25. COMMISSION DE PHOTOMETRIE STELLAIRE

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INTRODUCTION

An increased level of activity has characterized all branches of stellar photometry. During the last three years a large amount of observational material has been obtained.

At the present time the *UBV* photometric system is really a universal one for three-colour photometry. Many *UBV* standard sequences of high precision have been established in both hemispheres. Good progress in the evaluation of a common north-south *UBV* system has been made.

Investigations of the greatest importance have been carried out in the search for the new multi-colour system. Further progress in photometric research greatly depends on the amount of information contained in observational data; therefore it is very important to find the most effective multi-colour system.

Properties of two-colour diagrams, so widely used, have been studied very carefully.

New possibilities of obtaining an enormous amount of photometric data have now been opened up through the use of modern systems of automatization and digital computers. Successful results have been obtained in this field during recent years. These systems have been used to obtain photo-electric observations, measurements of photographic plates and reductions of all kinds. Now we have the possibility of starting large projects requiring a vast amount of observational data. But the greatest success would be attained if all these powerful methods were introduced in general photometric practice.

Progress made in the development of light-sensitive devices and in space technique now allows the carrying out of photometrical research in the vast region from 1000 Å to 15 μ. Successful investigations in the far ultra-violet and infra-red parts of the spectrum are being started.

The further development of stellar photometry would be greatly influenced by all these new possibilities.

The number of investigations carried out in the field of stellar photometry is so enormous that it is not possible to review all of them in the present report. Mention will therefore be made only of work on instrumentation, methods of observation, photometric systems and standards. The results of observations, when published, are included in the bibliography. The vast field of variable stars is completely excluded.

If references are present, authors' names are not included in the text.

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It is likely that several very important investigations were overlooked, when this preliminary report was prepared. But it is hoped to include them later when the definitive report is presented.

INSTRUMENTATION

Two very useful books containing chapters on the technical problems of stellar photometry have been published (**1, 2**).

Several observatories have erected telescopes intended for stellar photometry.

At Kitt Peak, two reflecting telescopes—a 48-cm and a 70-cm—have been put into operation. In 1961, a 91-cm reflector at the newly-built Okayama Astrophysical Observatory came into use for photo-electric observations. Another 91-cm reflector was completed at the Dadaira station of Tokyo University. Photo-electric observations have been started: at the Crimean station of the Sternberg Institute with the new 125-cm reflector; at La Plata Observatory with the 80-cm reflector; at Lwow Observatory with the 50-cm reflector; at the Inter-American Observatory at Cerro Tololo with the 40-cm reflecting telescope. At the observing stations of Geneva Observatory, two reflectors have been erected—a 72-cm at Jungfraujoch and a 100-cm in Haute-Provence. A 70-cm reflecting telescope is being erected at the Crimean Observatory and a 100-cm one at the Cape Observatory. A 50-cm transportable coudé reflector was constructed at the Milano-Merate Observatory. A 150-cm photometric telescope is now being designed at Kitt Peak. Two telescopes—a 50-cm and a 30-cm—are to be erected at the Trieste Observatory.

A very interesting and promising instrument has been designed and is located at the Edinburgh Observatory—a twin 40-cm telescope specialized for photo-electric photometry. Special features of this instrument are that it can be operated manually or automatically from a console in a warmed control room, and that one telescope of the pair provides continuous monitoring of sky transparency.

Development of photo-electric devices has been very successful. Even for 'classical' antimony-caesium photomultipliers, an effective gain in quantum efficiency has been attained (**3**). Multi-alkali photomultipliers, now commercially available, have a very high sensitivity and offer the possibility of extending measurements to 7500Å–8000Å. They are perfect for $H\alpha$ measurements.

Some of the very important properties of photomultipliers have been studied. Investigations made on the dependence of spectral sensitivity on temperature have led to contradictory conclusions (**4, 5, 6**). Further studies of this effect are being carried out at Göttingen Observatory by Lohman. The influence on its spectral response of voltage applied to the photomultiplier has also been detected (**7**). These facts are of such importance, when considering the problem of the stability of photometric systems, that further investigations for different types of photomultipliers are badly needed.

