

## 30. COMMISSION DES VITESSES RADIALES STELLAIRES

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### 30a. SOUS-COMMISSION DES VITESSES RADIALES FONDAMENTALES

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### 30b. SOUS-COMMISSION POUR L'OBSERVATION DES ÉTOILES DOUBLES SPECTROSCOPIQUES

PRÉSIDENT: D. B. McLaughlin.

MEMBRES: MM. Gollnow, Herbig, Pearce, Struve, O. C. Wilson.

Members of the Commission will have heard with sorrow of the death of Walter S. Adams, President of the Commission from 1935 until 1946 and member for thirty years from its inception until 1952. His extraordinary activity as an observer of radial velocities is well known, as were his human qualities as an organizer to those who had the good fortune to work with him. The *General Catalogue of Radial Velocities* (1953), edited by Ralph E. Wilson, in which the Mount Wilson Observatory heads the list of contributors to the 15 106 velocities with the figure of 49·2%, is a great monument to the memory of Adams.

The Report which follows conforms to the usual pattern in listing under separate observatories the radial-velocity work that is in progress or has been completed there. It is based on reports by or on behalf of sixteen out of eighteen members.

## OBSERVATORY PROGRAMMES

### *Royal Observatory, Cape*

Radial-velocity observations of southern stars have been continued with the 2-prism spectrograph at the Radcliffe Observatory. The first stage of an extensive programme on fundamental data for southern stars includes new determinations of velocity for twenty-five standard velocity stars and 343 other stars south of  $-26^\circ$ ; this work has been completed [1]. The criteria for selection [2] are large parallax or proper motion, or proximity to Selected Areas 140 to 206. The data include magnitudes and colours on the *BV* system and MK spectral types.

This work is being continued, the observing lists including high proper-motion stars (e.g. Luyten, p.m.  $> 0\text{''}2$  of arc) and all nearby stars accessible with the equipment.

A number of visual and interferometric doubles suggested by the Union Observatory as worthy of attention have been observed. Papers have been published on the system of  $\rho$  Vel [3, 4],  $\gamma$  Phe and  $\sigma$  Pup 1, ADS 1123 [5] and on HD 16157 [6].

In a programme on planetary nebulae, observations of twenty-five southern planetaries are available for measurement of radial velocities. Further observations are intended.

*South Galactic Cap.* A programme on radial velocities of 120 stars of HD types A0–A5,  $m = 6\cdot0$  to  $9\cdot2$ , within  $12^\circ$  of the south galactic pole has been begun by P. A. Wayman, seconded from the Royal Greenwich Observatory. Up to November 1957 over half the required number of spectra (at 29 and 49 Å/mm) have been obtained at the Radcliffe Observatory. Measurement and reduction on the Victoria system of wave-lengths has begun.

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It is expected that there will be a considerable improvement in the precision with which the distribution of  $z$ -motions for these types of stars is known, and some variation of this distribution with height above the galactic plane may be detected.

*David Dunlap Observatory, Toronto*

### *Yale zone 25° to 30°*

The radial velocities of 1042 G–M stars listed as brighter than 9th magnitude in the Yale Zone Catalogue with declinations between +25° and +30° have been published in *Publications of the David Dunlap Observatory*, vol. 2, no. 4. In addition to the radial velocities, MK classifications have been made and photographic magnitudes have been determined.

### *6° × 6° Kapteyn zones*

Radial-velocity measurements have been completed (but not published) for ninety-five stars of spectral class A 0 and later, between photographic magnitudes 7.5 and 8.0 in 6° × 6° zones centred on the Kapteyn areas from declination +15° northward between 0<sup>h</sup> and 6<sup>h</sup>.

### *8° × 8° Kapteyn zones*

Radial velocities have been completed (but not published) for 104 stars of spectral class A 0 and later, brighter than photographic magnitude 7.6 in the 8° × 8° zones centred on the Kapteyn areas from declination +15° northward between 9<sup>h</sup> and 18<sup>h</sup>.

### *Alpha Persei cluster*

Radial velocities have been completed (but not published) for fifty-eight faint stars which, on the evidence of proper motions, have been regarded by Heckmann as members of the Alpha Persei cluster. Sixteen of these stars need further observing for one reason or another. The velocity distribution of the other forty-two stars shows two maxima with a rather wide separation as well as a wide over-all dispersion.

### *Kapteyn area fundamental stars*

This programme includes fifty-five stars from Hins' *General Catalogue of Positions and Proper Motions* which are in Kapteyn areas 13–15, 29–35 and 53–60 (Galactic polar cap) and which are brighter than 10.1 photographic magnitude and not previously observed for radial velocities. One hundred and thirty-eight plates have been taken and the observations are being continued.

### *OB stars*

This programme consists of 102 OB stars of magnitude 10.6 and brighter selected as follows:

- (a) From the list in *Tonantzintla Bull.* no. 5.
- (b) The stars between –20° and the equator in *Tonantzintla Bull.* no. 9, pp. 41–5.
- (c) The stars in the aggregates north of the equator listed by Morgan, Whitford and Code in *Ap. J.* 118, 318, 1953.

Two hundred and fourteen plates have been obtained in this programme.

### *Dominion Astrophysical Observatory, Victoria*

(1) The extensive programme of northern B stars, referred to in previous reports, is practically completed as far as observing is concerned. The measurement of the spectrograms is about two-thirds done. Radial velocities have been determined to date for 380 stars while 170 stars remain to be measured. In addition to the radial velocities, plates of each star have been analysed with the microphotometer so that absolute magnitudes may be determined from the strength of the absorption at H $\gamma$ . This work is being carried out by J. A. Pearce and R. M. Petrie.

