25. STELLAR PHOTOMETRY (PHOTOMÉTRIE STELLAIRE)

INTRODUCTION

(A) *Scope of the Commission*

The scope of Commission 25 is difficult to define, as there are many gray areas between it and other commissions. As such, it is rather like the Spectroscopy Commission (29); both deal more with techniques and standards, and things in general, *not* with applications of the data to research more appropriate to other commissions. Indeed, the two Commissions 25 and 29 have many gray areas between them, some mentioned below. Another commission with which we share a large gray area is Instrumentation (9). We tend to include any detailed, specific reports of photometric instrumentation, especially its 'use' aspects, while they dwell on specifics of hardware. Image tubes have been discussed in depth by them in the last several meetings, but as image tubes become more operational (applied) our commission will be more active in discussing the 'use' aspects (but not the build or design aspects).

If we then eliminate from the Commission's scope any applications of photometry to research problems and any *design and fabrication* aspects of instrumentation, what is left? While there are still many gray areas, many of which may be discussed by the Organization Committee and the Commission as a whole at the Sydney meeting, and in later years, there are clear-cut topics that are of fundamental importance, and many of them are currently extremely interesting and dynamic. Many overlaps exist with Commission 45.

We include in our scope discussions of instrumentation as used in photometry, techniques of observations and of reductions of observations, observational parameters, standard systems, standard stars, standard sequences, discussion of observational errors, catalogs of photometric data, empirical and theoretical interpretation and calibrations of the observed parameters, etc.

Within this scope of interest, we cover the spectral region from X-ray to millimeter wavelengths, including the vacuum ultraviolet, the optical, and infrared regions. As to techniques, we include visual photometry (little used now), photographic photometry (high information content but low quantum efficiency), photoelectric photometry (low areal information but high quantum efficiency), and image tubes (potentially high information content and high quantum efficiency). We cover spectral resolutions from thousands of Angstroms up to several Angstroms; the highest spectral resolutions are within the scope of Commission 29 ('conventional' spectroscopy – photographic, photoelectric, or image tube, Fourier transform spectroscopy, etc.).

We include also measures of polarization, over the same wavelength regions.

(B) *What's new?*

The past three years have shown a continuing trend to the use of higher resolution: More observational parameters used and narrower bands for these parameters. Photometrical techniques in the allied field of spectroscopy have also expanded in this manner, as witness the increasing usage of Fabry-Pérot techniques, Fourier transform spectroscopy, and other interference techniques.

The wavelength regions used have been extended, and photometry from above the atmosphere (especially in the vacuum ultraviolet) and in the infrared are now routinely used in astronomical research.

Besides these procedures offering higher spectral resolution, photometry with higher time

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resolution is also now a standard technique, allowing astronomers to obtain information often not available by any other way.

Expanded use of improved instrumentation for data acquisition and handling, often involving the use of small on-line computers, is improving the quality and quantity of observational data obtained.

And, perhaps most recently, image tubes are becoming a viable factor in photometry. Many are now being used, primarily to increase the quantum efficiency and hence the limiting magnitude obtained in direct or spectral work. The impending usage of digital (linear) image tubes will mark a revolution in photometry, when routinely available. They will offer high quantum efficiency, high information content (and/or high spatial resolution), and linear response over a relatively large range. The potential is almost ideal, and while potentials may well not be achieved in all aspects, the future looks good and we all look forward to such devices with great enthusiasm.

Of the above techniques, I personally believe that the digital image tubes and photometry in the infrared will most increase our store of astronomical knowledge and understanding.

And we must remember that the reasons for development and improvements of equipment and techniques are not as exercises in themselves, no matter how intriguing or elegant. The astronomical knowledge and understanding gained so far by use of infrared techniques are huge, and the future bodes even better. We hope that digital (or linear) image tubery will be as good or better.

INFORMATION SOURCES

Two recent activities have helped greatly in the nearly impossible task of information retrieval. While astronomy is a small field relative to some, still the problem exists and increases with time.

First, the *Astronomy and Astrophysics Abstract* volumes (so far, two per year) offer us, grouped more or less by subject matter, abstracts of papers published in the astronomical literature. The presentation is rather complete and rather up-to-date. It has essentially negated the need for a review of published work in Commission reports, and none will be given in this report. Likewise work in progress, soon to be published, will be as well or better recovered in the Abstract volumes than it could be in Commission reports. We hope that, in the future, commission members will submit their reports to the commission in the light of that fact. In this Report, we will present rather fully information on published work submitted to the President. The hope is that in future reports information submitted will be of a general nature, summarizing work done and work planned, or of a specific nature relative to the commission's scope and not suitable for publication elsewhere.