Image tubes and image orthicons are being tested for photometric use. The possibility of obtaining satisfactory accuracy ($0^{m}{\cdot}04 - 0^{m}{\cdot}15$) in the determination of stellar magnitudes has been confirmed (**11, 12**). The gain in exposure time is remarkable. The limiting sensitivity of orthicon was considered (**13**). Sensitivities of photographic plate, image tube and image orthicon were compared (**15**). All these electronic devices are very useful when the shortening of exposures is important.

The problem of limiting sensitivities for photo-electric devices has been considered (**16**).

Progress in infra-red technique has been very considerable (**10**). Using a mercury-doped germanium detector cooled by liquid hydrogen it is possible to measure stellar radiation in the region $8 - 14\,\mu$. But in this wave-length region, thermal radiation of the atmosphere begins to be a serious disturbing factor (**34**).

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Modern space techniques permit the initiation of experiments on extra-terrestrial photo-electric photometry (**17**). Such experiments for ultra-violet shorter than 3000 Å have been reported (**18, 19**).

Many photo-electric photometers of the ordinary type have been put into operation at several observatories (**20, 21, 22, 23, 24**). Some special photometers for measurements in infra-red have been used (**29, 30, 31, 33, 34**).

Several improvements in the design of photo-electric photometers have been reported (**25, 26, 28**). A new very stable standard light source, based on the Čerenkov effect (**42**), has been developed (**41**). Its temperature effect is negligibly small, while for the widely-used luminous dyes it may be considerable (**39, 40**). Having a broad spectral emission band, Čerenkov's standard can be used to check the colour sensitivity of the apparatus. This kind of standard light source is being tested at the Crimean Observatory.

A stellar-automatized photometer with a programmed observing cycle has been put into operation (**35**). Another fully digitized photometer is being used for observations in ten spectral regions (**36**). The measurements are recorded on a perforated tape and can be immediately transmitted to the computer.

Multi-channel photo-electric photometers permitting simultaneous observations in different spectral bands have been used (**37, 38**). A three-channel photometer is being constructed at the Crimean Observatory (Dimov, Chuvaev) and a five-channel one has been started at the Observatory Milano-Merate (Masani).

The photon counting technique has been applied in many cases. A special installation to test photomultipliers for this kind of work has been described (**8**).

Electronic computers are intensively used at several observatories for the reduction of photo-electric measurements (**43, 44, 45**).

The possibility of observing faint stars raises the problem of the irregularities in brightness of the sky background caused by fluctuations in the surface distribution of the faintest invisible stars (**27**).

Elimination of extinction with the accuracy of $0^{m}\cdot01$ is not a difficult problem at the present time. Methods have been developed for obtaining fundamental photometric catalogues (sequences of photometric standards) (**46, 46a**). Secondary standards (in the natural system of photometer) can be obtained using well-determined standard sequences, if spectral responses of both systems are close together. But there are still some problems to be discussed. Restrictions in the application of the Bouguer law have been considered (**47, 49**). The precise formulae for the Forbes effect have been derived (**50**).

Stock communicates that the unusual stability of the extinction at Cerro Tololo permits photometric work with a precision of a few thousands of magnitude. This accuracy makes it necessary to revise methods and principles of determining and eliminating the extinction. He has developed a new method which assures greater accuracy in the elimination of extinction effects.

Extinction has been studied at other observatories also (**51, 52**). Wallenquist has observed stars in the *UBV* system, for the study of extinction at the Kvistaberg station.

A survey has been published of the theoretical and experimental researches on the infra-red transparency of the atmosphere carried out during the past two to three years (**53**).

In modern photometric investigations, photographic magnitudes are always determined with the aid of secondary photo-electric standards. These standards must be determined for the stellar field under investigation and in the same photometric system.

The most widely-used telescopes for photographic photometry are the Schmidt or Maksutov

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telescopes. But some difficulties arise when applying these telescopes to photometry (**56**). The question of the necessary number of photo-electric standards when using Schmidt (or Maksutov) telescopes is very much under discussion at the present time.