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(2) Observing is completed on the A-F stars in the north Galactic Pole area. Radial velocities have been determined for some sixty stars while about 120 stars remain to be measured. The programme has been extended by the addition of a large number of spectrograms of fainter stars of types F-K made available by the Lick Observatory. The two sets will be reduced to a common system and will supply the velocity distribution perpendicular to the galactic plane. This project is being carried on by G. J. Odgers and R. M. Petrie.

(3) Radial velocities are being obtained for 102 stars within  $2\frac{1}{2}^\circ$  of the centre of Praesepe cluster. A total of 154 spectra has been obtained to date. Radial velocities have been determined for twenty-seven stars from seventy-four spectrograms. It is hoped to complete the observing during the coming season. The observations are being made with a linear dispersion of 51 Å/mm at H $\gamma$  for the brighter stars and 90 Å/mm for the fainter stars. It is expected that this survey will add several new members to the cluster. The work is being done by Jean K. McDonald.

(4) *Stellar associations.* Spectrograms are being obtained of members of the nearer associations in order to study the radial-velocity distribution. The first paper on the subject deals with the Cassiopeia-Taurus group. The motions of forty-nine stars in this group have been investigated. New radial velocities of forty stars are given, based upon 668 spectrograms. Seven stars are found to vary in radial velocity. The new velocities are, on the average, 2 km/sec more negative than existing catalogue values. Proper motions are used to find the convergent point of the group and radial velocities then supply the stream motion and *K*-term.

It is concluded that the stars are a sample of the general population in that they possess normal solar motion plus average random motion. No expansion of the stars from a common region is found. The mean parallax deduced from the assumption of standard solar motion agrees exactly with the mean of the individual spectroscopic parallaxes.

Observations are being made on the  $\zeta$  Persei association and the stars in the neighbourhood of  $\eta$  and  $\chi$  Persei. This work is being done by G. J. Odgers and R. M. Petrie.

(5) *Pleiades Cluster.* J. A. Pearce has completed determining radial velocities of members of the Pleiades. New radial velocities have been determined for ninety-six members of the cluster, of which fourteen have not previously been measured.

(6) Extensive radial-velocity observations have been made by G. J. Odgers on the  $\beta$  Canis Majoris stars,  $\beta$  Cep, BW Vul, 12 Lac and  $\gamma$  Peg. The purpose of these observations is to determine as accurately as possible radial-velocity curves with good time resolution.

(7) Effective wave-lengths for radial-velocity work have been determined for low dispersion spectrograms 90 Å/mm at H $\gamma$  and for spectral classes A 0 to K 8. The results are now in press. The work is done by R. M. Petrie, D. H. Andrews and Jean K. McDonald. Effective wave lengths for spectral types B 0 to B 9 with the same low dispersion are now being investigated in order to make possible the extension of the Victoria velocity system for B stars to the low dispersion for observations of stars at great distances. The work is largely completed and is being done by R. M. Petrie.

(8) A new determination [22] of the Oort constant *A* confirms the earlier numerical values (see Analyses).

### *Haute Provence and Marseilles Observatories*

Ch. Fehrenbach reports:

(1) Measures of ten galactic fields are complete and ready for publication in early 1958. These will bring the total number of radial velocities published to 1200. All stars have been classified on the MK system.

(2) A further ten fields are being measured for radial velocities and are being especially searched for high-luminosity stars (M. Boulon-Mme Barbier) and for A stars (Mme Dufлот). These measures are directed towards the study of galactic rotation and, if possible, of spiral structure. A programme of photometric study of these stars on the *U, B, V* system is well under way.

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(3) The large objective prism of 40 cm diameter has been put into operation in July 1957. One of the prisms is somewhat faulty and will eventually be replaced; nevertheless, the images are good and easily measurable spectra of 12th magnitude are obtained in 40 min. Radial velocities of less precision should become possible down to magnitude 13.5. One hundred and twenty exposures have been taken and measures will begin very soon. The central portions of fields already taken with the small objective prism will be remeasured. The Galactic Pole will be searched for stars of high velocity.

(4) The construction of a new laboratory and dismantling the old have interfered with the programme of measurement. But during 1958 the work will progress in excellent conditions with three spectro-comparators (of which two are complete) and a staff of six astronomers and six technicians.

(5) The reductions are handicapped by the small number of known velocities and the uncertainty of velocities of stars fainter than 7th magnitude. It will be indispensable to determine velocities of some stars with slit spectrographs. The list of required velocities will be provided at the General Assembly and published in the *Journal des Observateurs*.

(6) M. Boulon has measured some velocities with a slit spectrograph which will be published in the *Journal des Observateurs*.

(7) M. Courtès has continued his study of emission nebulae. An important list of radial velocities will be published very soon.

### *Yerkes and McDonald Observatories*

Blaauw reports that his radial-velocity work has dealt mainly with a survey of spectroscopic binaries in the nearest associations. Since September 1954, about 1000 plates have been taken on this programme with the coudé arrangement of the 82-inch reflector of the McDonald Observatory. Most observations were made in the associations II Per, I Lac, I Ori and in the Cas-Tau group. All but a few of the plates in the associations II Per and I Lac have been measured and reduced. The purpose of this programme is the investigation of the frequency of duplicity among the members of young groups of stars and the determination of the elements of the spectroscopic binaries among these objects, and thus to obtain more knowledge of the stars in general in their earliest stages of development.