Sections of special interest to Commission 25 in the Abstracts are: 113, Stellar Magnitudes, Colors, and Photometry; 031, Optics, Methods of Observation and Reduction; 032, Astronomical Instruments; 034, Astronomical Accessories; and 114, Stellar Spectra, Temperatures, Spectroscopy. Of course, other sections include abstracts of subjects within the scope of the commission as well.

The second activity of great interest to our commission is the operation of the European Data Center. While other types of data are collected, the situation on photometric data is well along. In particular, an updating of the U.S. Naval Observatory Catalog of *UBV* data is nearly ready for publication, and a catalog of *uvby* and β data is nearly ready for press. Details are described below (Section titled Reports for Members) and elsewhere. (See Information Bulletin, Centre de Donnees Stellaires) Analysis of the data retained in such banks will be most useful, such as has been done by FitzGerald for the previous *UBV* catalog.

We certainly hope that the Center's activities will continue and expand, and that authors heed the Center's requests that they send, promptly and completely, preprints and reprints of their work that contain photometric data of any sort to the Center.

Copies of magnetic tapes essentially duplicating the Center data bank are available and no doubt other Observatories will have rather complete files (copies) of data in which they have an active research interest.

A valuable addition to the general reviews of photometry and special areas of photometry is now in press, and will update and expand the reviews given in such sources as the *Stars and Stellar Systems Compendium* and the *Annual Reviews of Astronomy and Astrophysics*: M. Golay has written a text, 'Introduction a la Photométrie Astronomique', with the following chapter headings:

1. Définitions générales et distribution de l'énergie dans les divers types spectraux;
2. Mesures photométriques, effets des largeurs de bandes passantes et de l'extinction interstellaire;
3. Représentation photométrique bidimensionnelle des étoiles;
4. Les photométries a plusieurs couleurs et a bandes passantes larges;
5. Les photométries a bandes passantes intermédiaires et étroites;
6. Les paramètres photométriques et leur corrélation avec les paramètres physiques caractéristiques des atmosphères stellaires;
7. Photométrie appliquée a divers objets stellaires.

Also several symposia and colloquia occurred recently, whose subject is of immediate interest to this commission:

Symp. **50**, 'Spectral Classification and Multicolor Photometry';

Symp. **54**, 'Problems of Calibration of Absolute Magnitudes and Temperatures of Stars';

Colloq. **23**, 'Astronomical Polarimetry'.

Finally, in closing this section, I would like to second the suggestion made by a number of commission members: Please, authors of papers containing photometric data, publish enough details of your observational procedures, filters, equipment, reductions, so that readers can clearly perceive what you have done, repeat or supplement parts of it as necessary, and, in any other way, better use the published data to supplement their own work. It would aid the Data Center's work too, I am quite sure.

REPORTS FROM MEMBERS

From B. Hauck, Institut d'Astronomie de Lausanne et Observatoire de Genève: *Photometric Catalogues.*

In accordance with the project presented at the Brighton meeting and following the method described at the Cordoba Symposium (**1**), we are undertaking the production of photometric catalogues on magnetic tape. For each system we want to have two files: (a) published data, (b) homogeneous data. These files are now ready for many little systems and for the uvby β system. For the six-color system, Nicollier has built up a tape with these two files and we have lately received from Dr. Kron a tape with new and unpublished measurements. Concerning the UBV system, Mermilliod (**2**) has compiled all measurements published since the publication of the Blanco Catalogue (22 869 measurements). All tapes may be obtained from the 'Centre de Données Stellaires', Observatoire de Strasbourg, 11, rue de l'Université, F–67 Strasbourg.

In relation to the uvby β tape, we are preparing a catalogue of homogeneous data, and we hope to submit it soon to Astronomy and Astrophysics, Supplement Series.

REFERENCES

1. Hauck, B. 1971, 'Photometric Data on Machine-Readable Form', presented text at the *IAU Symp.*, **50**, Córdoba.

2. Mermilliod, J. C. 1972, 'A New Catalogue of Stellar UBV Photoelectric Photometry', published in the *Bulletin d'Information du Centre de Données Stellaires de Strasbourg*, No. 3.

From B. J. Bok, Steward Observatory, Tucson, Arizona:

(1) *Work on Southern Milky Way Sequences:* During the past three years B. J. Bok, P. F. Bok and E. W. Miller have been actively engaged in establishing faint UBV stellar sequences for sections of the Southern Milky Way from Vela to Norma. We now have twenty new or extended UBV photoelectric sequences with finding charts available for distribution. A paper 'Photoelectric

Standards for the Southern Hemisphere II' has been submitted for publication to the *Astronomical Journal.*

(2) *Four-Color Photographic Photometry:* Julian J. Schreur completed a Doctoral Thesis on adapting four-color photometry of the Strömgren *uvby* varieties through photographic photometry.

