25. COMMISSION DE PHOTOMETRIE STELLAIRE

PRÉSIDENT: M. W. M. H. Greaves.†

MEMBRES: MM. Baade, Baum, W. Becker, Bok, Butler, Cousins, de Kort, Dessy, Dufay, Eggen, Fracastoro, Haffner, J. S. Hall, Harris, Heckmann, Hertzsprung, Hiltner, Holmberg, Hunter, Irwin, H. L. Johnson, I. R. King, Koelbloed, Kostylev, Kron, MacRae, Malmquist, Mees, P. Muller, Nikonov, Oosterhoff, Perek, Pettit, Rahman, Ramberg, Redman, Rybka, Schilt, Seares, Sharonov, Stebbins, Stoy, Tsesevich, Vanderlinden, van Rhijn, Velghe, Wallenquist, Weaver, Wesselink, Whitford, Woolley, Zonn, Zwicky.

25*a*. SOUS-COMMISSION DES SÉQUENCES DE MAGNITUDES

PRÉSIDENT: M. R. O. Redman.

MEMBRES: MM. Baade, Baum, Bok, Cousins, H. L. Johnson, Stoy, Tsesevich, Vyssotsky, Wallenquist, Whitford.

25*b*. SOUS-COMMISSION DES ETALONS DE MAGNITUDE STELLAIRE

PRÉSIDENT: M. R. H. Stoy.

MEMBRES: MM. W. Becker, H. L. Johnson, Kron, Oosterhoff, Redman, Rybka, Weaver, Woolley.

STANDARD SYSTEMS

It is clear that the primary task of the commission at the Dublin General Assembly will be the consideration of the report of the sub-commissions and the detailed examination of the points raised. It will be advantageous to summarize the background against which the sub-commissions were appointed.

In the Report of the Commission adopted at the Rome General Assembly it was pointed out that when precision of measurement is pushed far enough it must eventually become impossible for observers using two-colour photometry to transfer their results to each other or to reduce them to a common standard system (1). The difficulty arises from the existence of spectral line contributions to heterochromatic magnitudes and, for stars of later type, from the departure of the continuum from the conditions represented by a linear spectrophotometric gradient. The first of these effects is known to involve luminosity and the second may do so. The question at once arises whether modern precision in photometry does not call for three-colour work in which two parameters are available for reduction, one corresponding roughly to surface temperature and the other corresponding roughly to luminosity.

A further difficulty arises for space-reddened stars since space reddening modifies spectral energy distribution in such a way that their continua can no longer be represented by linear spectrophotometric gradients. This consideration *may* call for a third parameter in reductions and so for four-colour photometry.

The practical question is one of degree. If, for example, it had transpired that the effect of the luminosity parameter was confined to the third decimal place of a magnitude, then, for practical purposes it could be ignored and, apart from space-reddened stars, there would be no practical difficulty in the reduction of two-colour measures to a common standard. But from the discussion at Rome it appears that this is not so in general. Stoy pointed out that a comparison of the Cape Fabry magnitudes with those obtained by Johnson showed that to obtain a sufficient accuracy of transfer it seems necessary to use a relation involving both Johnson's $(B-V)$ and $(U-B)$ colour indices. Stoy (2) stated that 'in fact it was becoming increasingly clear that, in general, two-colour photometry was not able to define a magnitude system adequately precise for the needs of modern astronomical photometry'.

It is convenient at this point to refer to the work of Johnson (3), in which he concludes that the inclusion of radiation to the violet of 3800 Å in the measurements makes the relations between different two-colour systems non-linear and, in most cases, multi-valued. It is also convenient to mention here that recent work by Eggen (4) shows that for the redder stars there is an appreciable luminosity effect between his own photometric measures and the B and V measures of Johnson and Morgan (5). The values of V for the two sets of measures are in good agreement, but in the plot of $P-V$ (Eggen) against $B-V$ (Johnson and Morgan) the values of $P-V$ for $B-V>1{\cdot}0$ are different for giants and dwarfs. At $B-V=1{\cdot}5$ the systematic difference is 0·09 (the value of $P-V$ being greater for the giants), whereas the standard error of one value of $P-V$ is $\pm 0{\cdot}005$.