### *Mount Stromlo Observatory*

The radial-velocity programmes continue to come under the headings reported in *Trans. I.A.U.* 9, 437, except that the  $\theta$  Car Cluster (IC 2602) is being specially studied, and the programme on stars in the N 30 catalogue has been somewhat curtailed.

A high-velocity star, HD 203949, has been discovered.

Attention is called to the report on the Mount Stromlo Pre-Conference on Co-ordination of Galactic Research of 12 May 1957; see especially p. 27.

### *Radcliffe Observatory, Pretoria*

#### *O and B type stars*

The second stage of the programme on radial velocities of such stars has been completed and is in press [7]. The observations include fifty-nine stars with previously observed velocities (partly in a triple overlap with Victoria and Lick observatories on stars near the equator), and 130 stars selected for distance, mostly with  $m_0 - M \geq 11.0$ . For these faint stars coarser and faster emulsions were used than for the first stage, and it has been found necessary to adopt the adjusted wave-lengths of He 4471 and 4026 more or less in accordance with the recommendations of the Sub-Commission on standard wave-lengths [8]. Nevertheless, the corrections appear to vary with line width in such a way that it is possible that systematic errors of the order of  $2\frac{1}{2}$  km/s may appear in certain sub-groups of B stars due to standard wave-lengths alone. The spectra have been classified on the MK system and distances derived in most cases on the basis of measured colours. The plates have been sent to Cambridge for measurement of H $\gamma$  widths and application of

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Petrie's method, with the co-operation of R. O. Redman. An analysis of the velocities for galactic rotation is essentially complete.

Strong secondary components of the interstellar K line have been discovered in a few distant stars which suggest the presence of an inner spiral arm viewed tangentially at about  $l = 295^\circ$  [9].

The following clusters or associations are being observed for radial velocity: NGC 3293 (II Car), IC 2944 and NGC 6067.

Pagel [10], in a search for  $\beta$  CMa variables in the southern hemisphere, has shown that  $\tau^1$  Lup,  $\beta$  Cru belong to this group;  $\alpha$  Lup is probably another example although no light-variations have yet been established.

### *Globular clusters*

An important programme by T. D. Kinman on southern clusters, to supplement Mayall's work, is nearing completion. Ninety-five spectra of seventeen clusters for which no previous velocity was available have been measured and reduced. For eleven out of the seventeen clusters individual stars were observed. Thirty-three spectra of ten clusters previously observed by Mayall have also been measured. This material was obtained with the Cassegrain spectrograph at 86 Å/mm. Three additional clusters have also been observed with the Newtonian spectrograph (380 Å/mm), but more observations are required.

In an extensive study of velocities of individual stars in the globular cluster 47 Tuc, spectra of the short-period variables HV 810, 814 have been obtained to test the question of cluster-membership.

### *Magellanic Clouds*

Velocities of the brightest members of both Clouds are being obtained in considerable numbers (mostly at dispersions of 86 Å/mm, but some at 49 or 29 Å/mm). To date spectra of over sixty members of the Large Cloud have been secured, including a few F or G super-super-giants which are among the brightest stars in the Cloud. Spectra of the brightest cepheids in both Clouds have also been studied.

Work on the Small Cloud is hampered by the lack of a finding list like the HDE covering the Large Cloud, but some use has been made of the lists of emission objects by Henize and Lindsay.

### *Long-period variables*

Two or more spectra of eighty Me variables south of  $-30^\circ$  with  $m_{pg}(\max) < 10$  are now available for velocity measurements. This observational programme is essentially complete, but it is hoped to supplement it with observations of some of the brightest Me variables in or near the galactic nucleus.

### *Visual binaries*

Separate components of a few visual binaries with known parallaxes have been observed for velocity. ADS 6914 has proved to be of particular interest and observations will be continued.

### *Asiago Astrophysical Observatory*

S. Taffara reports radial-velocity observations of nebulae (NGC 1976, 6210, 6884) and of the following Be stars:  $k$  Cas,  $\gamma$  Cas,  $b_2$  Cyg, *Pleione*,  $\pi$  Aqr,  $\beta$  Psc,  $c$  Per,  $g$  Cam. Standard velocity stars, line intensity standard stars and spectroscopic binaries (reported to Sub-Commission 30b) are also being observed at this Observatory.

### *Berkeley Astronomical Department*

Radial-velocity work has been concentrated on observations of individual stars, especially spectroscopic binaries,  $\beta$  CMa stars and  $\delta$  Sct stars, and thus falls within the scope of Sub-Commission 30b. Nearly all the observations have been made at the Mount Wilson



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Observatory. Sahade and Struve list twenty-five papers published by them and their colleagues, mostly in *Ap. J.* or *P.A.S.P.*, but also in *Liège Symposia*, *Ann. Astrophys.* and *Proc. Amer. Phil. Soc.*

### *Cordoba and La Plata Observatories*

Gratton reports that at La Plata bright stars are being re-observed, mainly with a view to discovering long-period variations of velocity. At Cordoba, velocity work is confined mainly to standard stars.

### *Goethe Link Observatory, Indiana*

Edmondson reports that all faint K stars (about 150) on his programme at  $-45^\circ$  have been observed with the McDonald 84-inch reflector and that his programme on A stars is nearly complete. The work has been delayed owing to his absence in Washington.