From Gh. Chis, Observatoire Astronomique, Cluj, Rumania:

(1) *Photoelectric Photometry:* In Rumania, the photometric studies are carried out in the Bucharest Astronomical Observatory and in the Cluj Astronomical Observatory. In Bucharest, the observation of the variable stars with a photoelectric photometer (with EMI photomuliplier) continued in the UBV photometric system. In Cluj, a photoelectric photometer with a 1P21 photomultiplier was tested, and the system constants for the BV photometric system (Johnson) were determined. Both observatories obtained photoelectric observations of the variable stars (mainly eclipsing variable stars).

Some problems about the reductions of the photoelectric observations to the standard UBV photometric system and about the determination of the specific wavelengths of the UBV photometric system were studied.

In Cluj, a new photoelectric photometer was assembled in co-operation with Brno Observatory, Czechoslovakia, using an EMI photomultiplier and UBV filters.

(2) *Photographic Photometry:* In Cluj, photographic photometry also is used. The images of the stars are measured with a Schnellphotometer. In the past three years mainly the RR Lyrae-type variable stars were observed.

From A. W. J. Cousins, South African Astronomical Observatory, Cape Province, South Africa: Since we met in Brighton the Cape Royal Observatory has been absorbed recently into the new South African Astronomical Observatory and much of our effort has gone into establishing a new outstation near Sutherland on the Karroo.

Practically all the HR (BS) stars and most of the stars in the Herstmonceux catalogue of stars closer than 25 parsecs, and south of $+10°$ declination, have now been measured in V, $B-V$ and either $U-B$ or $(U-B)_c$. An attempt will be made to measure more of the fainter stars in the latter catalogue at our Sutherland outstation.

The promised list of 'Photometric Standard Stars' is in press as *Royal Observatory Annals*, No. 7 (Proofs have been checked.)

Two series aimed at checking the zero points of the standard sequences in the Harvard E and F regions have been compiled (see *Southern Hemisphere Bulletin*, No. 20, p. 23 for the zero point corrections.) The details, including more precise data for the brighter stars, should be published before the meeting.

I. S. Glass is measuring infrared magnitudes of selected objects at wavelengths from 1·25 to 20 microns. The detectors are a liquid nitrogen cooled PbS photoconductor and a liquid helium cooled germanium bolometer. The photometer can be used either with a rotating chopper or a vibrating mirror.

A University of Cape Town (Physics and Astronomy Dept.) team under Prof. B. Warner and R. E. Nather are extending their high-speed photometry to the southern hemisphere. (Lately their attention has been given to lunar occultations and flare stars.)

We expect to have a McMullan electronograph working on our 1 m reflector by the end of the year and intend observing faint stars (mag. 15 or 16) by conventional methods for establishing the zero points. New equipment includes a two-channel 'Peoples Photometer' from the Royal Greenwich Observatory and a more versatile instrument, with an on-line computer, from the University of Texas.

From J. Dachs, Ruhr-Universität Bochum, Germany: A data acquisition system which is controlled by a Hewlett-Packard model 2114-B Computer has been adapted to the photoelectric stellar photometer at the 61-cm reflector of the University of Bochum installed at the European Southern Observatory, La Silla, Chile. In 1973, a rapid scanning spectrometer will also be availabel at this telescope (Drs. Haupt, Maitzen, Schlosser, Schmidt-Kaler of the University of Bochum).

A system of photoelectric standard photometry of the width of the Hα line in early-type stars has

been established by measuring 104 bright southern stars with interference filters of 13 Å and 157 Å width centered on Hα (J. Dachs and Th. Schmidt-Kaler 1972, *Mitteilungen Astr. Gesellschaft*, **31**, 166).

From H. Eelsalu, Institute of Physics and Astronomy, Estonian Academy of Sciences, Tartu, U.S.S.R.: My contribution to photometry has been limited to theoretical studies. The only article which has appeared so far (*Tartu Publ.*, **39**, 157, 1971) is devoted to the solution of the differential equations which describe the two-stage photographic process in the case of faint images. The concept of the latter has been outlined earlier by V. Riives (*Tartu Publ.*, **38**, 98, 1970). In particular, V. Riives has proposed an expression that is an efficient alternative to Baker's formula for photographic darkening.

At Tartu observational work goes on too. I think that the techniques of photoelectric observations of clusters and galaxies through slits developed by Veltmann *et al.* are worth mentioning.

