30. COMMISSION DES VITESSES RADIALES

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MEMBRES: Abt, Batten, Bouigue, Boulon, Duflot, Gollnow, Gratton, Kraft, Northcott, Pagel, Preston, Sahade, Underhill, Wayman.

The Commission suffered a severe loss by the death on 8 April, 1966 of its President, Robert Methven Petrie, a few weeks before his 60th birthday. Well known to astronomers throughout the world, Petrie was, at the time of his death, Dominion Astronomer of Canada and Director of the Dominion Astrophysical Observatory at Victoria, British Columbia. He was a Vice-President of the IAU from 1958 until 1964. He served as a member of Commission 30 from 1950 onwards, being its Vice-President from 1961 to 1964, when he became President. From 1950 to 1955 he was President of the Sub-Commission on Standard Wavelengths.

His astrophysical contributions were numerous and diverse. Within the field of our Commission his influence was of capital importance. His work on standard wavelengths and on methods of measurement of spectra has been of fundamental importance to our knowledge of the velocities of early-type stars. His analyses of the motions of B-stars, and of the equivalent widths of the Balmer lines in their spectra have been corner stones in the edifice of modern ideas concerning galactic structure.

IAU SYMPOSIUM NO. 30

At the time of his death, Petrie was engaged in planning IAU Symposium No. 30, to be held in Toronto from 20 June to 24 June 1966, on the topic, 'Determination of Radial Velocities and their Applications'. His sudden death brought home to the surviving members of the organizing committee, the full realization of their dependence on him. Even so, the ground work which he had laid had been carried out with such foresight and care, that the Symposium took place successfully, very much as he had planned it. The meeting, which was thus transformed into a kind of memorial to our late President, could not have taken place but for the devoted efforts of the organizing committee, especially the Canadian members, and, more particularly, Professors Heard and MacRae of Toronto.

The Symposium took place on the Campus of the University of Toronto, by courtesy of the University authorities, under the presidency of the acting President of the Commission. About 60 astronomers attended.

Since the printed report (1), dedicated to R. M. Petrie, is likely to be published before the Prague General Assembly, no detailed account is needed here. However, because certain contributions were of outstanding interest, while others are not mentioned elsewhere in this report, a partial list of topics discussed is included.

Among new techniques presented, especially notable was the photo-electric method of Griffin. Mrs Rubin and her co-authors represented the growing body of observers using image tubes, particularly for very faint objects. De Vaucouleurs demonstrated velocity measures of galaxies by a scanning technique and by a photoelectric method.

Oscilloscope plate-measuring device were described by Gollnow and by Andrews and their inherent errors discussed by Scarfe.

A paper by the late R. M. Petrie and J. M. Fletcher demonstrated techniques for attaining extremely high accuracy with a coudé spectrograph.

Weaver described his definitive reduction of Trumpler's velocities of stars in clusters. This is likely to become a standard reference for classical photographic methods of radial velocity measurement.

Abt reported the near completion of a catalogue project including a plate-by-plate measurement catalogue of the Mount Wilson material.

The Marseilles-Haute-Provence group, led by Fehrenbach, gave a general conspectus of their objective prism work.

Bertiau described a very comprehensive Fortran programme for the determination of elements of spectroscopic binary orbits.

Dommanget reported the appearance of his catalogue of visual binaries worthy of spectroscopic observation.

There was a considerable interest in the evolutionary significance of the properties of binary stars and several speakers discussed their statistics (e.g. Batten, Blaauw, Bouigue).

In a subsequent brief report to the Executive Committee regret was expressed that there had been no opportunity to welcome to the Symposium colleagues from the countries of eastern Europe and Asia, and it was hoped that in future astronomers from these areas would join in the activities of our Commission. It is therefore very gratifying to receive a report from the U.S.S.R. which is included below.

REPORTS FROM OBSERVATORIES

The next part of the report summarizes, as has become customary, the written reports received from various observatories.