In this connection, Argue reports that comparison of photo-electric observations and photographic measurements for the same stellar field shows that there is a positional effect on Schmidt photographic plates. A photographic Purkinje effect has also been demonstrated. From 100 to 200 photo-electric standards are needed to obtain accurate photographic magnitudes for stars of all spectral classes in an interval of 10^m and for an area of about 3° in diameter.

At the present time photometric measurements of photographic plates are carried out with iris-microphotometers. Many efforts have been devoted to determining the most effective use of these instruments (**57, 58, 59, 63, 64, 65**). Servo-systems have been used for the automatic setting of the iris diaphragm (**60, 61**). Digital reading is also used (**62**).

Fellgett reports that, at Edinburgh Observatory, a very interesting design study has been made for an automatic measuring engine 'Galaxy'. This machine is intended to detect and measure the star images on a Schmidt photograph without human intervention. The settings for position and for brightness measurements are made simultaneously, and the brightness measure is a generalization of the conventional iris setting. The Galaxy measuring engine is expected to be completed in 1966.

The principle of the iris-photometer is being applied to the photographic measurements for the H-lines photometry by Worrall (Cambridge). This method is being developed for measuring $H\gamma$ equivalent widths from unbroadened objective prism spectra using a one-dimensional 'iris' diaphragm.

Computers are widely used for the reduction of photographic measurements.

The development of a polarimetric apparatus is being continued. A photo-electric polarimeter has been mounted on the 100-cm telescope by Broglia (Milano-Merate). Integration of photo current (**68**) and automatization (**69**) have been used in photo-electric polarimeters. A two-channel polarimeter with two photomultipliers has been constructed at the Observatory of Leningrad University (Dombrovsky, Vasiliev, Shulov) and a four-cell one at Göttingen Observatory.

Important questions concerning methods of stellar polarimetry have been considered (**70**).

Instrumental effects have also been discussed (**71, 72**).

PHOTOMETRIC SYSTEMS

Each of two well-known three-colour systems *UBV* and *RGU* has advantages and drawbacks. Until very recently the greatest drawback of *RGU* was the difficulty of reproducing it by photo-electric means. For that reason the preference was given to *UBV*. Many photoelectric standard sequences, so necessary for all kinds of photometric work, have been established in this system. Now that the multi-alkali photomultipliers are being put into operation, it is possible to establish a photo-electric *RGU* system (**76**). But the careful comparison of both systems shows that *RGU* has no great advantages over *UBV* (**56, 75, 77**), and it seems unwise to carry out a vast amount of work in establishing new photo-electric *RGU* standards.

UBV system is now the most used standard three-colour system of stellar photometry.

But this system also has some drawbacks. Its response curves are very wide, giving difficulties when using two-colour diagram, when excluding extinction and when transforming a natural *UBV* system to the standard one. These considerations are particularly relevant to the *U* system for which extinction varies rapidly with wave-length (**88**).

It is obvious that the natural *UBV* systems cannot be identical to the standard one; photomultipliers, filters and coating of mirrors may be somewhat different. Different natural

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systems are obtained even if the same filters are used on different reflectors (**82**). According to reports from Argue, these differences may be unexpectedly large. His *UBV* observations at Kitt Peak were shared between 16- and 36-inch reflectors. Identical filters were used. But it was found that the two photometers differed considerably in their $(B-V)$ and $(U-B)$ scales and it was impossible to connect both natural systems by a simple linear relation. This clearly shows the difficulties arising in reductions of photometric systems. Of course these difficulties depend on the accuracy to be obtained in final results. In any case the necessary colour filters must be chosen very carefully (**83, 107**).

A quite different *U* system is obtained with refractors: It is a so-called 'refractor' system U_c with a cut-off at longer wavelength than the original *U* system (**81, 113**). This system shows better stability and reproducibility than *U*, having all the principal advantages of the latter. In accordance with this, it has been suggested that a better ultra-violet system *U* might be obtained if the cut-off were at 3400 Å and not at 3000 Å (**88**).