Instrumentation is also being developed here, L. Luud *et al.* have coupled photoelectric photometers with on-line computers (*Edinburgh Publ.*, **8**, 1971, 63; *Tartu Publ.*, **40**, in press). Veismann has discussed design problems of high-precision photoelectric photometers (*Tartu Publ.*, **39**, 1971, 334), as well as other questions.

From Alejandro Feinstein, Observatorio Astronomico, La Plata, Argentina: For about 350 stars, including standard stars, B, Be, metallic line stars and several other objects, the Hα, Hβ, and Hγ lines were measured with interference filters. This program was especially designed to detect and study the variation with time of the Hα emission in early-type stars. From observations obtained in 1970 and 1972 at Kitt Peak and Cerro Tololo, the Hα and Hγ system was firmly established. Some Be stars show clearly the variation of the Balmer emission. This correlates also with the Hβ data obtained by Crawford and his group. A preliminary report was presented at the IAU Symposium No. 50, held in Cordoba, October, 1971 (Feinstein, in press).

From G. Godoli, Catania Astrophysical Observatory, Italy: The three-color simultaneous photometer employed in flare star patrol has undergone some modification (Paterno, L., 1971, *Mem. Soc. Astron. Ital.*, **42**, 99). Another similar photometer is planned for construction, and work has begun for construction of a photon counting photopolarimeter.

From J. A. Graham, Cerro Tololo Inter-American Observatory, Chile: Graham has completed and published *uvby* photometry for 94 of the Feige high latitude blue stars (*P.A.S.P.*, **82**, 1305 (1970)) and for 80 white dwarf stars (*Astron. J.*, **77**, 144 (1972)). Further observations of 90 blue stars from the Slettebak and Brundage lists have also been made. These observations are now being prepared for publication.

From W. A. Hiltner, The University of Michigan, Ann Arbor:

(1) A circular polarimeter has been completed and is now (July 1972) undergoing the final shakedown on the 52-in. telescope at Ann Arbor.

(2) A spectrometer-polarimeter is nearly completed (July 1972). Its resolution is 4 Å per second of arc at the 52-in. reflector with a 600 grooves per mm grating and second order.

(3) Work has begun on a two-beam photometer for observing variable stars with short period variations.

(4) We are designing a four-cell polarimeter for very faint objects but construction has not yet started.

From G. E. Kron, U.S. Naval Observatory, Flagstaff, Arizona: This report covers work done at the Flagstaff Station of the U.S. Naval Observatory on stellar photometry with the electronic camera. Contributions have been made by Harold Ables, Anthony Hewitt any myself. Barry Newell of the Yale Observatory has been working on the same problem employing electronic plates taken here.

We have found that precision is limited to approximately $\pm 0{\cdot}05$ mag. We believe that this limitation is not inherent in the method, but is the result of the limited accuracy of the spatial measurement of the microphotometers we have used for measuring the plates.

Under the direction of Anthony Hewitt, a special micro-photometer is being built at Flagstaff to test the hypothesis and to be used for stellar photometry. This machine is being built with

unusual attention to precision. When all sources of error affecting the accuracy of stellar photometry are combined, it is hoped that the contributions of the machine alone to the total error will be $\pm 1\%$ or less. Particular attention is being given to accuracy of the spatial measurement by employing short, accurate screws for the measurement function, screws that are used over the same parts of their threads for each star. Translation from star to star is accomplished by a separate screw system not used during the measurement process. This machine, which is still under construction, should be finished no later than March, 1973.

From A. U. Landolt, Louisiana State University, Baton Rouge, Louisiana: A faint extension of the UBV photometric system has been established photoelectrically, using Kitt Peak National Observatory telescopes, in the 24 Selected Areas around the celestial equator. More than 600 stars are involved, approximately 350 of which have been observed several times each on several nights over a three year observing period. The majority of the stars are between $V = 10$th and 13th magnitude, with the extreme range in magnitude being $8 \lesssim V \lesssim 14{\cdot}6$. The new standards cover a color range of 2·0 magnitudes in $(B - V)$ and of 3·0 magnitude in $(U - B)$. The rms errors for a majority of the stars are 0·02 magntitude or less, for both the magnitudes and color indices. Finding charts are being prepared, and will be published. In addition, several Feige and Giclas blue stars near the celestial equator have been observed extensively to provide additional faint blue standards. The value of these hundreds of new faint standards should be (a) that they are available to the big telescopes in both hemispheres, and (b) that they form an internally consistent photoelectric magnitude and color system all around the sky.

