterochromatic photometry. II. (in Russian). *Bull. Vilnius Obs*,. no. 11, 1.
143. Straižys, V. 1964, The selection of spectral regions for heterochromatic photometry. III. Observational test of the system *X, Y, Z* (in Russian). *Bull. Vilnius Obs.*, no. 11, 11.
144. Straižys, V., Zdanavičius, K. 1965, The selection of spectral regions for heterochromatic photometry. IV. Two-dimensional classification of red stars (in Russian). *Bull. Vilnius Obs.*, no. 14, 3.
145. Straižys, V. 1966, The selection of spectral regions for heterochromatic photometry. V. The classification of early-type stars and ultraviolet magnitudes (in Russian). *Bull. Vilnius Obs.*, no. 16, 3.
146. Straižys, V., Zdanavičius, K. 1965, Two-dimensional photometric classification of red stars (in Russian). *Astr. Cirk.*, no. 320, 1.
147. Straižys, V. 1963, Optimum wavelengths for determination of interstellar absorption (in Russian). *Astr. Cirk.*, no. 254, 3.
148. Steinlin, U. 1963, Basic remarks about the choice of colors for systems of multicolor photometry. *Contr. Bosscha Obs.*, no. 21, 34.
149. Wood, H. J. 1966, Photoelectric Balmer-line photometry. *Contr. Kitt Peak nat. Obs.*, no. 96.
150. Beer, A. 1966, Calibration problems in hydrogen luminosities. *IAU Symposium.*, no. 24, 322.
151. Fernie, J. D. 1965, An absolute magnitude calibration of the Hβ index for early-type stars. *Astr. J.*, **70**, 575.

https://doi.org/10.1017/S0251107X00030546 Published online by Cambridge University Press