It would be futile not to face the implications of the comparisons quoted by Stoy in 1952, of Johnson's investigation, and of Eggen's recent work. It comes to this: If two observers A and B each work on a two-colour basis, it can happen that A's measures for two stars differ significantly in colour and magnitude whereas B finds the colours and magnitudes to be identical. Consequently it is not always possible to convert individual values on one two-colour system to another two-colour system with an accuracy comparable to that of either system. Furthermore, it is not a question of abandoning linear transformations for non-linear ones; the trouble seems to lie in the circumstance that two parameters, involving surface temperature and luminosity, are required for reduction from the system of one observer to that of another. In the discussion at Rome Weaver pointed out that modern precision photo-electric photometry had brought us up against a real practical difficulty in converting measures from one system to another.

There are two obvious ways of meeting the difficulty. One would be for all two-colour observers to use approximately the same wave-length ranges. Reduction to standard would still be necessary because of variations in types of instrument, in cells, and in plates, and of residual variations in filters. But with a suitable choice of wave-length ranges the errors inherent in reduction of two-colour magnitudes could be materially diminished and it might well be that they could be relegated to the third decimal place and so cease to be of practical consequence. This procedure was advocated at Rome by Weaver, who considered that the wave-length ranges used should be chosen so as to conform as closely as possible to the existing international pg and pv systems. Weaver urged that in the blue measures the ultra-violet to the shortward of, say, 3800 or 3900 Å should be eliminated; it has been recognized that the Balmer absorption in the ultra-violet can contribute materially to the difficulties that have been experienced. Weaver also advocated that all observers should use the same N.P.S. stars for standardization. He considered that this would remove the difficulties arising from inconsistencies in the N.P.S. standards.

Another way of meeting our difficulties would be for all observers to employ three-colour photometry with wave-length ranges chosen so as to give good separation of the temperature and luminosity parameters. At the Rome General Assembly the commission had before it a memorandum by W. Becker setting forth the advantages of three-colour photometry with equivalent wave-lengths at about 6400, 4700 and 3700 Å. Spectrophotometric work has indicated that (with the exception of space-reddened stars) the first two of these wave-lengths would give a two-colour system such that one observer's measures can be transferred to the system of another by a linear transformation, whereas this might not hold to high accuracy (especially for the redder stars) if an equivalent wave-length shorter than 4700 Å was substituted for the second. The inclusion of the third equivalent wave-length at about 3700 Å would supply quantitative information about Balmer and other absorption and about the depression in the shorter wave-lengths for the late-type stars. In the discussion at Rome Becker emphasized that he was of the opinion that the international spectral regions for pg and pv magnitudes should not be changed but should be reproduced as exactly as possible by all who wished to observe in these spectral regions. On the other hand, there were problems which required photometry in regions other than the international ones and it was in connexion with such problems that he advanced his proposals for three-colour photometry. In his memo-

randum Becker had stated that he had employed the three spectral ranges proposed for more than ten years. Becker also advocated the construction and distribution of standard filters.

In the discussion at Rome Redman agreed with Weaver that any new magnitude systems should disturb the international *pg* and *pv* systems as little as possible. Stoy, as has already been stated, favoured three-colour work and suggested a third colour range in the ultra-violet in addition to the existing photographic and visual ranges. Baade objected to this on account of the extinction difficulties in the ultra-violet. He agreed with Weaver that the ultra-violet should be eliminated from the photographic range and he suggested that in future this range should be limited to 3900–5000 Å.

With this background, and having regard to recommendations I and II of Sub-commission 25*a* (on Sequences of Magnitudes) (6), the commission recommended the appointment of a new Sub-commission on Standards of Stellar Magnitude with the following terms of reference:

1. To examine the conditions under which accurate working magnitudes can be referred to a standard *pg*, *pv* system with errors not exceeding $0^m.02$.
2. To examine the desirability of re-defining the zero of the international *pg*, *pv* scales and if possible to bring forward specific recommendations.
3. To examine and report on Dr Becker's proposals for the establishment of standard magnitudes at the same wave-lengths.
4. To examine and report on Dr Weaver's proposals for the establishment of a standard photo-electric colour and magnitude system.
5. To examine and report on the desirability and practicability of Dr Becker's suggestion that the I.A.U. should sponsor the construction and distribution of standard filters.