Evidently, when establishing a natural photometric system, it is necessary to have its response curve as close as possible to that of the standard one. But there are some doubts that the published response curves for *UBV* strictly correspond to the standard *UBV* system established by observations (**84, 85**). This follows from the discrepancies between calculated and observed colours. It has been suggested that the cause lies in the different working conditions of the photomultiplier during the different series of measurements (**84**). Perhaps the possible changes in response curves with varying voltage and temperature (**4, 7**) may be the cause of the discrepancies under consideration. Detailed studies of physical effects responsible for the instability of photometric systems are very badly needed.

In many cases, when reducing natural *UBV* systems to the standard one, it is necessary to use transformation formulae containing terms depending on the colour excess (**86**). But there are many examples when reductions using the simplest formulae give satisfactory results (**89, 90**). Of course that depends on the accuracy to be obtained.

The problem of avoiding systematic differences between the north-and-south *UBV* standard systems may be considered as practically solved (**82**). This conclusion is supported by the recent observations carried out by Argue at Kitt Peak Observatory. Using twenty-five stars common with the Cape 'Equatorial zone' photometry, it was possible to show that zero-points of both sequences are in very good accord.

It is very reasonable to transform the old visual catalogues of Harvard and Potsdam to the modern standard *V* system, taking into account the systematic personal errors of observers. This work is being carried out by Rybka and his collaborators at Cracow Observatory. Observations of the stars of HA50 brighter than $6^{m}\cdot5$ and belonging to the northern hemisphere have been reduced to a unique system and subsequently to the standard *V* system. The *V* magnitudes obtained were communicated to the Yale Observatory to be included in the new edition of *Bright Stars Catalogue*. Reductions for the southern stars are being carried out. Transformation formulae to the standard *V* system for Potsdam photometry have also been obtained (**78**).

There is a variety of new multi-colour photo-electric systems with different band-widths intended to study properties of stellar radiation, interstellar extinction, and to segregate stars according to spectral types, luminosity classes and metal contents.

Johnson's wide-band system (**36**) is practically a continuation of the red and infra-red of the *UBV* system. This ten-band system covers the spectral region from 3000 Å to 14μ. Bands named *U,B,V,R,I,J,K,L,M,N* have the following effective wavelengths: $0\cdot36\mu$, $0\cdot44\mu$, $0\cdot55\mu$, $0\cdot70\mu$, $0\cdot80\mu$, $1\cdot25\mu$, $2\cdot2\mu$, $3\cdot6\mu$, $5\cdot0\mu$ and 10μ. Another multi-colour system (with band-width of the order of 500 Å) is Golay's. It consists of seven (or five) bands (**108**). The five-band

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system is a detalization of *UBV*. The four-colour system, used by Kruszewski, has bands of the same width as Golay's, centred at 3500Å, 3800Å, 4550Å and 5500Å.

Borgman's seven-colour system is an intermediate one between wide-band systems and the narrow ones. The width of its bands is about 200Å. They are centred at 3295Å, 3560Å, 3750Å, 4055Å, 4550Å, 5240Å and 5880Å and named *R,Q,P,N,M,L*, and *K* (not to be confused with Johnson's). Strömgren's system must be mentioned too. It is a 200–300Å wide four-colour system centered at 3500Å, 4100Å, 4700Å and 5500Å (very near to Kruszewski's).

There are also many special narrow-band systems (Hβ, Hγ and others) obtained by photometric and spectro-photometric methods.

Two-colour diagrams provide excellent possibilities for the interpretation of photometric data. But all their properties must be studied with the greatest care (**96, 100**). As has been revealed by observations, two-colour diagrams may show effects which can restrict the accuracy of the results to be obtained, if not accounted for with the necessary precision. That is, the curvature of reddening lines, their changing slope with the spectral type, the complicated run of the unreddened line, and so on. All these effects must be investigated as functions of the parameters of the photometric systems. The best way of doing this is to calculate all necessary data, starting from the known energy distribution in the spectra of stars belonging to different spectral and luminosity classes, the law of interstellar reddening and the response curves of systems to be investigated.