From P. Mianes, Observatoire de Lyon, France: 'Photomètre photoelectrique automatique 6 couleurs'. *Principe:* deux diaphragmes dans le plan focal du télescope et séparés par une distance de 14 mm sont obturés alternativement par un cache, le 1er diaphragme se trouve sur l'axe principal du télescope et laisse passer la lumière de l'étoile, le 2ème diaphragme de même dimension laisse passer la lumière du 'fond de ciel'.

Réalisation – Le photomètre comporte:

- 1 roue à diaphragmes (11 doubles diaphragmes de 0·5 à 6 mm de diamètre)
- 1 roue à filtres comportant 6 logements de filtres, 1 logement de source étalon, 1 cache pour l'obscurité
- 1 viseur de champ
- 1 viseur de diaphragmes
- 1 cellule

Le photomètre peut tourner autour de l'axe optique pour la recherche d'une position de 'fond de ciel' sans étoile parasite.

Les mesures se font part intégration de 5, 10 ou 20 secondes: (a) sur l'étoile, (b) sur le fond avec enregistrement sur imprimante.

Le passage au filtre suivant peut être automatique ou bien commandé.

Un affichage préalable permet (1°) la répétition des mesures sur un filtre donné, (2°) la répétition des cycles de la roue à filtres.

A chaque tour de la roue à filtres, une source étalon au tritium (avec différents filtres possibles) permet l'étalonnage du photomètre.

Résultats: une séquence d'étoiles failbes (jusqu'à $m = 16$) a été mesurée au télescope de 60 cm de l'Observatoire de Haute Provence, dans le système UBV avec une cellule non refroidie; les résultats sont excellents: pour $m = 16$, le signal en U de l'étoile représente 25% du signal du fond de ciel dans un diaphragme de 0·8 mm de diamètre.

Nous étudions actuellement des photomultiplicateurs infrarouges pour les adapter à ce photomètre (ex.: mesures en 6 couleurs de Lick).

From H. and A. Moreno, Cerro Calan Observatory, University of Chile, Santiago. They report that they are continuing their studies of extinction and transformation problems in wide band photometry, that has already resulted in several publications (see *Astronomy & Astrophysics Abstracts*).

From P. Notni, Deutsche Akademie der Wissenschaften zu Berlin, Sternwarte Babelsberg,

Germany: A twin 4-channel automated photoelectric photometer behind two joint semi-automated 40-cm-telescopes has been designed and built at Potsdam. It will be used mainly for UBV observations of variable magnetic stars of small amplitude.

Small photoelectric scales have been set up, but not yet published, near existing ones to account for field effects on photographic plates. (They have been communicated, on request, to Dr Argue.) Photographic magnitude scales will eventually be set up using a small prism with the Tautenburg Schmidt telescope. Difficulties arise from the dependence of the photometric step on magnitude.

Near M 3, a photographic UBV photometry on Tautenburg plates of about 2600 stars up to $B-20$ has been finished at Babelsberg and will be published in the near future.

From K. Osawa, Tokyo Astronomical Observatory, Japan: A simultaneous three-color photometer has been installed recently at the 36-in. reflector at the Okayama Observatory. This photometer is very useful for observing flare stars, of which variation of light and color are very rapid.

From A. G. Davis Philip, The Dudley Observatory, Albany, New York: Eighty field horizontal-branch stars have now been found in fields at high galactic latitudes by means of Strömgren four-color photometry of faint A stars (60 by Philip and 20 by Drilling). Over 50 of these stars have been measured in the four-color and Hβ systems. An article, analyzing FHB stars as a group, is in preparation. A summary of this work can be found in *IAU Symposium* No. 50. It has been found that the FHB stars have four-color and Hβ indices which are similar to those found for BHB stars in globular clusters.

Four-color observations have been made of 39 standard stars and 42 secondary standard stars of spectral types 09-K3. The zero point errors in b–y, c_1, and m_1 are 0·001, −0·002, and 0·000, respectively, relative to the published values of Crawford and Barnes (1970).

The δc_1 index has been calibrated to give $\delta \log g$, (*Ap.J.*, **171**, *L* 51) and $(b-y)_0$ is related to θ_e. $\log g$, θ_e diagrams can be constructed both for A stars in globular clusters and in the general field. Comparison of these data with the predictions of evolutionary theories is now underway.

Photometry of A stars in high galactic latitude regions in the four-color and Hβ systems allows the interstellar reddening to be accurately calculated. Summary reports of this work were given at *IAU Symposium*, No. 50 and No. 52. At $b > |40°|$ no area was found with a reddening $E_{b-y} > 0{\cdot}01$. Except for a small area near the NGP (where $E_{b-y} = 0{\cdot}035$) the reddening surrounding the NGP is equal to zero. At the SGP, $E_{b-y} = 0{\cdot}01$.