Arising out of recommendation V of the sub-commission on Sequences of Magnitudes the commission recommended that this sub-commission be reappointed and charged with the task of attempting to establish recommended key sequences at $-45°$.

These two sub-commissions have now submitted a combined report which is given below.

Report of Sub-commissions 25*a* and 25*b*

(Sub-commissions on Sequences of Magnitudes and Standards of Stellar Magnitude)

There is general agreement that all magnitude measures should be reducible to a common standard system without any essential loss of accuracy and that in general the astronomer who produces the magnitudes should also provide the calibration allowing the reduction to be done. Apart from an ambiguity in the reduction of data for blue stars, the general experience is that there is no essential difficulty in reducing accurate magnitude measures to a standard *pg*, *pv* system with standard errors not exceeding $\pm 0^m.02$.

In ordinary wide-band photometry there is no serious technical difficulty in setting up a Pogson scale in any given region of the sky with standard errors not exceeding $\pm 0^m.02$ down to 18^m or 19^m. For stars fainter than this, the problem becomes more difficult; measures consume more time and errors tend to rise. Baum reports accidental errors from $0^m.02$ at 20^m to $0^m.2$ at 23^m, but believes no systematic scale error is involved.

Although it is believed that the zeros of such Pogson scales can be transferred from one part of the sky to another with standard zero errors not exceeding $\pm 0^m.02$, cautious observers are aware of the difficulties. Baum remarks: 'Zero-point transfers over large distances in the sky, however, are still not entirely free of complications, and probably warrant further attention.' Becker, Rybka and Wallenquist emphasize the desirability of having local standards of zero point well distributed over the sky. Cousins, Stoy and Wallenquist suggest that, as far as photo-electric observers are concerned, well-observed bright stars may serve for this purpose.

Standard systems

Two-colour *pg*, *pv* observations are likely to continue to be widely used. Kron and Rybka think that the present International System should continue to be used as the basis for two-colour photometry. The defects of the North Polar Sequence are now generally recognized. Kron suggests using the Interim Magnitudes proposed in the 1952 Report, and making some agreed colour extensions to remedy existing shortcomings. Much of the ambiguity in a *pg* system can be avoided by excluding light of wave-length shorter than 3800 Å, but early-type stars are necessary to define the system.

During the past three years, the value of observations in the ultra-violet has been increasingly recognized. The addition of this third colour gives the measures much greater physical significance, especially in the direction of sorting stars into absolute magnitude classes, and of distinguishing intrinsically red stars from blue stars reddened by interstellar matter. Oosterhoff suggests that the measures of Johnson and Morgan should be used as the basis for a three-colour photometry. Johnson has pointed out that linear transformations between one $U-B$ system to another are not generally satisfactory. This is particularly true when one set of measures has been made with aluminized optics and the other with glass and silvered optics.

Redman has expressed fears that the continued introduction of new magnitude systems may lead to confusion and has urged that efforts should be directed towards producing a system of parameters to describe stellar radiation, closely connected with the units of physics and not subject to change with the introduction of new observing techniques. A magnitude system should be a concise and simple way of describing stellar radiation; it is not a complete spectrophotometry. His suggestion that astronomers should consider abandoning the traditional magnitude scale in favour of a $\log_{10} I$ scale has met with no support.

Cousins and Stoy feel that Redman has rather exaggerated the complexity of the different magnitude systems that have been, and are being, brought into use and has tended to underestimate their interconvertibility. Their experience with three-colour photometry at the Cape is still very limited, but it seems sufficient to indicate that most magnitudes and colours, whether wide or narrow band, in the *pg*, *pv* region can be reduced to other similar systems with satisfactory accuracy (e.g. standard errors not exceeding $\pm 0^{m}{\cdot}02$) even if the ultra-violet light is not excluded, provided both the $U-B$ and the $B-V$ colours are known.