152. Abt, H., Golson, J. 1966, On the separation by Balmer-line photometry of high and low luminosity stars having H-alpha in emission. *Astrophys. J.*, **143**, 306.
153. Beer, A. 1964, Photoelectric distances of 461 northern OB stars and galactic structure for $H\gamma$ luminosities. *Mon. Not. R. astr. Soc.*, **128**, 261.
154. Andrews, P. J. 1966, Narrow band photoelectric photometry of O and B-type stars. Thesis, Cambridge.
155. Price, M. J. 1966, Narrow-band photoelectric $H\alpha$ photometry in late-type stars. *Mon. Not. R. astr. Soc.*, **133**, 449.
156. Price, M. J. Narrow-band photometry in the study of stellar populations. Comparison of the Hyades and Coma Berenices open clusters. *Mon. Not. R. astr. Soc.*, **134** (in press).
157. Price, M. J. Narrow-band photometry in the study of stellar populations. The sodium D lines in late-type stars. *Mon. Not. R. astr. Soc.*, **134** (in press).
158. Kovar, R. P. 1965, Population discriminant for late-type dwarfs. *Astr. J.*, **70**, 142.
159. Miner, E. 1966, Narrow-band photometry of F5–K5 stars. *Astrophys. J.*, **144**, 1101.
160. Peat, D. W. 1964, Photometry of the orange-red Ca I triplet in late-type stars. *Mon. Not. R. astr. Soc.*, **128**, 475.
161. Fernie, D. 1965, The $\lambda 4226$ line as a spectrum-luminosity indicator in late-type stars. *Astr. J.*, **70**, 675.
162. Scarfe, C. D. 1966, Photoelectric observations of Fe I lines in late-type stellar spectra. *Mon. Not. R. astr. Soc.*, **133**, 99.
163. Gyldenkerne, K. 1964, A three-dimensional spectral classification of G and K stars. *Publ. Kbn. Obs.*, no. 178.
164. Gyldenkerne, K. 1964, Photoelectric narrow-band classification of late-type stars. *Publ. Kbn. Obs.*, no. 180.
165. Gyldenkerne, K., Helt, B. 1966, Two-dimensional narrow-band classification of M stars. *IAU Symposium*, no. 24, 162.
166. Barnhart, P., Haynie, W. 1964, A program of stellar narrow-band infrared photometry. *Mém. Soc. R. Sci. Liège*, **9**, 425.
167. Jasevičius, V. 1964, On the three colour system used in Vilnius Observatory and its reduction to the system *U,B,V* (in Russian). *Bull. Vilnius Obs.*, no. 10, 19.
168. Urasin, L. A. 1963, Spectrophotometric and photometric investigations in Galaxy (I) (in Russian). *Bjull. Obs. Engelgardta*, no. 34, 130.
169. Urasin, L. A. 1965, Spectrophotometric and photometric investigations in Galaxy (II) (in Russian). *Bjull. Obs. Engelgardta*, no. 38, 47.
170. Matjagin, V. S. 1965, Three-colour photographic photometry with the Macsutov's meniscous telescope (in Russian). *Trudy astrofiz. Inst. Akad. Nauk Kasakh. SSR*, **5**, 303.
171. Rozis-Saulgeot, A.-M. 1965, Du rôle des raies d'absorption dans les magnitudes photoélectriques: cas du Soleil. *Ann. Astrophys.*, **28**, 562.
172. Wallerstein, G., Helfer, H. Photometric methods for measuring the metal content of K giants. *Astr. J.*, **71**, 350.
173. Ažusienis, A., Juodakas, A. 1964, The relation between magnitudes of Zeiss astrotriplet and the system *B*, *V* (in Russian). *Bull. Vilnius Obs.*, 11, 45.
174. Ažusienis, A. 1965, The correlation between magnitudes m_{pg} and *B* in the case of chromatic aberration (in Russian). *Bull. Vilnius Obs.*, no. 14, 24.
175. Kolesnik, L., Polischuk, E. 1966, Relation of two-colour system obtained at the telescope AZT-2 with *B*, *V* system (in Russian). *Dokl. Ukr. Akad. Nauk*, **9**.
176. Kreiner, J. M. 1964, A comparison of the colour indices obtained with those of Wroclaw system. *Acta astr.*, **14**, 219.
177. Shevchenko, V. Reduction to the *V* system by using colour changes of a variable star (in Russian). *Trudy Tashkent. Obs.*, Ser. II, **2** (in press).
178. Straižys, V. 1964, The relation between heterochromatic and monochromatic magnitudes in three-colour systems (in Russian). *Astr. Zu.*, **41**, 128.

Photometric standards

179. Jackisch, G. 1963, Mikrovariabilität und Zustandsgressen von hellen Sternen. *Veröff. Sternw. Sonneberg*, **5**, 309.

https://doi.org/10.1017/S0251107X00030546 Published online by Cambridge University Press