Comparison of the *RGU* and *UBV* two-colour diagrams by the outlined method has just been carried out (**75**). But a more detailed study of the whole problem has been undertaken at the Vilnus Observatory, using for numerical integration a BESM-2 computer (**101, 102, 103, 104, 105, 106, 107**). Investigations of properties of two-colour diagrams have verified that the reddening lines in the ($U-B$, $B-V$) diagram are curved, while in the ($U-G$, $G-R$) they are straight. Dependence of the slope of the reddening lines on spectral type is found in both systems, but it is less prominent in *RGU*. The deformation of the main sequence line with reddening is also detected in both systems. Variation of the ratio of total to selective absorption (R) is about ten times less in *RGU*. It is evident that the effects under consideration are less prominent in *RGU* than in *UBV*. But it has been shown that this stems only from the narrower band-width of the *RGU* system.

The effect of the band-width on the properties of the *UBV* two-colour diagram has been studied. The curvature of reddening lines and the dependence of their slope on spectral class completely vanish when the half width of response curve equals 200Å. The variations of R with spectral type and reddening are also negligible in such a system.

Photometric systems of this kind have practically the same properties as the monochromatic ones and it seems reasonable to call them 'quasi-monochromatic' systems. The Borgman and Strömgren multicolour systems are good examples. It is evident that the most accurate results can be obtained with the quasi-monochromatic two-colour diagrams.

The transformation formulae connecting photometric systems have also been investigated. It has been confirmed that formulae connecting *UBV* and *RGU* include the terms depending on colour excess. Correlation of both U systems is non-linear and multi-valued. The transformation formulae from the B- to G-colours of strongly reddened stars are also complicated.

The possibility of establishing a new multi-colour system which would give maximum information has been considered (**107**). But a large amount of spectro-photometric data is necessary for further investigations.

STANDARD SEQUENCES

The question of the instability of stellar radiation is very pertinent when establishing the standard sequences. Some time ago, Kron, Johnson and Iriarte suspected that practically all

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the standard stars showed variations in brightness and colour. But further careful examination of observations of these stars covering a long period of time could not detect fluctuations exceeding $0^{m}.02$ (**110**). It was also suggested that the fluctuations mentioned above may have been the result of insufficient elimination of extinction effects (**111**). The same conclusion on the good stability of standard stars may be reached when considering the results of the very extensive work on standard sequencies being done at the Cape Observatory. (**81, 92, 113, 114, 115, 116, 117, 118, 119, 120, 121**). There, three-colour *UBV* photo-electric photometry has been continued in order to obtain data for the HR stars south of +10° declination and for fainter stars of astrophysical interest. Special emphasis has been placed on the HR stars within 10° of the equator that can be observed from both northern and southern observatories. Measures have been completed for more than three-quarters of these stars. A catalogue that will give mean *V* magnitudes and $B-V$ colours for stars brighter than 5·0 (HR) and south of +10° declination, based on all available observations, is being prepared. For most of these stars, the external standard error of *V* and $B-V$ is smaller than $\pm 0^{m}.01$. The photographic photometry in connection with the 'Cape Photographic Catalogue for 1950' has been continued and the last plates are now being measured. This catalogue will cover the sky south of −30° declination, with the exception of the 'Cape Astrographic Zone' (−40° to −52°). Similar photometry is planned for this zone also. A few observations have been made to provide secondary sequences for photographic photometry and more are contemplated when the 100-cm reflector, now being erected, is available for use.

At the Inter-American Observatory at Cerro Tololo, a new *UBV* standard sequence, accessible from both hemispheres, is being set up by Stock and his collaborators. This system contains 18 fundamental standard stars spread conveniently around the sky. These stars are being used to determine atmospheric extinction and to assure the constancy of the system. These stars have already been observed several hundred times each. In addition, several hundred secondary standard stars well distributed over the sky (between declination +20° and −35°) and over the spectral sequence have been chosen. Each of these secondary standard stars is observed on at least six different nights. The internal accuracy of the catalogue is expected to be $\pm 0^{m}.002$ (mean error). The observations of this programme shall be completed in 1964.