Allegheny Observatory

Beardsley reports: The radial velocity programme continues essentially without change since being reinstituted in 1958. It consists of all stars listed as SB, without orbit in the Wilson Radial Velocity Catalogue, brighter than magnitude 7·0, earlier than Go, and north of $-20°$ declination. A few additional stars fainter than 7·0 or later than Go have been placed on the programme from time to time. The programme is supplemented by those stars north of $-20°$ listed in the new Bright Star Catalogue as having no radial velocity. A number of Be stars and a group of stars designated as 'Astrometric-Spectroscopic Binaries' are being observed as well.

Instrumentation consists of the Keeler 31-inch (79 cm) reflector and Mellon one-prism spectrograph giving a dispersion of 40 Å/mm at Hγ.

Standard velocity stars are observed at every session in an effort to tie the programme directly to the standard velocity system. Measures are made on a null-projection machine similar to that used at Victoria. A Grant machine will be installed in 1966. With National Science Foundation support the output of radial velocities from Allegheny should be much increased in 1967. To date over 2800 plates have been taken. In the next few years an extensive analysis of the quality of these radial velocities will be undertaken.

It is expected that nearly 3000 radial velocities from the period 1905–17 will be published in 1967.

Cambridge Observatories

Griffin reports that he has developed the Cambridge technique of narrow-band stellar photometry with a slit spectrometer to measure radial velocities photoelectrically (2). A diaphragm containing 234 apertures whose positions correspond to those of strong lines in the

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blue region ($\lambda\lambda$4370–4830Å) in the spectrum of Arcturus, is matched against the spectra of other late type stars and its position then determines the relative Doppler shift. Using the Cambridge 92 cm-reflector, stars of $m_v = 9$ are measured to about 2 km s^{-1} standard error at the rate of 6 to 8 stars per hour. All stars later than about G5 can be measured using the same diaphragm. Observations of fifth magnitude stars of which the velocities have been determined photographically confirm the freedom of the method from detectable systematic errors, and show a standard deviation of 1 km s^{-1} per observation at this magnitude. Some hundreds of velocities, mainly in the +15° selected areas, have been measured with the new equipment. A series of observations of the spectroscopic binary, 73 Leo, has also been made (**3**).

Mount Stromlo Observatory, Canberra

Observations of B-stars in four selected fields along the Southern Milky Way (at longitudes 17°, 245°, 312° and 328°) which had been started by B. J. Bok, Gollnow and Mowat, are now almost completed. These were made with the grating spectrograph at the Newtonian focus of the 74-inch (188 cm) reflector. Preliminary results for the stars at 245° and 328° (Puppis and Norma) have been given by Mowat at the Mount Stromlo Symposium (**4**) and at IAU Symposium No. 30 (**1**). In both cases the distances derived for these groups of stars from their radial velocities are in very good agreement with those derived from Hβ photometry. The group in Norma appears to belong to the nearer Sagittarius arm rather than to the more distant Norma-Scutum arm.

The observations of selected nebulosities and stars in the Large and Small Magellanic Clouds made with the same instrument (Bok, Gollnow and Mowat) are also practically completed, and some of the results for the Small Cloud have been published in cooperation with Hindman of the Radiophysics Laboratory, Sydney, who made radio measurements in H I (**5**).

The same equipment has been used by Westerlund, Stokes and Lewis to investigate radial velocities of southern galaxies, and of some supernova remnants seen as emission nebulae in the Milky Way and Magellanic Clouds.

The 32-inch (81 cm) camera of the Mount Stromlo coudé spectrograph has been used by Dunham and by Buscombe for studies of velocities of interstellar clouds from measures of the Ca II and Na I absorption lines. Bessell has studied the velocity variations of several dwarf cepheids, mainly with the 10-inch (25 cm) R.E.O.S.C., camera.

The 2-prism Zeiss spectrograph, transferred to the Cassegrain focus of the 50-inch (127 cm) reflector, has been used by Buscombe to complete a study of the cluster, Messier 7, and to obtain velocity measures of B8 stars (in cooperation with Heard) and supergiants (many of which had been recognized photometrically by Walraven). Webster has completed a study of planetary nebulae in the Galaxy and Magellanic Clouds, and Roslund has made observations of B stars in the III Sgr association.