180. Jackisch, G. Lichtelektrische Photometrie von A-Sternen am Kottamia Observatorium der VAR. *Mitt. astr. Ges.*, no. 21 (in press).
181. Cousins, A. W. J. 1965, Micro-variability of Sun and stars. *Irish astr. J.*, **7,** 133.
182. McCullough, J. 1964, A photoelectric search for ultra-short period variable stars. *Astr. J.*, **69,** 251.
183. Hoffleit, D. 1964, *Catalogue of bright stars*. Third revised edition. Yale Univ. Obs.
184. Iriarte, B. Johnson, H. L., Mitchell, R., Wisniewski, W. 1965, Five-color photometry of bright stars. *Sky Telesc.*, **30,** 21.
185. Johnson, H. L., Mitchell, R. I., Iriarte, B., Wisniewski, W. 1966, *UBVRIJKL* photometry of the bright stars. *Comm. Lunar Planet. Lab.*, no. 63.
186. Nekrasova, S. V., Nikonov, V. B., Rybka, E. 1965, Photoelectric magnitudes and colours of photoelectric standards in Selected Areas. II. Catalogue (in Russian). *Izv. Krym. astrofiz. Obs.*, **34,** 69.
187. Cousins, A. W. J. 1963, *UBV* standards in the equatorial zone. *Observatory*, **83,** 254.
188. Cousins, A. W. J. 1963, Photometric data for stars in the equatorial zone (fifth list). *Mon. Notes astr. Soc. Sth. Afr.*, **22,** 130.
189. Cousins, A. W. J. 1964, Photometric data for stars in the equatorial zone (sixth list). *Mon. Notes astr. Soc. Sth. Afr.*, **23,** 10.
190. Cousins, A. W. J. 1964, Photometric data for stars in the equatorial zone (seventh list). *Mon. Notes astr. Soc. Sth. Afr.*, **23,** 175.
191. Cousins, A. W. J. 1965, Photometric data for stars in the equatorial zone (eighth list). *Mon. Notes astr. Soc. Sth. Afr.*, **24,** 120.
192. Cousins, A. W. J., Lake, R., Stoy, R. H. 1966, Photoelectric magnitudes and colours of southern stars. *R. Obs. Bull.*, no. 121.
193. Lake, R. 1963, Photoelectric magnitudes and colours for southern stars. *Mon. Notes astr. Soc. Sth. Afr.*, **22,** 79.
194. Lake, R. 1964, Photoelectric magnitudes and colours for 100 southern stars. *Mon. Notes astr. Soc. Sth. Afr.*, **23,** 14.
195. Lake, R. 1964, Photoelectric magnitudes and colours for 100 southern stars (fifth list). *Mon. Notes astr. Soc. Sth. Afr.*, **23,** 136.
196. Lake, R. 1965, Photoelectric magnitudes and colours for bright southern stars (sixth list). *Mon. Notes astr. Soc. Sth. Afr.*, **24,** 41.
197. Corben, P. M. 1966, Photoelectric magnitudes and colours of bright southern stars. *Mon. Notes astr. Soc. Sth. Afr.*, **25,** 44.
198. Cousins, A. W. J. 1963, Standard magnitudes and magnitude sequences in the southern hemisphere. *Contr. Bosscha Obs.*, no. 21.
199. Cousins, A. W. J. 1966, Fabry photometry of bright southern stars with an appendix giving detailed observations of bright variable stars made at the Cape prior to 1966. Roy. Obs. of Good Hope, pp. 45.
200. Cousins, A. W. J. 1966, On standard magnitudes and $B-V$ colours of bright stars in the southern hemisphere. *Observatory*, **86,** 69.
201. Stoy, R. H. 1965, Photoelectric three-colour magnitudes for southern stars. *Mon. Notes astr. Soc. Sth. Afr.*, **24,** 29.
202. Stoy, R. H. 1966, Cape photographic catalogue for 1950. *Cape Annals*, **21,**
203. Evans, D., Laing, J., Menzies, A., Stoy, R. 1964, Fundamental data for southern stars. *R. Obs. Bull.*, no. 85, 207.
204. Roslund, C. 1964, Investigation of a Milky Way Field in Scorpius. I. Magnitudes and colours of O and B stars. *Ark. Astr.*, **3,** 357.
205. Elvius, T., Lyngå, G. 1965, Three-colour photometry of 43 stars in Kapteyn's Selected Areas at southern galactic latitudes. *Ark. Astr.*, **3,** 467.
206. Sjögren, U. 1964, Photometric and spectrophotometric observations with a discussion of the interstellar absorption in the region of Kapteyn's Selected Area 8. *Ark. Astr.*, **3,** 339.
207. Elvius, T., Häggkvist, J. 1966, Photoelectric measurements of stars in Kapteyn's S.A. of + 60° zone. *Ark. Astr.*, **4,** 49.
208. Ljunggren, B. 1966, A photoelectric and spectrophotometric investigation of a region near the north galactic pole. *Ark. Astr.*, **3,** 535.

209. Ljunggren, B., Oja, T. 1965, Photoelectric measurements of magnitudes and colours for 849 stars. *Ark. Astr.*, **3**, 439.