Blue horizontal-branch stars in 10 globular clusters have been measured (ω Cen, M3, M4, M5, M13, M55, M92, NGC 362, 3201, 6752). All clusters, except for the two intermediate metal abundant clusters M3 and M13, have similar $\log g$, θ_e relations. The surface gravities of BHB stars in M3 and M13 have larger c_1 indices and smaller surface gravities.

A new, v', filter ($\lambda_e = 4220$ Å, 1/2 width = 45 Å) has been used to supplement the Strömgren four-color system. This filter avoids the Hδ line and preliminary data indicate that the m'_1 index is a better measure of [Fe/H] and the c'_1 index a better measure of $\log g$ in the region $0.54 \leqslant \theta_e \leqslant 0{\cdot}70$.

From F. Rufener, Geneva Observatory, Switzerland: The last published edition of the catalogue of stars measured in the Geneva Observatory photometric system was presented by F. Rufener (*Astron. Astrophys. Suppl.*, Ser. 3, 181–252). Now, more than 18000 photometric observations are accumulated in the U B V B_1 B_2 V_1 G system. A provisional catalogue (internal publication) resulting from a complication of 14000 measures gives the colors for 3400 stars. A new edition of the catalogue is in preparation.

A balloon-borne stellar UV photometer has been flown successfully from France in October 1972. The telescope is a 15 cm Cassegrain. The photometer consists of a filter wheel with six bands, 100 Å wide, between 2090 Å and 3100 Å and a pulse counting photoelectric detector. This first flight was devoted to a system performance analysis. Four stars were measured. (Huguenin).

A dual beam photometer for differential and quasi-simultaneous seven-color observations is coming in operation. It will open new fields for the U B V B_1 B_2 V_1 G system (variable and faint stars) and allow the use of imperfect photometric skies. A 14 channels real time treatment for the photon counter is operated by a mini-computer. (Burnet, Rufener).

A microdensitometer has been built and is now under test. This instrument has a special design

to permit a semi-automatic evaluation of stellar magnitudes on electronographic plates obtained with a Lallemeand electronic camera through filters of the Geneva photometric system. (Pilloud, Goy).

From E. Rybka, Cracow Astronomical Observatory, Poland: All magnitudes of 9110 RHP stars (*Harv. Annals*, 50) have been transformed to the V system, and the final catalogue, containing magnitudes reduced to a uniform system, is ready for print.

Photoelectric observations in the UBV system of additional standard stars of magnitudes 7·5, 9·5 and 10·5 visual and of spectral types A, F-G and K in S.A. 1 to 43 have been finished by O. P. Abuladze at Abastumani Observatory under my general supervision.

From U. Steinlin, Astronomische Anstalt der Basel Universität, Binningen, Switzerland: Steinlin and Buser are investigating the possibility of calculating color indices from spectral scans and from various filter and instrument sensitivity curves to find a way for the rational selection of multicolor systems for defined purposes. The variation of the instrumental data, together with the spectral scans of the pertinent types of stars, should give for each application of multicolor photometry the most efficient selection of colors.

From V. Straižys, The Vilnius Astronomical Observatory, U.S.S.R.:

The general scheme of three-dimensional photometric classification of stars was developed and described in Straižys, Sviderskienė, *Astronomy and Astrophysics*, **17**, 312, 1972. The limiting magnitude of the Vilnius photometric system is increased by the replacement of glass filters by interference ones with high maximum transparency. The new filter U is composed from ultraviolet filter UFS-2 and 50% 3 mm solution of $CuSo_4$. The half-widths and maximum transmissions of the new filters are listed in Table 1.

Table 1.

	U	P	X	Y	Z	V	T	S
λ_0 nm	346	375	405	460	515	540	625	655
$\Delta\lambda$ nm	50	24	18	22	18	25	20	30
Max %	56	55	65	70	70	70	75	80

The new filter set increased limiting magnitude approximately 1^m in comparison with earlier glass filters.

Some photometric programs are being realized with the help of the system: (1) Two dimensional classification of BS stars having no MK classification. About 700 stars are already observed and classified (*Bull. Vilnius Obs.*, No. 34, 1972), (2) The investigation of interstellar absorption in the direction of a number of important galactic and extragalactic objects, (3) The investigation of stellar population in different galactic directions, (4) The investigation of certain pulsating variable stars. Some programs are being realized in collaboration with other Soviet observatories: Crimean Astrophysical Observatory, Special Astrophysical Observatory, Shemakha Astrophysical Observatory, Latvian Radioastrophysical Observatory, etc.