A new grating spectrograph, designed by Meinel, has been brought into use on the 40-inch (102 cm) reflector at Siding Spring for studies of long-period variables by Buscombe, and of galactic B-stars by Lyngå, and of members of the III Pup association by Westerlund.

A more elaborate model of the impersonal setting device with greatly improved electronics has been put into use (Gollnow, Rudge and Thomas, (**1**)).

References (**6**) to (**16**) cover recent publications embodying radial velocity measures which have not previously been noted in these reports. They include velocities for about 550 field stars.

Royal Observatory, Cape of Good Hope

Two more papers in the series of Fundamental Data for Southern Stars, (Nos. 5 and 6) (**17**), (**18**), have been published. Material for a further list is available on file. A considerable

number of new sub-dwarfs is included in these lists. Attention has been paid to the rapid handling of data for spectroscopic binaries. Orbital elements for nine stars of which HD 2070, 15064, 123515, 155099, 159656, 183007, 194184, 200334 are single-lined and HD 188164 double-lined, are in press (**19**). During his visit to the University of Texas, Evans collaborated with Andrew T. Young in devising an analogue method for rapid determination of the periods of recurrent phenomena such as velocity variation in spectroscopic binaries (**20**). In addition, computer programmes were written by E. Barker and D. Wells, on the one hand for the iterative determination of orbital elements, on the other, as a development of Lafler and Kinman's method, (**21**) for the determination of periodic times.

The Cape-Radcliffe programmes have been occupied recently to a large extent by further work on a selected list of RR Lyrae stars, for which both photometric and spectroscopic observations are planned. For the list of about 60 stars some 260 spectra have so far been obtained. In recent months D. H. P. Jones, Clube and Menzies have been concerned in this work.

A short list of extragalactic velocities based on spectra obtained with the new Newtonian spectrograph at the Radcliffe Observatory was published by Evans and Malin (**22**). Some further spectra have recently been obtained by D. H. P. Jones.

A note on the cepheid HR 5527 (misprinted as 5227), previously thought to be a double star, HD 130701/2, has been published by Evans (**23**).

Owing to the interruption consequent on his visit to the U.S.A., Evans has not yet completed his new analysis of p Velorum but this should be finished shortly (**1**).

For the same reason the revision of the Mount Wilson Radial Velocity Catalogue has lagged, though Miss Y. Z. R. Thomas has continued work on this. The card catalogue contains some 9500 cards, each referring to a star, about equally divided between stars which have been previously observed, and new stars. It is hoped to report definitive progress on this project at the Prague General Assembly (**1**).

D. H. P. Jones (**24**) has extended the error investigation of Wayman (**25**) to the two Herstmonceux spectrographs and finds that the additional error element to be applied in passing from formal probable error to real standard error has the same value as for the Pretoria cameras. Expressed in terms of microns on the plate it has the same value for all the cameras of all three spectrographs.

D. H. P. Jones and H. C. Lagerweij (**26**) have made a spectroscopic and photometric study of the δ Scuti variable, 1 Monocerotis (HD 40535).

David Dunlap Observatory, Toronto

Since 1964 the Hilger Prism spectrograph at the Cassegrain focus of the 74-inch (188 cm) telescope has been replaced by an all-reflection grating spectrograph which has dispersions of 10 Å/mm and 40 Å/mm. Crampton and others (**1**) have found that the 40 Å/mm grating system is faster than the 66 Å/mm prism system and comparable in accuracy for the determination of radial velocities with the 33 Å/mm prism system.

A Grant oscilloscopic comparator is now in use for measuring spectrograms, and programmes have been devised for the reduction of measurements by electronic computer.

Heard (**27**) has published the radial velocities of 55 Kapteyn Area fundamental stars in high galactic latitude.

Heard and Petrie (**1**) have investigated the radial velocities and other criteria of cluster membership for 77 stars in the field of the α Persei cluster. Spectroscopic binaries were found to be rare in this cluster.