### *Leiden Southern Station*

Observations of selected southern OB stars have been continued with the 74-inch reflector of the Radcliffe Observatory, Pretoria.

### *Lick Observatory*

Herbig reports that radial-velocity work is concerned with:

- (1) some twenty bright stars with variable velocity reported to Sub-Commission 30*b*.
- (2) R CrB variables.

In the latter programme, begun in 1949, a large amount of material has accumulated, but no results can be quoted as yet.

The spectra obtained for velocities of faint stars near the north Galactic Pole [11] have been handed over for measurement at Victoria.

### *Mount Wilson Observatory*

Münch [12] has published details of his important programme on radial velocities of the interstellar Ca II and Na I lines in 112 distant stars between  $l=55^\circ$  and  $160^\circ$ . Separate components due to concentration of gas in the Orion and Perseus arms are clearly distinguished. An exponential rather than a Gaussian distribution of velocities of the gas clouds is suggested by the intensity ratios of the interstellar lines, in agreement with Blaauw's independent analysis of the velocities. The observational programme is being extended to more southerly declinations.

Other velocity work at Mount Wilson has been mainly concerned with stars of variable velocity and has been communicated to Sub-Commission 30*b*.

## RADIAL VELOCITIES OF SUPER-GIANTS

Several investigations have indicated doubts as to the precise significance of 'radial velocities' of super-giants as usually measured on medium dispersion. In W. S. Adams' last published paper [13] he discusses the doubling of ultimate lines in  $\alpha$  Ori which he discovered with high dispersion many years ago. The violet component is attributed to a surrounding shell, with apparently constant radial velocity; the red component appears to originate in the reversing layer and to be subject to pulsational variations. A similar situation holds in the case of  $\alpha$  Her as studied on high dispersion by A. J. Deutsch [14]. In this case the circumstellar shell lines are also found in the G type visual companion, indicating a minimum radius of  $2.10^5 R_\odot$  for the shell. Deutsch finds that this vast envelope is expanding at the rate of 10 km/s and that the system is thus permanently losing material at the rate of at least  $3.10^{-8} M_\odot$ /year.

Abt [15] has found eight A and F type super-giants to be semi-regularly variable in radial velocity. He suspects that all stars in the HR diagram above  $M_v = +1$  and to the right of the main sequence are variable in light and radial velocity.

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## ANALYSES

The value of the Oort  $A$  constant of galactic rotation has been the subject of considerable controversy. Weaver's discussion<sup>[16]</sup> of Joy's Cepheids led to a value  $A = 10.8 \pm 1.8$ . Stibbs<sup>[17]</sup> combining his southern material obtained at the Radcliffe Observatory with Joy's finds  $A = 19.5 \pm 1.9$  or  $19.9 \pm 2.0$  for an assumed longitude of the galactic centre  $325^\circ$  or  $328^\circ$  respectively, and with no  $K$  term. Gascoigne and Eggen<sup>[18]</sup> have derived  $A = 17.5 \pm 1.9$  from 37 Cepheids with distances based on their colours. Oosterhoff<sup>[19]</sup> using Leiden colours on southern Cepheids has re-analysed Stibbs's velocities and finds  $A = 17.4 \pm 2.1$ .

For B stars, Weaver<sup>[20]</sup> has also found the low value of  $A = 13.2 \pm 2.7$ , while Bahng, Code and Whitford<sup>[21]</sup> have recently found  $A = 11.5 \pm 1.5$ , claiming that the curve of angular velocity approaches that of solid-body rotation much closer to the Sun than has been suggested by the 21 cm radio observations. Absolute magnitudes on the MK system have been used.

Petrie, Cuttle and Andrews<sup>[22]</sup> find  $A = 17.3$  from seventy-nine stellar velocities and  $A = 18.7$  from sixty-four interstellar velocities, the distance scale depending on Petrie's method (equivalent widths of H $\gamma$ ). They give a final mean value  $A = 17.7 \pm 1.1$  (p.e.).

The discrepancy between these solutions has been attributed to the use of different distance scales<sup>[23]</sup>. However in an unpublished analysis of much new southern material on distant O and B type stars, with distances based on the MK calibration, Feast and Thackeray have found  $A = 17.4 \pm 1.5$  (m.e.). A considerably lower value of  $A$  is found for stars with distances greater than 3 kpc, but it is considered that this group contains a large proportion of stars with over-estimated distances. The angular velocity curve agrees well with that of the radio observations and the curvature does not agree with that suggested by Bahng, Code and Whitford. There is some indication that the lower value of  $A$  found by others may be due in part to systematic errors in radial velocities of faint B stars derived by different observatories. The same analysis yields a value for the distance to the galactic centre which, although rough, is of interest in view of doubts which have arisen concerning the value 8.2 kpc as frequently adopted in recent years. The most probable value is 9 kpc but values between 7.5 and 11.5 kpc are not excluded; this again depends on the MK scale of distances.

## LARGE DOPPLER SHIFTS

Observations of the 21 cm radiation from the Magellanic Clouds had already confirmed the Doppler proportionality of shift to wave-length at optical and radio wave-lengths, i.e. a ratio of wave-lengths of  $5.10^5:1$ . Another striking confirmation of the Doppler principle has been the agreement of the red shift (about 16 800 km/s) of the 21 cm line observed (in absorption) by Lilley and McClain<sup>[24]</sup> in Cygnus A with the optical red shift (from emission lines). Minkowski and O. C. Wilson<sup>[25]</sup> have discussed the comparison and also confirm proportionality to wave-length over the optical range from 3830 to 6472 Å.