The suggestion that standard filters should be constructed and distributed is withdrawn.

Some members of the sub-commissions consider that the limited man-hours available to stellar photometry is an important factor to be considered in making proposals for standard magnitude scales.

Standard Areas

The 1952 Report recommended that standardizing work should be concentrated in the following regions:

The N.P.S. at declination $+90°$; S.A. 68, C2, C4, C7, S.A. 85 and 89, at $+15°$; the nine E regions at $-45°$. This is a compromise suggestion, taking into account extensive work already done. This choice of regions has been criticized by Kron, who would prefer six areas at $+15°$ and six at $-15°$.

The matter seems likely to be settled *de facto* rather than *de jure*. Extensive work has been reported by Baum for the following regions: the N.P.S.; S.A. 51, 54, 57, 61 at $+30°$; S.A. 68, 71, 89 at $+15°$; S.A. 94, 107 at $0°$. Vyssotsky reports photographic and photo-electric observations in the twelve C regions. Kron and Wallenquist have both reported photo-electric photometry in the N.P.S. Oosterhoff reports photo-electric observations in E 8 and 9, which confirm the scale of the Cape S. system to a fraction of 1%. The Cape observers are continuing work in the E regions. Becker has suggested that of the regions at $+15°$ one or two fields should be selected specially for the comparison of photometric systems of different observers and that the magnitudes and colours in these

one or two fields should be completed by spectrophotometric work, chiefly with the aim of checking computed isophotal wave-lengths by direct, accurate measurements.

Recommendations

The sub-commissions wish to suggest for consideration by Commission 25:

1. That for standardizing two-colour photometry, observers should use
   (*a*) a modification of the International *pg*, *pv* system;
or (*b*) the *B*, *V* system of Johnson and Morgan (5);
or (*c*) in the southern hemisphere, the 1953 *S* system (7).

2. That for standardizing three-colour photometry, observers should for the present use the *U*, *B*, *V*, system of Johnson and Morgan (5). (Becker comments that there would be some advantage in choosing, instead of *B*, a system centred on a rather longer wave-length, about 4700 Å.)

3. That observers be urged to use a filter (such as a GG13)to cut out radiation with wave-lengths shorter than 3800 Å whenever 'blue' or 'photographic' magnitudes are being observed.

4. That further investigations be made to determine definite relationships between the various systems of standard magnitudes.

The Task of the Commission

It now becomes the duty of Commission 25 to examine the report of the sub-commissions and to make such recommendations as may be thought appropriate.

It will be noted that with regard to the remit to the Sub-commission on Sequences of Magnitudes the sub-commissions have reported that the Cape observers are continuing their work on the E regions. In fact, Stoy and Cousins have reported that the system of standard magnitudes in the nine E regions at $-45°$ has been completely revised and is now based exclusively on observations with Fabry or photo-electric photometers. Details are given in Cape Mimeograms nos. 2–4. The sub-commissions have made no recommendations on this remit and no immediate action by the commission seems to be required.

With regard to remit (5) to the Sub-commission on Standards of Stellar Magnitude it has now been reported that the suggestion for the construction and distribution of standard filters has been withdrawn.

Turning to recommendations (1) to (4) of the sub-commissions these do not include any recommendations with regard to Weaver's proposals (remit (4)) in so far as these proposals urge that all two-colour observers should use approximately the same wave-length ranges. The sub-commissions have suggested (recommendation (3)) that for the measurement of 'photographic' magnitudes wave-lengths shorter than 3800 Å should be eliminated and it seems likely that there will be substantial support for this proposal. But beyond this the sub-commissions have made no specific proposals for standardization of filters to be used in two-colour work and they presumably wish to leave this matter to the whole commission for a decision on the principle. The argument in favour of Weaver's suggestion has been restated above.