Crampton has completed the observations for a programme of radial velocities of 60 Be stars, the purpose of the investigation being a kinematic study with the help of distances derived from Schmidt-Kaler's absolute magnitude calibration.

Hube has nearly completed a radial velocity programme of 250 B8–B9 stars of the Bright Star Catalogue north of declination $-26°$ and as yet unobserved for radial velocity, and he proposes to extend this study to more southerly B8–B9 stars at the Radcliffe Observatory. He will attempt to correlate his velocity data with distances, age grouping, and rotational velocities.

Dunsink Observatory

Radial velocities of 315 southern stars south of declination $-20°$ of photographic magnitude about 8·5, evenly distributed over the sky, with spectral types in the Henry Draper Catalogue from F5 to Mb have been determined on the system of the General Catalogue of Radial Velocities. The spectra were obtained in 1958–60 at the Radcliffe Observatory, Pretoria as a programme undertaken on behalf of the Royal Greenwich Observatory. Photoelectric measures of U_c, B and V for these stars have been made at the Royal Cape Observatory. A list of the data, including MK spectral types derived visually has been communicated to Evans for inclusion in the revision of the General Radial Velocity Catalogue (**28**). Densitometer tracings of the spectra are now being made at Dunsink for spectral classification purposes.

Royal Greenwich Observatory, Herstmonceux

Woolley and Harding (**29**) have published radial velocities of 96 stars derived from 241 spectra obtained with the coudé spectrographs at Mount Wilson and Palomar, and Radcliffe Observatories. Twelve double stars and nine stars in the Hyades are included. The possibility of a systematic difference between the measured velocities of giants and dwarfs in the same cluster is considered.

Harding has published radial velocities of bright members of the globular cluster ω Centauri (**30**). Woolley and Aly (**31**) have published radial velocities of 18 RR Lyrae stars, for which, in most cases, the velocity curves are obtained.

At Herstmonceux the grating spectrograph with dispersions of 40 and 80 Å/mm at the Cassegrain focus of the Yapp 36-inch reflector is being used for the determination of radial velocities of a list of spectroscopic binaries brighter than 7·5 m_{pg}, for which no orbital elements have previously been determined. Radial velocities of 633 stars of HD spectral types B9-A5, brighter than $m_v = 6·3$ and north of the equator, have been determined, using the 1 prism spectrograph. Estimates of spectral type and of $|\, v \sin i \,|$ have also been made, and the results are in press (D. H. P. Jones, Palmer, Walker and Wallis (**32**)).

A coudé spectrograph with a dispersion of 10 Å/mm in the second order in the blue, attached to the 30-inch (76 cm) reflector, has been brought into use. A programme of measurements of radial velocities of IAU standard stars has been undertaken to test the stability of the instrument, and the results, accompanied by a description of the instrument, are in press (Harding, Palmer and Pope (**33**)).

In 1965, D. H. P. Jones observed five stars intensively at 80 Å/mm with the Yapp reflector, in a search for short-period velocity variation. Only one star, HD 107904, was found certainly to show variations. It has since been confirmed as a δ Scuti variable by Wachmann (**34**).

By kind permission of the Egyptian Ministry of Scientific Researches, a number of radial velocity programmes is being carried out with the 74-inch (188 cm) reflector at Kottamia, U.A.R., in collaboration with the staff at that Observatory. These include the report on RR Lyrae stars (Woolley and Aly) mentioned above. In addition the following programmes continue:

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(*a*) Observations of semi-regular variables brighter than 11·5 m_{pg} not listed in Wilson's Catalogue.

(*b*) Spectroscopic binaries with unknown orbital elements between 7·5 and 11·5 m_{pg}.

(*c*) Ao stars in the north galactic cap ($\alpha = 11^h\,00^m$ to $14^h\,30^m$, $\delta = +10°$ to $+50°$, 1900·0), which are in the HD but not in Wilson's Catalogue. Preliminary results from this programme were presented at IAU Symposium No. 30 at Toronto (Woolley, Aly and Asaad (**1**)).