## VISUAL BINARIES AND STARS WITH COMPOSITE SPECTRA

At a joint meeting of Commissions 27 and 29 in Dublin, 1955, the importance of radial velocities of stars with composite spectra and of visual binaries with rather long periods was noted. A relevant addendum to the Report of Commission 30 was published<sup>[26]</sup>, and in September 1956 a circular letter was sent to all members of the Commission. In reply, R. M. Petrie reported that stars with composite spectra (with emphasis on systems classified by Hynek as G+A or K+A) are being observed at Victoria. Some visual binaries are also being observed, and the programme may be extended on the advice of G. van Biesbroeck.

References to work on southern visual binaries will be found in the foregoing reports from the Royal Observatory, Cape, and from the Radcliffe Observatory.

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### RECOMMENDATIONS FOR FUTURE RESEARCH

(1) The recommendations of the 1953 Groningen Conference<sup>[27]</sup> continue to form a sound basis for long-term programmes on radial velocities.

(2) Blaauw again stresses the importance of continued observation of distant clusters and associations<sup>[28]</sup>, adding that one of the most important desiderata is the application of the objective-prism method at a southern station. The latter suggestion was warmly supported at the Stockholm Conference on Co-ordination of Galactic Research.

(3) Another problem mentioned at the Stockholm Conference was the importance of detecting members of the disk population near the Sun, especially RR Lyr variables. Radial velocities of RR Lyr variables, selected for proximity to the galactic plane and for characteristics on their light-curves (Baade) would be very valuable in this connexion.

(4) Improved or new velocities of distant B stars or Cepheids lying within the zone at distances of about  $R_{\odot} \pm 1$  kpc from the galactic centre could be very valuable for a determination of  $R_{\odot}$  (Weaver)<sup>[29]</sup>.

(5) The possible existence of serious systematic errors in radial velocities of faint stars ( $m > 7.0$ ) warrants concentrated efforts by various Observatories. In this it is desirable that workers with the objective-prism method and with slit spectrographs should co-operate to the fullest possible extent.

(6) See above under Visual Binaries and Stars with Composite Spectra.

A. D. THACKERAY

*President of the Commission*

### REFERENCES

- [1] Evans, D. S., Menzies, A. and Stoy, R. H. *M.N.* **117**, 534, 1957.
- [2] *Trans. I.A.U.* **9**, 436, 1955.
- [3] Evans, D. S. *M.N.* **116**, 537, 1956.
- [4] Arp, H. C. and Evans, D. S. *M.N.* **116**, 547, 1956.
- [5] Evans, D. S. *Mon. Not. Astr. Soc. S. Afr.* **16**, 4, 20, 1957.
- [6] Evans, D. S. *Mon. Not. Astr. Soc. S. Afr.* **16**, 30, 1957.
- [7] Feast, M. W., Thackeray, A. D. and Wesselink, A. J. *Mem. R.A.S.* **68**, 1, 1958.
- [8] *Trans. I.A.U.* **9**, 439, 1955.
- [9] Thackeray, A. D. *Nature*, **178**, 1458, 1956.
- [10] Pagel, B. *M.N.* **116**, 10, 1956.
- [11] *Trans. I.A.U.* **7**, 309, 1950.
- [12] Münch, G. *Ap. J.* **125**, 42, 1957.
- [13] Adams, W. S. *Ap. J.* **123**, 189, 1956.
- [14] Deutsch, A. J. *Ap. J.* **123**, 210, 1956.
- [15] Abt, H. *Ap. J.* **126**, 138, 1957.
- [16] Weaver, H. C. *Astr. J.* **60**, 202, 1955.
- [17] Stibbs, D. W. N. *M.N.* **116**, 453, 1956.
- [18] Gascoigne, S. C. B. and Eggen, O. J. *M.N.* **117**, 430, 1957.
- [19] Oosterhoff, P. Th. I.A.U. Symposium no. **7**, 53, 1957.
- [20] Weaver, H. C. *Astr. J.* **60**, 208, 1955.
- [21] Bahng, J. D., Code, A. D. and Whitford, A. E. *Sky and Telescope*, **16**, 529, 1957.
- [22] Petrie, R. M., Cuttle, P. M. and Andrews, D. H. *Astr. J.* **61**, 289, 1956.
- [23] *A.A.S. Conference, Harvard*, 1957.
- [24] Lilley, A. E. and McClain, E. F. *Ap. J.* **123**, 172, 1956.
- [25] Minkowski, R. and Wilson, O. C. *Ap. J.* **123**, 373, 1956.
- [26] *Trans. I.A.U.* **9**, 445, 1955.
- [27] I.A.U. Symposium, no. **1** (Groningen), 40, 1953.
- [28] *Trans. I.A.U.* **9**, 445, 1955.
- [29] Weaver, H. C. *Astr. J.* **59**, 375, 1954.



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### 30a. SUB-COMMISSION ON FUNDAMENTAL RADIAL VELOCITIES

Since the last meeting of the Union, sufficient new observations of standard velocity stars have not been reported to warrant revision of the velocities listed in the Supplementary Report in *Trans. I.A.U.* 9, 442, 1955. However, attention is directed to certain observations which may warrant dropping some super-giant stars from the lists, and to other observations which may lead to adding a few southern stars to the list.