At the Lunar and Planetary Laboratory, Johnson started a programme of *U,B,V,R,I,J,K* observations on bright stars. He plans *UBVRI* observations for all stars brighter than $V=5^{m}$ north of declination −30°, and *J* and *K* observations of about half of these. The *UBVRI* part of the programme is about 75% complete and the *J*, *K* part about 50%.

Eggen has completed at Mt Palomar *UBV* photo-electric observations of all stars to visual magnitudes 5·5 north of the equator.

Crawford and Golson are continuing work on a faint extinction star network. Pairs of red and blue stars between magnitudes 8 and 10, approximately two hours apart in right ascension and at 0° declination, are used for this purpose. 90% of the work is finished.

A large number of faint stars have been observed by Westerlund (Mt Stromlo Observatory) in the Strömgren four-colour system, and in *I* and *R* colours. A sequence of photographic standards to the 16th magnitude in Pleiades, in a photometric system close to *RGU*, has been established (**122, 123**).

Photographic magnitudes for 3300 comparison stars of 901 variable stars in a region near the galactic centre have been determined (**124**).

OBSERVATIONS

In addition to published papers (**126** to **265**) some investigations not yet published will be briefly mentioned.

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Photo-electric magnitudes and colours for about 300 O- and B-stars have been measured in the *UBV* system by Roslund at the Boyden Observatory.

At Kitt Peak Observatory, O- and B-stars have been observed by Meltzer using the narrow-band interference filters. He also observed in the ultra-violet a number of highly reddened O B stars. Strömgren completed four-colour and H-lines observations for bright A- and F-stars. Perry obtained narrow-bands photometry of A-type stars. Abt and Golson have been carrying out *UBV* observations for about 450 late-type dwarfs brighter than 9^m. Slaughter has completed *UBV* observations of stars suspected to be white dwarfs.

High-velocity stars have been observed in *UBV* by Imagava and Takayanagi (Okayama Observatory) and in four-colour system by Strömgren (at Kitt Peak Observatory).

Three-colour observations of all F and G type stars with known velocities have been completed by Eggen (Palomar Observatory). He has also observed in the *UBVRI* system M dwarfs found by Vyssotsky.

Multi-colour observations have been obtained by Golay and his collaborators for more than 350 stars at the Jungfraujoch Observatory. Plans are being made to observe, in the seven-colour system, metallic stars, sub-dwarfs and stars with known velocities.

H. L. Johnson is making *L*, *M* and *N* observations of selected bright stars. Nearly 50 stars have been observed (Lunar and Planetary Laboratory).

With the installation of the rotatable polarization telescope at Yerkes Observatory, Hiltner anticipates the observation of all early-type stars within 300 parsecs of the Sun.

At the Haute-Provence Observatory, Bigay (from the Lyon Observatory) is carrying out the *UBV* and Hβ photo-electric observations for O-A0-type stars on 11 Selected Areas near galactic plane. Limiting magnitude is the 13-th. One of the aims of this work is to obtain calibration sequences for photographic measurements. The programme contains 2000 stars in the following Selected Areas: SA 8, 9, 19, 24, 40, 49, 64, 74, 87, 98 and 110.

At the Uppsala Observatory, under the supervision of T. Elvius, a number of *B V* photo-electric measurements in SA have been carried out. Ekedahl has determined *B V* magnitudes for about 160 stars brighter than 11^m for SA2-7 and 11; Lindén for SA18 and 19 (**21**) and Sjögren for SA8. Elvius has determined pg and pv magnitudes for about 300 stars in SA19 close to NGC7654. Photographic *B* and *V* magnitudes have been determined by Eriksson in SA141.

W. Becker reports that at the Basel Observatory three-colour photometry of star fields in SA51, 54, 57, 71, 82, 94, 107, 133, 141, and 158 is being carried out. *UBV* and *RGU* systems are used. Photo-electric standards have been determined by Purgathofer (Vienna Observatory).