(*d*) Ko stars taken from the HD catalogue which have no known radial velocity, in the areas

$\alpha = 3^h\,20^m$ to $5^h\,20^m$: $\delta = +10°$ to $+20°$ (1900·0)
$6^h\,00^m$ to $8^h\,00^m$: $+33°$ to $+43°$
$18^h\,10^m$ to $20^h\,10^m$: $+55°$ to $+65°$
$21^h\,15^m$ to $00^h\,15^m$: $+29°$ to $+39°$

(*e*) Members of Gliese's catalogue of stars within 20 parsecs, brighter than 11·5 m_{pg} and north of $-30°$, with no known radial velocity.

In August–September 1966, Woolley and Palmer undertook a programme of observations of W Virginis variables, using the 100-inch (254 cm) Newtonian spectrograph at the Mount Wilson and Palomar Observatories.

A line-scanning measuring machine developed in the Observatory workshops has been brought into use.

Marseilles and Haute-Provence Observatories

The delegation attending the Toronto Symposium, headed by Fehrenbach gave a general summary of the work undertaken with the various objective prism telescopes since its inception (**1**). The publication of some of the work has had to wait for the establishment of satisfactory reference star velocities in the areas. Among galactic fields studied, those numbered 5–15 and I–M, together with the special fields designated δ Tau, P Cygni, *h* and χ Persei, and Praesepe have been published. All these, with the exception of the last named, have been observed with the small objective prism (PPO) at Haute-Provence. Results for twenty Selected Areas, observed with the small objective prism, and, in three cases, reobserved with the large objective prism, have been published. These results are included in the Draft Report of Commission 33 (Committee on Selected Areas), where the reference numbers of Selected Areas under study are given. Here also are listed the names of the Parenago areas now being studied with the large objective prism (GPO 3), and that one, ($5^h\,56^m0$, $+27°\,34'$), already published, for which the plates were taken with the small objective prism. References additional to those previously published are Rebeirot (**35**), Fehrenbach *et al.* (**36**).

Mme Rebeirot and Imbert have published a trial list of velocities (33 stars and two standards) obtained with the short focus ($F/1·1$) camera of the Haute-Provence coudé spectrograph (**37**).

La Plata Observatory

Radial velocities have been determined for the following stars:

HD 698 (Spectroscopic binary: Sahade (**38**)); V 453 Scorpii (eclipsing variable: Sahade and Frieboes-Conde (**39**)); 17 Leporis (peculiar star, spectroscopic binary, late-type component: Ringuelet-Kaswalder, Sahade and Wallerstein (**40**)).

Stars in course of measurement are the following:

δ Librae: All the material from Allegheny, Michigan and Mount Wilson is being remeasured by Sahade, Hernández, Faÿ and Cohen.

WY Velorum, symbiotic star, is being studied by Sahade and Hernández, who are also studying the red region of β Lyrae.

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The eclipsing variable ϵ Coronae Aústrinae is being studied by Sahade, Hernández, Sisteró and Ringuelet-Kaswalder.

PGC 4444 (=HD 159176), a sixth magnitude spectroscopic binary Oe 5 star, for which an orbit was given by Trumpler, is being reinvestigated by Hernández.

Sahade presented a paper to the Toronto Symposium under the title 'A systematic effect in the radial velocities determined with an oscilloscope-type comparator' (**1**).

Radcliffe Observatory, Pretoria

(1) *B Stars:* A fourth list of radial velocities of southern B stars has been published (**41**). This comprises 73 stars, (including 19 faint companions of visual binaries) selected as members of the Scorpio-Centaurus association. As reported to IAU Symposium No. 30 by Thackeray (**1**), these velocities strongly confirm the concept of group motion, but the radial velocities alone do not determine a convergent with sufficient precision to derive a K-term. The existence or otherwise of a K-term must be decided by determining a convergent from more accurate proper motions.