#### *Variability of super-giants*

Abt (*Ap. J.* 126, 138, 1957) has reported that  $\alpha$  Per (HD 20902, MKK class F5 Ib), which is a standard velocity star, varies in velocity with an amplitude of about 2 km/sec in a period of about four days. His observations of other A- and F-type super-giants has led him to the conclusion that it is probable that all such stars are velocity variables. Also Gratton has reported that Feinstein has found velocity variations for another standard velocity star,  $\alpha$  Car (HD 45348, MK class Fo Ib-II), amounting to 3 or 4 km/sec in a period of one hour. Gratton believes that all super-giants should show variations of this kind due to macroturbulence.

In view of these observations it is recommended that the stars  $\alpha$  Per and  $\alpha$  Car should be dropped from the list of standard velocity stars, and that the constancy of the velocity of the other super-giants on the lists be viewed with suspicion pending their further investigation with high dispersion.

#### *Possible additional southern standards*

It will be recalled that, from time to time, members of the sub-commission have recommended the addition of further standard velocity stars in the southern hemisphere. Evans has proposed the following stars for this purpose: HD 2151, 128898, 203608. For each of these stars five or six Cape observations (at Pretoria) are now available.

It is recommended that further observations of the afore-mentioned stars be made at southern observatories with a view to testing further the constancy of their velocities and adding them to the list.

#### *Recent observations*

Evans has reported observations with the Radcliffe telescope, since the last meeting of the Union, of the following standard velocity stars: HD 693, 4128, 80170, 157457, 171391, 203638, 223648; and Jaschek has reported observations at La Plata and Cordoba of the following: HD 4128, 18884, 29139, 36079, 36673, 45348, 51250, 81797, 108903, 109379, 150798, 186791, 204867, 206778, 222368. The velocities from these observations are not, at the time of writing, ready for inclusion in the report. At a later time when they are reported, a revision of the listed velocities may be called for.

#### *Comparator standards for objective-prism work*

At the last meeting of the sub-commission in 1955, Fehrenbach drew attention to the need for velocities of constant-velocity stars of all classes to serve as comparator standards in the objective-prism work of himself and others; the sub-commission undertook to study this problem. It is now understood from correspondence with Fehrenbach that his need has been met in part by data supplied by Petrie and Heard, and that a list of additional stars for which he requires observations with slit spectrographs will be furnished by him at the forthcoming Congress.

JOHN F. HEARD

*President of the Sub-Commission*

## COMMISSION 30

### 30*b*. SUB-COMMISSION FOR THE OBSERVATION OF SPECTROSCOPIC DOUBLE STARS

The chief activity of this Sub-Commission, as in previous years, has been the compilation and distribution of a list of stars of variable radial velocity currently under observation with slit spectrographs. This list was completed and distributed in April 1958. The distribution list included all members of Commission 30, as well as some observatories where slit spectrographic work is done, but which now have no representative on Commission 30.

The number of stars on the current list is 329, of which only nineteen are being followed at more than one observatory. A considerable number of objects on the list are not true binaries, but are Be spectrum variables, Cepheids,  $\beta$  Canis Majoris stars, or other types in which variable line-displacements have been established, or in which there is a strong presumption that such variation will be found. A canvass of the membership of the Sub-Commission shows that a majority favor the continued listing of these non-binary objects. Some have suggested that they form a separate list.

The interests of this Sub-Commission overlap a little with those of Commission 42. However, there appears to be little duplication of effort. The main problem is one of communications. It is very desirable that Commission 42 and Sub-Commission 30*b* exchange information concerning eclipsing binaries in special need of spectrographic observation and on stars currently being observed. Such exchange might profitably be carried out more frequently than once in three years.

There is also an area of common interest of Commission 26 and Sub-Commission 30*b*. Spectrographic observation of visual binaries is very important. Such work is a long-term project, and it can be most effective if guided by ephemerides. Dr P. Muller, President of Commission 26, has advised us that ephemerides have been computed, by J. Dommanget of the Paris Observatory, for a large number of binaries. Publication or distribution of these ephemerides appears very desirable.

DEAN B. MCLAUGHLIN

*President of the Sub-Commission*

*Report of Joint Meetings of Commissions 30, 30a and 30b. 14 August 1958*

ACTING PRESIDENT: R. M. Petrie.

SECRETARY: M. W. Feast.

The Meeting was held in the Conference Hall of the Sternberg Institute, Moscow. Dr Petrie announced that the President, Dr A. D. Thackeray, was unfortunately unable to be present in Moscow. He then called for discussion of the reports of Commissions 30 and 30*a* which had been previously circulated in the *Draft Reports* and of the Report of Sub-Commission 30*b* which was read to the meeting by Dr O. C. Wilson acting on behalf of Dr McLaughlin. Discussion on the Sub-Commission reports was taken first.

Discussing the report of Sub-Commission 30*a* Dr Gratton drew attention to the section dealing with the variability of super-giants. He proposed that all super-giants be omitted from lists of standard stars. This proposal was carried. Dr Fehrenbach spoke of the need for standard stars in objective prism work on radial velocities. Dr Petrie replied that observers with slit spectrographs were anxious to help in this matter so far as was possible. He hoped that definite proposals, indicating the stars for which slit velocities were desired, would be provided by the slitless velocity workers.