At Mt Stromlo Observatory, Westerlund is carrying out *UBVRI* or Strömgren four-colour photometries for O- B- and emission stars in the South Coalsack region. Extensive photo-electric measurements have been made by Ljunggren and Oja (Uppsala Observatory) in many regions. A catalogue for 849 stars (*B*, *B-V*) mostly located in the Milky Way, is ready for print.

Photographic photometry in *B*, *V* system for the region of southern galactic pole has been carried out by Eriksson (Uppsala Observatory) and for a region in Puppis, by Lindoff (Lund Observatory).

Strömgren and Crawford have made *UBV* photo-electric photometry for a number of stars in a $4° \times 4°$ area near the north galactic pole in the visual magnitude range of 13·0–15·5 selected as ultra-violet excess stars.

Moreno has carried out at the Inter-American Observatory, at Cerro Tololo, *UBV* photo-electric photometry for 228 stars which are known, or possible, members of the Sco-Cen association. An extension of this programme to include fainter stars is planned. During the past two years, Hiltner, Morgan and Neff have done additional *UBV* photo-electric photometry

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on O-type associations (Yerkes Observatory). Magnitudes and colours in *UBV* system for 31 OB stars have been determined in the region of RS Pup by Westerlund at Mt Stromlo.

Worral of the Cambridge Observatory is making a photographic *UBV* survey of the region of the VII Cas association. About 1000 stars have been selected. He hopes also to apply his method of Hγ photographic photometry. The Burakan and Tautenberg Observatories are carrying out a joint investigation of 28 associations in the photographic *UBV* system.

Imagava and Takayanagi are observing in the *UBV* photo-electric system stars belonging to open clusters (Okayama Observatory). Eggen at Palomar Observatory has made three-colour observations in galactic, globular clusters and standard fields. Photo-electric sequences have been established by Westerlund (Mt Stromlo Observatory) near NGC4852 and 6193; limiting magnitude is $V = 15{\cdot}5$.

Golay is starting seven-colour observations of galactic clusters at the Geneva Observatory.

Haffner (Hamburg-Bergedorf Observatory) has observed at Boyden Station clusters NGC3579, 5460, 6243 and 6322. Schmidt (Bonn), Engren (Lund) and Vanýsek (Prague) are taking part in the study of these clusters. A joint programme on the *UBV* photometry for 16 open clusters has been started at Hamburg-Bergedorf and Bonn Observatories.

Chincarini (Padova-Asiago Observatory) is continuing his researches on two-colour *UBV* diagrams for open clusters.

Westerlund (Mt Stromlo) has determined magnitudes and colours (mostly *V* and *B-V* but also *I* and *R-I*) for members of associations and clusters in the Magellanic Clouds. Photo-electric observations in the four-colour system and in *I* and *R* are being done for some Magellanic Clouds objects.

Bigay (Observatoire de Lyon) has continued two- and three-colour photo-electric observations of galaxies in the *UBV* system. The programme contains about a hundred galaxies belonging to the general field and to the Virgo and Coma clusters. Observations have been carried out for 50 galaxies.

MISCELLANEOUS

C. Jaschek reports that a bibliographic card catalogue of all stars which have been observed photo-electrically is being compiled at La Plata Observatory. The purpose of the catalogue is to furnish an exhaustive bibliographic reference of all observations done. It will not contain the values themselves, because of the difficulty of reference to one standard system. Nor will it contain stars in globular clusters or other galaxies. Objects of this kind will be specially listed. It is expected that this work will be completed about July 1964.

Three conferences have been held during the past three years on the problems connected with stellar photometry.

A conference on photometric standards was held at the Crimean Astrophysical Observatory on 17 and 18 June 1961. Problems of narrow-band photometry were discussed at the Conference on Spectral Classification, held at Kitt Peak Observatory on 14 and 15 December 1961 (**271**). The third conference, an International Symposium on Photometry and Spectral Classification, was held at Bandung in April 1963. The proceedings of this Symposium will be published.

V. B. NIKONOV
President of the Commission

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