210. Häggkvist, L., Oja, T. 1966, Photoelectric photometry of bright stars. *Ark. Astr.*, **4**, 137.

211. Oja, T. 1966, A spectrophotometric survey of stars along the Milky Way. (Part II). *Uppsala astr. Obs. Ann.*, **5**, no. 4.

211a. Oja, T. 1966, A photometric study of a region in Cassiopeia. *Uppsala astr. Obs. Medd.*, no. 157.

211b. Häggkvist, L. 1966, Photoelectric magnitudes and colours for visual binaries, *Uppsala astr. Obs. Medd.*, no. 156.

212. Argue, A. N. 1966, *UBV* photometry of 550 F, G and K type stars. *Mon. Not. R. astr. Soc.*, **133**, 475.

213. Argue, A. N. Red and infrared magnitudes and colours for 300 F, G and K type stars. *Mon. Not. R. astr. Soc.*, (in press).

214. Rufener, F., Hauck, B., Goy, G., Peytremann, E., Golay, M. 1964, Catalogue des étoiles mesurées dans le système photométrique de l'Observatoire de Genève. *Publ. Obs. Genève*, no. 66.

215. Iriarte, B. 1965, Fotometria fotoelectrice en *BVRI* para 275 estrellas en su mayoria entre −25° y −50°. *Bol. Obs. Tonantzinla*, **4**, 33.

216. Bigay, J. H., Lunel, M. 1965, Photométrie photoélectrique en trois couleurs (*U,B,V*) d'étoiles chaudes dans la 'Selected Area' 8. *C. r. Acad. Sci. Paris*, **260**, 3853.

217. Bigay, J. H., Lunel, M. 1965, Photométrie photoélectrique *UBV* de 263 étoiles B et A de la S.A.8. *J. Observateurs*, **48**, 171.

218. Bigay, J. H. 1966, Photométrie photoélectrique en trois couleurs (*U,B,V*) d'étoiles chaudes dans la SA 40. *C. r. Acad. Sci. Paris*, **262**, 1570.

219. Osawa, K. 1965, Spectral classification and three-color photometry of A-type stars. *Ann. Tokyo astr. Obs.*, **9**, 123.

220. Gutièrrez-Moreno, A., Moreno, H., Stock, J., Torres, C., Wroblewski, H. A system of photometric standards. *Publ. Dep. Astr. Univ. Chile*, no. 1 (in press).

221. Jerzikiewicz, M., Serkowski, K. Fifty standard stars for yellow and blue magnitudes. *Publ. astr. Soc. Pacif.*, (in press).

222. Pfleiderer, J., Dachs, J., Haug, U. 1966, Lichtelektrische UBV-Photometrie von Standardsternen in vier Sternfelder am Äquator. *Z. Astrophys.*, **64**, 116.

223. Harris III, D. L., Upgren, A. R. 1964, Photoelectric magnitudes and colors of stars near the galactic pole. *Astrophys. J.*, **140**, 151.

224. Takayanagi, K., Shimizu, T. 1966, *U,B,V* photoelectric photometry of the Ursa Major group. *Mem. Coll. Sci. Univ. Kyoto*, Ser. A, **31**, no. 2.

225. Hogg, A. R. 1963, A southern photoelectric magnitude sequence. *Publ. astr. Soc. Pacif.*, **75**, 194.

226. Mayer, P. 1964, Photoelectric measurements of OB stars. *Acta Univ. Carolinae Math. Phys.*, no. 1, 25.

227. Hardie, R. H., Heiser, A. M., Tolbert, C. R. 1964, A study of the B stars in the Orion Belt region. *Astrophys. J.*, **140**, 1472.

228. Imagawa, F. 1964, Observational results of three-color photometry for F-type stars. *Dep. Astr. Univ. Kyoto. Repr.*, no. 22, 61.

229. Eggen, O. 1964, Colors, luminosities and motions of the nearer G-type stars. *Astr. J.*, **69**, 570.

230. Przybylski, A., Kennedy, P. 1965, Radial velocities and three-colour photometry of 52 stars with large proper motions. *Mon. Not. R. astr. Soc.*, **129**, 63.