Turning to recommendation (1)—standardization of two-colour photometry—the commission will have to decide whether they are going to give approval to any of the three systems listed, and, if they do, whether they will endorse only one of the three or more than one. The arguments in favour of one standard system, to be used by all observers, are obvious and need not be stated here. But a consideration which will have to be kept in mind is that when it comes to the operation of observing programmes a commission of the I.A.U. is a consultative and not a legislative body. It can recommend procedure, but individual astronomers can adopt any course they please. Generally speaking, I.A.U. commissions have been careful not to make recommendations on observational procedure unless it has become apparent that workers in the relevant field are prepared to accept them. In the present instance, for example, it seems unlikely that the Cape astronomers,

who have spent a great deal of trouble in establishing the 1953 *S* system, will be willing to modify it in the immediate future. They naturally will wish to devote their energies to their valuable and extensive zone work. The discussion at Dublin will doubtless make it clear what various observers are prepared to do, and what they are not prepared to do. It may be that the commission will feel that it must subordinate the ideal to the practical and to give alternative recommendations, at any rate for the present. It must be remembered that advances in observational astronomy have been made in the main by the hard work of individual astronomers. It often happens that their efforts eventually bring matters to a stage at which future procedure becomes obvious; when that stage has been reached formal endorsement by a body such as the I.A.U. becomes of advantage. It is for the commission to decide whether that stage has or has not been reached in the present instance.

There is clearly much to be said for each of the three two-colour systems suggested by the sub-commissions. The argument for (*a*) is obvious; one naturally wishes to preserve continuity as much as possible. On the other hand (*a*) in its present form is not definite; if it is to be recommended, a more precise statement of the modifications required to the International *pg*, *pv* system would be required. A more complete specification would constitute a task for a sub-commission, but the whole commission would first have to decide whether it approved of (*a*) in principle.

The arguments for (*b*) and (*c*) are that they are existing systems which are adequate and ready for use. The 1953 *S* system has been established with a view to immediate needs in the southern hemisphere. If, arising out of recommendation 2, the commission recommends the three-colour system of Johnson and Morgan for the standardization of three-colour photometry, that recommendation would then constitute an argument in favour of (*b*) since it is clearly advantageous that the adopted standard two-colour system should consist of two of the colours included in the standard three-colour system.

Turning to recommendation (2)—standardization of three-colour photometry—the commission will have to consider Becker's suggestion that instead of the *B* magnitudes of Johnson and Morgan a system should be substituted centred on a rather longer wave-length, about 4700 Å. The reasons for this are given on p. 339 above; below 4700 Å stars of the later spectral types exhibit a depression below the continuum corresponding to the linear spectrophotometric gradient for the longer wave-lengths. For these stars there is also heavy absorption for the shorter wave-lengths and luminosity effects may be involved. In fact, the comparison, referred to above, between Eggen's *P* magnitudes and the *B* magnitudes of Johnson and Morgan seems to show that luminosity effects are actually involved for the redder stars. By eliminating the ultra-violet from photographic magnitudes (recommendation (3)) we shall minimize the effect of Balmer absorption, which is greatest near spectral type A0, but for the stars of late type the depression and absorption in the blue and violet is a factor which has to be considered.

On the other hand the establishment, with all modern high precision, of the modified three-colour system suggested by Becker would involve a considerable amount of labour. The system of Johnson and Morgan is immediately available as it stands; their work, as Stoy has remarked, has provided the framework of what appears to be an adequate and acceptable system of standard magnitudes and colours for a three-colour photometry with equivalent wave-lengths at about 3500 Å (*U*), 4300 Å (*B*) and 5500 Å (*V*). This system is rendered the more valuable because the spectral types of most of the standard stars have been accurately classified on the revised system of the *Yerkes Spectral Atlas*.

It would be, of course, open to the commission, whilst recommending that observers should use the system of Johnson and Morgan for standardizing three-colour photometry, to add a resolution welcoming experiments on the modified system suggested by Becker. There may be something to be said for such a course.

With regard to recommendation (4) of the sub-commissions it will probably be felt that it amounts to a recommendation of the obvious. But this remark must be qualified by the consideration that two-colour systems are not always connected by one-to-one relations to the requisite accuracy.