The theoretical investigation of photometric systems by integration of stellar energy curves is continued. For this aim the catalogue of detailed energy distribution curves of 50 representative stars of different spectral types and luminosities in the interval 3000–10000 A is prepared summarizing all available data. The catalogue is published in *Bull. Vilnius Obs.*, No. 35, 1972. These energy curves can be used to compute the parameters of photometric systems and the relations between their magnitudes and color-indices.

During the IAU Praha meeting in 1967, a working group for the revision of UBV system was formed, including Cousins, Johnson, Stock, and Straižys. Unfortunately, the group had no possibility of meeting to discuss the problem in detail. We, in Vilnius Observatory, have prepared an improvement of color-index *U-B*, which will be completely definite and out-of-atmosphere. The filter U is placed in the ultraviolet beyond the Balmer jump and has $\lambda_0 = 346$ nm. It is the same filter which is used for the magnitude U of the Vilnius photometric system (Table 1). The color-index *U-B* will be reduced outside the atmosphere with extinction coefficient depending on spectral

type, luminosity class, and interstellar reddening. For the stars with MK classification, it will be possible to transform old *U-B* values to the new ones.

From B. T. Ulrich, The University of Texas at Austin: Development during the past three years has been confined primarily to laboratory studies of the Josephson junction. During one of these years Dr Ulrich was on leave from the University of Texas at the École Normale Superieure of the University of Paris to do research on Josephson junctions. His travel to the École Normale was subsidized in part by an IAU travel grant. The primary result of experiments at the École Normale was a better understanding of the detection mechanism for the wide-band mode of detection in the Josephson junction. The research was reported in a paper 'Parametric Oscillations in Superconducting Double Point Contact Structures' to be published in the *Proceedings of the Thirteenth International Conference on Low Temperature Physics*, Boulder, Colorado, August 1972. Recently new results have demonstrated that the Josephson junction may also be used as a mixer in which the AC Josephson oscillation serves as the local oscillator for the mixer. In the heterodyne mode, the Josephson junction offers promise for use as a tuneable receiver of short millimeter wavelength and submillimeter wavelength interstellar molecular lines.

Outside the laboratory a third version of the Josephson junction detector has been used successfully at the Cassegrain focus of the 2·7-m McDonald Observatory optical telescope. The results of observations of 3C273 and of the galactic center were reported at the *Liège International Astrophysical Symposium* in 1971. At present under development is a new improved photometer system, the fourth version, which will also be a Cassegrain instrument for the McDonald Observatory telescope.

From Å. Wallenquist, Uppsala University, Sweden:

1. *The Institute of Astronomy, University of Lund*

G. Lynga and S. Wramdemark have measured *UBV* magnitudes within three areas each covering approximately ½ square degree. About 100 stars are measured in each area. Magnitude limits are $V = 17^{m}.5$, $B = 18^{m}.5$ and $U = 17^{m}.5$ (photoelectric measurements). Karin Särg and S. Wramdemark have measured photoelectrically about 100 stars to an apparent magnitude limit of $V = 12^{m}.0$ situated in an area of about 1 square degree at $\alpha = 0h27m$, $\delta = +62°.5$.

K. Bern and S. Wramdemark have measured *UBV* magnitudes photoelectrically in nine areas, each area about 10 square degrees and containing about 75 stars. The magnitude limit is $V = 14^{m}.5$. A. L. Ardeberg, Katrin Särg, S. Wramdemark have measured photoelectric *UBV* magnitudes of 127 stars in four areas, each area covers $2° \times 2°$. Most stars are brighter than $V = 11$. (See the appendix to the Commission report dealing with sequences.)

2. *Stockholm Observatory, Saltsjöbaden*

Simultaneous photoelectric and spectroscopic observations of Ae- and T Tauri-stars have been performed by G. Gahm, L. Nordh and G. Olofsson at the European Southern Observatory in Chile. The stars were observed over 9 nights in 14 spectral regions from 3600 Å to 10600 Å. Several flare-like events were registered. Olofsson and Nordh have carried out infrared observations (1·25, 1·65, 2·2 μm) with a photometer equipped with a signal averager; it was proved possible to do accurate colour photometry even when the atmospheric conditions were non-photometric.

For an investigation of the relationship between the continuous spectrum and the line spectrum of early type stars, U. Sinnerstad has recently carried out photometric and spectrographic observations of 75 bright main sequence B2-B5 stars at the European Southern Observatory in Chile. The photometric part of the investigation consists of uvby photometry and narrow band photometry for the line indices Hβ, Hγ, and He I 4471.