231. Przybylski, A., Kennedy, P. 1965, Radial velocities and three-colour photometry of 166 southern stars. *Mon. Not. R. astr. Soc.*, **131**, 95.

232. Tolbert, C. R. 1964, A *UBV* study of 94 wide visual binaries. *Astrophys. J.*, **139**, 1105.

233. Wildey, R. 1964, The stellar content of χ and h Persei cluster and association. *Astrophys. J. Suppl.*, **8**, 439.

234. Johnson, H. L. 1965, Infrared photometry of M-dwarf stars. *Astrophys. J.*, **141**, 170.

235. Mendoza, E., Johnson, H. L. 1965, Multicolor photometry of carbon stars. *Astrophys. J.*, **141**, 161.
236. Mendoza, E., Eugenio, E., Johnson, H. L. 1965, An investigation of late-type stars. *Bol. Obs. Tonantz.*, **4**, 57.
237. Neugebauer, G., Martz, D., Leighton, R. 1965, Observations of extremely cool stars. *Astrophys. J.*, **142**, 399.
238. Breckinridge, J. B., Kron, G. E. 1964, Red and infrared photometry of double stars. *Publ. astr. Soc. Pacif.*, **76**, 139.
239. Blanco, V. 1964, $B-V$ and $V-I$ colors of giant M stars. *Astr. J.*, **69**, 730.
240. Crawford, D. L., Perry, C. L. 1966, Four-color and Hβ photometry of open clusters. I. The Hyades. *Astr. J.*, **71**, 206.
241. Strömgren, B. 1964, On the chemical composition and kinematics of disk high-velocity stars of the main sequence. *Astrophys. Norv.*, **9**, 333.
242. Borgman, J. 1965, Seven-colour photometry of A, F, G, K and M stars. *Bull. astr. Inst. Netherl.*, **17**, 58.
243. Ponsen, J., Oosterhoff, P. Th. 1966, Five-colour photometry of high-velocity stars and of pulsating variables of different types. *Bull. astr. Inst. Netherl. Suppl.*, no. 1.
244. Oosterhoff, P. Th., Ponsen, J. 1966, Discussion of five-colour observations of stars of high velocity. *Bull. astr. Inst. Netherl.*, **18**, 150.
245. Crawford, D. L., Mancler, J. 1966, Standard stars for photoelectric Hβ photometry. *Astr. J.*, **71**, 114.
246. Crawford, D. L. 1965, Photoelectric Hβ photometry for B stars in the Orion Belt region. *Astr. J.*, **70**, 671.
247. Peat, D. W. 1964, Hα photometry of late-type stars. I, F, G and K stars north of the equator. *Mon. Not. R. astr. Soc.*, **128**, 435.
248. Peat, D. W. 1966, Hα photometry of late-type stars. II. F and G dwarf stars south of the equator. *Mon. Not. R. astr. Soc.*, **131**, 476.
249. Schmidt-Kaler, Th. 1964, Die galaktischen emissions B Sterne. *Veröff. Sternw. Bonn*, no. 70,
250. Bahner, K. 1963, Energy distribution in the spectra of early-type stars. *Astrophys. J.*, **138**, 1314.
251. Willstrop, R. V. 1965, Absolute measures of stellar radiation. II. *Mem. R. astr. Soc.*, **69**, 83.
252. Oke, J. B., Conti, P. S. 1966, Absolute photoelectric spectrophotometry of stars in the Hyades. *Astrophys. J.*, **143**, 134.
253. Kharitonov, A. V. 1964, Energy distribution in the spectra of four stars in absolute units (in Russian). *Izv. Akad. Nauk Kazakh. SSR Fiz. Mat. ser.*, no. 3, 28.
254. Karjagina, Z., Kharitonov, A. V. 1964, Absolute energy distribution in the spectra of 17 stars (in Russian). *Izv. Akad. Nauk Kazakh. SSR Fiz. Mat. ser.*, no. 3, 10.
255. Kharitonov, A. V. 1966, Distribution of energy in spectra of 13 stars in absolute units (fourth list of extra-atmospherical spectrophotometric standards) (in Russian). *Trudy Inst. astrofiz. Akad. Nauk Kazakh. SSR*, **7**, 9.
256. Kharitonov, A. V., Neljubin, N. The method and preliminary results for the energy distribution in the spectrum of α Lyrae standardized by the central part of the solar disk (in Russian). *Trudy Inst. astrofiz. Akad. Nauk Kazakh. SSR*, **8**, (in press).
257. Kharitonov, A. V. Absolute energy distribution in the spectra of 14 bright stars in Pleiades (in Russian). *Astr. Zu.* (in press).
258. Aller, L. H., Faulkner, D. J., Norton, R.H. 1964, Photoelectric spectrophometry of selected southern stars. *Astrophys J.*, **140**, 1609.
259. Aller, L. H., Faulkner, D. J., Norton, R. H. 1966, Photoelectric spectrophotometry of selected southern stars. *Astrophys. J.*, **144**, 1073.
260. Van den Bergh, S., Sackman, I. 1965, Photoelectric spectrophotometry of stars. II. *Astr. J.*, **70**, 353.
261. Walker, R. G., D'Agati, A. 1964, Infrared stellar irradiance. *Appl. Opt.*, **3**, 1289.
262. Heddle, D. W. O. 1964, The importance of absolute photometry. *Ann. Astrophys.*, **27**, 800.