Other considerations will doubtless be brought forward in the discussion at Dublin. A full discussion is clearly necessary before the commission can decide upon its recommendations.

Progress Reports

From the reports sent in by members of the commission it is clear that a considerable amount of work is being done. It is impossible to mention all items here and, in fact, one member of the commission has commented that he does not think that the I.A.U. should publish 'a sort of master three-year report for every observatory'. It thus becomes the unenviable task of the President to make a selection as best as he can.

Progress continues on the measurement of magnitudes in Standard Areas. Reference has already been made to the Cape work on the E regions and to the photo-electric photometry in the N.P.S. reported by Kron and Wallenquist. Published work includes that of Beer, Redman and Yates (8) on the Selected Areas at $+15°$ and that of Rybka (9) who has given photo-electric measurements of 6^m stars near Selected Areas in zones $+75°$ and $+60°$. Van Rhijn reports the publication of photographic magnitudes for stars in the Selected Areas at the equator (10). Oosterhoff reports the publication by Walraven and Fokker (11) of colours of B- and A-type stars in fifty-four Selected Areas mostly below 30° galactic latitude and down to $-15°$ declination. Oosterhoff also reports progress in the Leiden programme of photographic magnitudes in the Southern Selected Areas.

Baum reports the completion of a programme for setting up photo-electric sequences in nine Selected Areas. This work represents an important advance in that the 400 stars involved range down to the 22nd or 23rd magnitude. A photon-counting photometer was used at the prime focus of the Palomar 200-inch telescope.

Turning to the major zone photometric catalogues Schilt reports that the zone work on A.G. stars carried out at the Rutherfurd Observatory has been completed by the publication of no. 32 of *Contributions from the Rutherfurd Observatory* containing the photographic magnitudes of 55,700 stars in zones $+10°$ to $+20°$ and $+30°$ to $+50°$. With the zones previously published the northern skies have been covered from $+10°$ to $+60°$. It is not intended to extend the work beyond these limits.

Stoy and Cousins report progress with the measurement of the photographic and photovisual magnitudes of the 70,000 stars to be included in the Cape Photographic Catalogue for 1950.0. They also report the completion of the programme for determining the photographic magnitudes and photo-electric colours of stars south of Dec. $+6°$ with H.R. magnitudes 5·0 and brighter. The results are given in Cape Mimeograph no. 1 and these stars are now being used as secondary standards for a new photo-electric programme which includes all stars in the *Yale Bright Star Catalogue* between $-4°$ and $-64°$ together with a number of fainter stars from the Cape radial velocity and parallax lists.

Nikonov reports that at the Crimean Astrophysical Observatory E. S. Brodskaya, J. J. Nazarova, A. B. Numerova and P. F. Shajn are completing the determination of photographic and photovisual magnitudes of about 19,000 stars down to magnitude 12·5 in four regions of the Milky Way. Tsesevich (12) has determined photographic magnitudes for the majority of the B.D. stars within the limits $21^h\,40^m$ to $22^h\,20^m$ of R.A. and $-9°$ to $+9°$ Dec. Nikonov (13) has published a catalogue of photo-electric colour equivalents of 1048 stars. This information is extracted from Nikonov's report, which shows that considerable photometric activity is in progress at the Crimean Astrophysical Observatory and at the Engelhardt Astronomical Observatory.

Malmquist and Wallenquist report the publication, by Eklöf (14), of blue and red magnitudes for about 1800 stars down to the 12th magnitude in a region of Auriga.

Members of the commission will be glad to know that Stebbins and Kron now have the material on six-colour photometry of 400 stars in continuation of the results previously given by Stebbins and Whitford (15). It is hoped that this work will appear in print before the Dublin General Assembly. Stebbins and Kron are also obtaining six-colour data for the Sun.

Reference has already been made on pp. 339 and 342 above to the papers by Johnson, Johnson and Morgan, and Eggen.