In connexion with the report of Sub-Commission 30*b* a proposal from Dr J. E. Merrill that there be closer co-operation between Commissions 30*b* and 42 (photometric double stars) was discussed. A motion 'that 30*b* ask 42 to provide to spectroscopists a list of eclipsing binaries in urgent need of spectroscopic observation whilst 30*b* will provide 42

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with a list of eclipsing binaries being spectroscopically observed' was carried. The Acting President was requested to draw the attention of Commission 42 to this resolution at the meeting of that Commission.

The Acting President welcomed Dr P. Muller (President of Commission 26) and Dr Dommanget who had come to the meeting to draw the members' attention to the urgent need for radial-velocity observations of visual double stars (see Recommendation (6) of the report of Commission 30). Dr Dommanget addressed the meeting on the subject and his report is appended (Appendix A). After discussion, a proposal that Dr Dommanget be requested to prepare a list of suitable pairs together with radial-velocity predictions was adopted unanimously. Dr Dommanget announced that much of the data desired was already in a suitable form for publication and after discussion with Dr Fehrenbach it was tentatively agreed that the data be published in *Journal des Observateurs*.

The other recommendations in the report of Commission 30 were then discussed. Dr Blaauw spoke in favour of continuing observations along the lines of the Groningen Report. In connexion with recommendation (2), Dr Fehrenbach announced his intention of taking his objective prism equipment to South Africa in January 1959, where he will be mainly engaged on work in the region of the Magellanic Clouds. It was agreed that, especially in view of recent findings, a considerable overlap in the observations of faint stars at different observatories was extremely desirable.

Sample pages of a manuscript compiled in 1945-7 by Korytnikov and Martynov of the Engelhardt Observatory, containing a bibliography of spectroscopic binaries, were passed round the meeting for examination. The manuscript consists of 701 + xxv pages and covers the literature from 1886 to 1946. The Acting President announced that Dr Martynov was interested in the reaction of members of the Commission to such a catalogue; if the Commission approved of the project Dr Martynov was prepared to bring the catalogue up to date by including the literature since 1946. Several members of the Commission spoke strongly in favour of this important project and a motion asking Dr Martynov to continue his work was adopted unanimously. After some discussion on the form in which the bibliography should be published it was decided to leave this matter in the hands of Dr Martynov, and his co-workers.

The Secretary read a recommendation from Dr Dyer, who was unable to be present himself, concerning radial-velocity work on dwarf stars near the Sun. Dr Dyer's proposals are appended to this report (Appendix B). A discussion showed general support for the methods of selection of nearby stars for study proposed by Dr Dyer. It was decided that it was unnecessary to adopt a formal resolution on this matter but that the proposal should be printed so as to be available to those planning programmes of this nature. Since the Mt Wilson Observatory was specifically mentioned in Dr Dyer's proposal, Dr O. C. Wilson pointed out that no large radial-velocity programmes were at present being carried out there but that it was sometimes possible to arrange for other workers to carry out programmes of the type discussed by Dr Dyer, at Mt Wilson.

To conclude the business part of the meeting the adoption of the reports of Commissions 30, 30a and 30b was moved and carried unanimously.

A number of speakers then presented brief reports of recent work. Dr Feast drew attention to a radial-velocity study of stars in the galactic cluster NGC 3293 (*M.N.R.A.S.* in press) in which an unexplained dependence of radial velocity on stellar magnitude was found. He stressed the importance of extending this work to other clusters. Dr Petrie reported that the Victoria programme for the determination of radial velocities for 550 stars in the range 7<sup>m</sup>5 to 8<sup>m</sup>5 and B 0-B 5 was now nearing completion. Dr Fehrenbach reported on his recent work in determining radial velocities by the objective prism technique. He now has in operation two objective prisms with apertures of 40 cm and 15 cm. Finally Dr Buscombe spoke on the Mt Stromlo radial-velocity programmes. So far work has been concentrated on the determination of radial velocities for stars in the N 30 catalogue. A paper is in press giving velocities for sixty such stars. Appended to this report (Appendix C) is a statement by Dr Courtès on his important work in the use of interferometric techniques for radial-velocity work on emission nebulae, which he was unable to present at the meeting.

## COMMISSION 30

### APPENDIX A

(Report by Dr J. Dommanget)

*Premières indications sur l'ampleur d'un programme d'observation systématique des vitesses radiales relatives des composantes des couples stellaires visuels à orbites connues*

(1) En 1955, un premier catalogue d'éphémérides de vitesses radiales relatives des composantes des étoiles doubles visuelles à orbites connues avait été dressé. Ce catalogue contenait environ 360 couples pour lesquels la vitesse radiale relative du compagnon était donnée aux époques 1955, 1960, 1965. Parmi ces 360 couples, seuls:

- 96 témoignèrent d'une vitesse radiale relative dépassant 5 km/sec
- 24 témoignèrent d'une vitesse radiale relative dépassant 10 km/sec
- 6 témoignèrent d'une vitesse radiale relative dépassant 15 km/sec

dans la période quinquennale 1955-60.

Ce catalogue n'a pas été publié car, de l'avis de plusieurs spécialistes, il semblait préférable de fournir aux spectroscopistes les courbes des vitesses radiales relatives en fonction du temps, plutôt que des valeurs discrètes de  $V_r$ . Un fichier est en cours d'établissement, dans ce sens, à Uccle. Celui-ci comprendra quelque 550 fiches portant les courbes des vitesses radiales relatives déduites des éléments orbitaux les plus récents.

(2) Sur la base de ces premières données, on peut prévoir que le nombre de couples dont les vitesses radiales relatives dépasseront, au cours d'une période de 5 ans:

- 5 km/sec, sera de 145 environ,
- 10 km/sec, sera de 35 environ,
- 15 km/sec, sera de 10 environ.