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263. Chubb, T. A., Byram, E. 1963, Stellar brightness measurements at 1314 and 1427 Å; observation of the O I twilight glow. *Astrophys. J.*, **138**, 617.
264. Bogess, A. 1964, B star colours between 2000 and 3000 angströms. *Ann. Astrophys.*, **27**, 805.
265. Alexander, J. D. H., Bowden, P. J., Heddle, D. W. O. 1964, Southern hemisphere observations of ultraviolet radiation from celestial objects. I. Experimental techniques. *Proc. R. Soc. London*, **A279**, 510.
266. Bless, R. C., Code, A. D., Houck, T. E., McNall, J. F., Taylor, D. J. 1965, Ultra violet observations of stars. *Astr. J.*, **70**, 667.
267. Byram, E. T., Chubb, T. A., Friedman, H. 1964, Measurements of stellar brightness in the far ultraviolet. *Astr. J.*, **69**, 135.
268. Byram, E. T., Chubb, T. A., Werner, M. W. 1965, 1115 Å far ultraviolet stellar photometry. *Ann. Astrophys.*, **28**, 594.
269. Stecher, Th. P. 1965, Ultraviolet spectrophotometry of early-type stars. II. *Astr. J.*, **70**, 693.
270. Boggess III, A., Borgman, J. 1964, Interstellar extinction in the middle ultraviolet. *Astrophys. J.*, **140**, 1636.
271. Almar, I. 1964, Bemerkungen über die absolut – Standardisierung der Sternhelligkeiten. *Mitt. und Ergebn. der Satellitbeobachtungsdienst DDR*, no. 8, 49.
272. Krzeminski, W., Serkowski, K. Photometric and polarimetric observations of the nearby strongly reddened open cluster Stock 2. *Astrophys. J.* (in press).
273. Stepień, K. 1965, Polarimetric measurements in the north polar region. *Acta. Astr.*, **15**, 51.
274. Kruszewski, A. 1963, Measurements of polarization in the region of the III Cephei Association. *Acta Astr.*, **13**, 92.
275. Serkowski, K. 1965, Further polarimetric observations of highly polarized stars in two spectral regions. *Acta Astr.*, **15**, 79.
276. Lodén, L. O. 1965, A polarimetric investigation in the Milky Way. *Stockh. Obs. Ann.*, **22**, no. 8.

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