Kron, White and Gascoigne (16) have given red and infra-red magnitudes for 138 stars. The results were reduced to the previous system of red and infra-red magnitudes (17). The work published in 1953 sets up standards of zero-point and colour over the whole sky, and Kron reports that he and his collaborators have now measured the colours and magnitudes, on this red and infra-red system, of nearly 300 stars of known parallax. This list contains nearly all the stars in the whole sky with parallax greater than or equal to 0".100. The southern stars were measured in Australia at Mount Stromlo.

Several members of the commission have reported work on stars in clusters and in the Magellanic Clouds.

Turning to technical developments Baum has designed, constructed, and brought into operation a charge-integrating photon counter whose performance has thoroughly confirmed the theoretical advantage of charge-integration as against a rate-of-charge system when faint objects are being measured photo-electrically. Reference has been made above to the results obtained in Selected Areas down to the 22nd or 23rd magnitude. The limiting magnitude of the counter is fainter than the practical limit of photographic magnitude with the same telescope.

Nikonov reports photo-electric developments at the Crimean and Engelhardt Observatories. These include an investigation by himself on the application of multicolour electrocolorimetry to the study of selective light absorption in the interstellar medium.

Haffner reports the construction of a new Iris diaphragm photometer which is being used at the Hamburg-Bergedorf Observatory for the measurement of in-focus photographic images. Its outstanding characteristics are great mechanical and electro-optical stability, convenient focusing and operation, measurements to better than 0·01 magnitude and measurement speed up to 120 stars per hour.

Perek reports work on the development of a photo-electric photometer at the Brno Institute of Astronomy. Mees reports major improvements in the sensitivity of infra-red photographic emulsions. Butler (18) has carried out preliminary experiments at Dunsink Observatory on the development of an indirect method of star counting.

Scintillation

For the time being Commission 25 is giving hospitality to this subject. At the Dublin meeting the commission will have to decide whether it will continue to do so. A progress report has been prepared by H. E. Butler and appears as an Appendix to this Report.

Agenda for the Dublin Meeting

The principal business is the consideration of the report of the sub-commissions.

The commission will have to decide whether it will continue to regard studies of scintillation as coming under its auspices.

The following topics for discussion have been suggested by members:

1. The zero-point problem in stellar photometry (Rybka).
2. Atmospheric extinction (Nikonov).
3. The need for further photometry down to the 23rd magnitude (Baum).
4. The need in the southern hemisphere for primary and secondary sequences extending down to the 20th magnitude (Butler).
5. The need for extending sequences of red magnitudes to cover faint stars (Dessy).
6. The need for monochromatic magnitudes of stars in Hα light (Shajn).
7. The need for new observatories in sites where the climate is excellent (Irwin).
8. The desirability of preparing special charts for Selected Areas (Wesselink).
9. The problem of star-counts on plates obtained with Schmidt cameras (Butler).

In addition to the more formal business before the commission Dr Baum has undertaken to arrange a symposium on image tubes. This should be a most valuable part of the proceedings at Dublin.

W. M. H. GREAVES
President of the Commission

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APPENDIX

REPORT ON STUDIES OF SCINTILLATION

Introduction

Definition

It is assumed that the word 'scintillation' includes all effects connected with atmospheric seeing, whether the object viewed be a star or an extended body.

Scope of report

This review covers roughly the last ten years and is not intended to be comprehensive.

General

Astronomers have been forced to take notice of scintillation because of its nuisance value. A considerable amount of observational and theoretical work has already been carried out. Nevertheless, the main interest that astronomers have in fully understanding scintillation is that they may thereby be in a better position to try and overcome its ill effects. On the other hand, the study of scintillation is of great interest to meteorologists. Since observation usually requires the telescopic equipment of an astronomical observatory, it would appear that the active observers of scintillation will remain astronomers, although much of the interpretation of the results will of necessity be done by meteorologists.

Observations

Between 1948 and 1954 several series of observations were made of the intensity variations of the telescopic image of a star, particularly by Boutet (1), Butler (2), Ellison and Seddon (3), Goldstein (4), Hosfeld (5), Mikesell, Hoag and Hall (6), Nettleblad (7) and