3. *The Uppsala Observatory*

T. Oja and L. Häggkvist

Bright stars (photoelectric determinations):

(a) *BV* for about 600 stars of later type contained in Bright Star Catalogue, all with $\delta > +10°$ (Häggkvist and Oja, 34 cm Uppsala refractor)

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(b) *UBV* for about 175 southern stars of late types from the said catalogue (Oja, Danish ESO 50 cm telescope)
(c) *UBV* for about 40 southern stars from the said catalogue (Oja, ESO 50-cm telescope)
Stars situated near the North Galactic Pole (photoelectric determinations)
(a) *BV* for about 600 stars, late giants, with $B<11{\cdot}5$ and $b>70°$ (Häggkvist and Oja, 34 cm refractor at Uppsala)
(b) *UBV* for about 2000 stars of the same kind and in the same region as (a) (Häggkvist, Flagstaff)
Sequences:
(a) *UBV*, stars brighter than $V=15$ in SA 4, 32, 55, 58, 80 and 81 (Häggkvist, Flagstaff)
(b) *UBV* in southern open clusters: NGC 2287, 2323, 2437, 2451, 2516, 2546, 2548, 3532, 5316, 6087, 6494, 6633 and IC 4756 (Oja 1 m- and 50-cm telescopes at ESO).

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D. L. CRAWFORD
President of the Commission

APPENDIX

Listing of sequences suitable for calibration of photographic plates

At the Brighton Meeting, the President of Commission 25, A. W. J. Cousins, requested Bok and Argue to contact interested parties with a view to drawing up lists of suitable sequences (*Proceedings*, **XIVB**, 1970, 182). We are grateful to E. W. Miller, Steward Observatory, for his assistance.

A letter requesting information on recent work was circulated on 26th July, 1972. In all, 180 copies were sent, addressed to all members of Commission 25, certain selected members of Commissions 28, 33, and 37, known or believed to be active in photoelectric photometry, persons listed as having undertaken photoelectric programmes in the Annual Reports of KPNO, CTIO, and ESO for 1969–71, and authors of suitable publications listed in *Astron. and Astrophys. Abstracts*, 1969–71. We apologize to any potential contributor who has been missed from our selection, but would stress that we are still anxious to receive additional data, now and in the future.

Of the 180 requests, 31 produced replies representing 40 authors and giving information on 412 sequences containing 3 or more stars, plus 4 covering wide areas of sky that could not be fitted into our cataloguing procedure and are given separately.

The distribution of the 412 fields in RA and Dec is as shown in Table 2. There are seen to be zones of avoidance at the two celestial poles, and a pronounced maximum at high southern de-

Table 2. Distribution of Sequences in RA and Dec.

	RA	0·1^h	2·3^h	4·5^h	6·7^h	8·9^h	10·11^h	12·13^h	14·15^h	16·17^h	18·19^h	20·21^h	22·23^h	Total
Dec	70°			1		1	1	1	1		1		1	7
60	50	2	1			1	1			2		2	3	12
40	30	4	5	2	1	5	4	9	1	7	4	6		48
20	10	6	1	1	5	1	4	14	8	4	5	3	4	56
0	−0	3	7	3	6	2	1	3	3	1	6	5	7	47
−10	−20	3	1	2	13	1		1	2	6	2	3		34
−30	−40	2	2	1	3	16	1	1		17	4			47
−50	−60	1		26		17	32	30	11	8	1			126
−70		21	1	11				1				1		35
														412

clinations. Activity at northern declinations is not negligible, however, due partly to interest in QSO fields and partly to the Selected Areas.

The extent to which the data are available is summarized in Table 3, from which it is seen that two-thirds of the sequences either have been published or are 'in press'.

Table 3. Numbers of Sequences in various stages of availability.

Number published (including theses)	189
Number 'in press'	96
Number soon to be submitted for publication	32
Number not published, but for which details may be obtained from author on request	95

The whole material has been assembled into a report. No attempt has been made to assess the quality of any sequence or to apply any form of censorship, other than the exclusion of sequences comprising fewer than 3 stars. For each sequence the information given is:

(1) RA and Dec (1950);
(2) Galactic coordinates l, b;
(3) The author's own designation of the sequence field;
(4) The approximate area of sky covered;
(5) Number of stars;
(6) Magnitude range;
(7) Photometric system;
(8) Literature reference; postal address of author in case of unpublished data.

It is hoped to circulate the material to all commission members and all respondents early in 1973, together with a request for corrections, suggestions and additional sequence data. The new material, plus corrections to the original draft, will be available at the Sydney IAU Meeting as a separate report.

The response to our circular has underlined the considerable activity in photoelectric photometry in both hemispheres, which in turn calls for two things. First, adequate distribution of the material to give observers easy access, and second, an arrangement for the continual growth of the compilation. These are two matters that should be discussed at the Sydney Meeting, the latter point in consulation with the Working Group on Numerical Data.

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