*A priori*, les époques les plus favorables à l'observation, celles des maxima des courbes de  $V_r$ , doivent se répartir assez régulièrement dans cette période quinquennale, de telle sorte qu'un programme qui les englobe toutes, imposerait annuellement la considération de:

81 couples pour lesquels	$0 \text{ km/sec} < V_r \leq 5 \text{ km/sec}$
22 couples pour lesquels	$5 \text{ km/sec} < V_r \leq 10 \text{ km/sec}$
5 couples pour lesquels	$10 \text{ km/sec} < V_r \leq 15 \text{ km/sec}$
2 couples pour lesquels	$15 \text{ km/sec} < V_r$

Total 110 couples par an.

Pour connaître le nombre de couples *effectivement* observables chaque année, il faut encore prendre en considération non seulement la grandeur du phénomène à mesurer ( $V_r$ ) mais encore les caractéristiques spectroscopiques et photométriques des composantes des couples. Notre ignorance des possibilités instrumentales dont disposent individuellement les observateurs désireux de se charger d'un tel programme, nous empêche d'évaluer plus loin l'importance de leur tâche. Toutefois, en ne considérant comme observables que des vitesses radiales relatives supérieures à 5 km/sec, on trouve que leur programme ne comprendrait annuellement qu'une vingtaine de couples au maximum.

### APPENDIX B

(Report by Dr E. R. Dyer)

The motions of dwarf stars in the population surrounding the Sun, which seems to be a mixture of at least *two* populations (Vyssotsky and Skumanich, *Astr. J.* **58**, 96, 1953, Dyer, *Astr. J.* **61**, 228, 1956, Vyssotsky and Dyer, *Ap. J.* **125**, 297, 1957) have been sadly neglected. In view of the great importance of kinematic behaviour as a clue to the nature and possible history of stellar populations, the investigation of their motions should be more systematically pursued.

Progress has been slow, in part due to the following factors: It has been difficult to identify the intrinsically faint dwarfs against the background of other stars, except by their large

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proper motions. It has been shown (Dyer, *Astr. J.* 59, 218, 221, 1954) that identification of dwarfs by their proper motions only (instead of, for example, by their objective prism spectra), yields in effect only the higher-velocity component of the total-velocity distribution, which in the case of the red dwarfs (Dyer, *loc. cit.*, 1956) by itself tends to show the characteristics of the 'disk population' in a mild way. The low-velocity components (that is those more or less sharing the Sun's motion), which obviously escape detection in proper-motion surveys, have characteristics nearly typical of the 'arm population', that is, deviation of the vertex, genuine streams, etc. (Dyer, *loc. cit.*, 1956).

There are now in existence the following lists of stars, discovered on objective plates at the McCormick Observatory by Vyssotsky and colleagues, and hence *not* subject to the selection effects mentioned above:

(a) About 900 stars, dK 8 to dM 8, published in *Ap. J.* and *Astr. J.* at intervals from 1942 to 1958;

(b) About 1400 stars, dF 8 to dG 8, separated into hydrogen-rich and hydrogen-poor classes (the list is not published, but Vyssotsky and Skumanich showed their different velocity-dispersions from their proper motions);

(c) About twenty high-latitude stars B 5-A 2 (Cowley, *Astr. J.* in press).

All these stars are in the range 7.5 to 12.5 photographic magnitude.

Another factor impeding progress in the investigation of the motions of these faint stars is the large amount of observing involved. But I can say in the light of my experience at Mt Wilson that it would be perfectly feasible to observe a sample of, say, 150 stars in one year at an observatory like Mt Wilson, with a dispersion of 100 Å/mm. This would lead to a p.e. of about  $\pm 5$  or  $\pm 6$  km/sec for a single observation, which is entirely adequate for statistical purposes. Furthermore, the work is not unduly burdensome.

I take this opportunity to *recommend*, in view of the above, that astronomers with access to low-dispersion spectrographs on moderately large telescopes observe at least a sample of the lists mentioned above, for only then will we have a clear idea of the velocity-distributions, absolute magnitudes, etc., of the various classes of dwarfs and sub-dwarfs that populate our neighbourhood.

### APPENDIX C

(Report by Dr G. Courtès)

La vitesse radiale des régions H II est pratiquement inconnue en dehors des quelques nébuleuses les plus brillantes qui ont été observées avec des spectrographes suffisamment dispersifs. La richesse des champs d'émission H $\alpha$  dans la Voie Lactée et la répartition caractéristique de ces astres le long de l'équateur galactique ouvraient un domaine de recherche, intéressant pour l'étude de la structure de la Voie Lactée, en particulier par la comparaison possible des vitesses radiales et de l'effet de la rotation différentielle de la Voie Lactée, et par celle des vitesses radiales de l'hydrogène interstellaire et des étoiles excitatrices. Ces vitesses, mesurées avec un étalon de Pérot-Fabry, pour 35 régions H II, sont, avec quelques exceptions, en accord relativement bon avec la rotation différentielle, si l'on adopte pour distances celles publiées par Morgan et ses collaborateurs. Cet accord est particulièrement bon pour les bras spiral lointain (de  $l = 70^\circ$  à  $l = 110^\circ$ ); les vitesses radiales des 6 nébuleuses observées dans cette région se répartissent entre  $-40$  et  $-50$  km/s.