Feast and Shuttleworth have published extensive analyses of radial velocities of OB stars, Cepheids and clusters (**42, 43**). Velocity dispersions of the various objects, including interstellar gas are compared. A statistical correction for distances of B stars, (which becomes serious beyond 3 kpc), is determined. The ω (R) curve agrees well with the 21 cm curve after this correction is applied. A value of $A = 14{\cdot}3 \pm 0{\cdot}8$ km s^{-1} kpc^{-1} is derived, and $R_0 = 9{\cdot}5 \pm 1{\cdot}0$ kpc. Feast and Thackeray (**44**), point out that the ω (R) curve derived by Münch and Münch can be seriously affected by such statistical corrections to the distances of the stars used.

Thackeray (**45, 46**) has observed radial velocities of eight 9th-magnitude stars for comparison with objective prism velocities by the Fehrenbach group.

A programme is being initiated to observe radial velocities of the remaining 150 early-type southern stars brighter than $7{\cdot}5\ m$ with unknown radial velocities.

Graham, now at Kitt Peak National Observatory, has discussed nine distant B-type stars in Ara for which radial velocity material was obtained at Pretoria and concludes that the ratio of total to selective absorption is smaller than previously believed (**47**).

(2) *Me variables:* Feast (**48**) has completed an important programme on 51 Me and 2 Se variables towards the galactic centre. The large velocity dispersion and steep velocity gradient with longitude across the galactic centre is closely similar to that exhibited by the planetary nebulae. The velocity dispersion is related to period in the same way as for Me variables in the solar neighbourhood.

Feast (**49, 50**), has disproved the suspected presence of any Me variable in a globular cluster with period appreciably greater than 200 days. This strengthens the belief that there is no essential difference between the Me variables in globular clusters and in the general field. CH Sct (period: 190·6 days), has been shown to belong to the globular cluster NGC6712 despite some opinions to the contrary (**51**).

Feast is currently observing velocities of semi-regular and S-type variables.

(3) *Cepheids:* Feast (**52**) has completed observations of distant (2·5 to 4·5 kpc) cepheids near $l^{II} = 290°$. Velocity curves are derived for 10 cepheids, while observations near maximum light have also been secured for 11 other faint cepheids. The results, compared with velocities of OB stars and H I gas in the same region, confirm the concept of large-scale regional motions which produce humps in the $\omega(R)$ curve. A value of $R_0 = 9{\cdot}8 \pm 1{\cdot}4$ kpc is derived.

T. Lloyd Evans is reobserving some southern cepheids for radial velocity, especially V 636 Sco, whose γ-velocity seems to have changed.

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M. Breger has observed the cepheids U Sgr and S Nor at 29 Å/mm throughout their cycles. He also observed the βC Ma variable, α Lup, as well as the variable velocity star, β Cen, which is also suspected to be of this or a closely related class (**53**).

(4) *Clusters:* Thackeray and Wesselink (**54**) have published radial velocities of stars in the so-called cluster IC2944. No clear-cut variation of velocity with magnitude is found. The uncorrected velocity dispersion in this young cluster is 6·4 km s^{-1}. Evidence of expanding gas around the cluster is found.

T. Lloyd Evans is observing radial velocities in NGC6383 and IC2581.

(5) *Binaries:* Orbits of six double-lined spectroscopic binaries of early type have been published: HD140008, 178322 (**55**); δ Pic (**56**); HD147971, 75759 (**57**); HD175544 (**58**). Two of these were Radcliffe discoveries, and two more recent discoveries (HD104631, 161756), are being investigated. Other binaries under investigation include HD101131, 101205, (in IC2944), 93403, 136504, 142096, 155775, and HD161783 (**59, 60**).

Sher observed a number of suspected binaries of relatively small amplitude belonging to the Sco-Cen association.

Feast has studied the remarkable supergiant eclipsing system BL Tel (**61**), a high-velocity star out of the galactic plane.

Thackeray (**62**) observed S Equ during eclipse and found satellite lines during partial phases. Spectroscopic observations of this star have been continued for Dr M. Plavec.

(6) *Miscellaneous:* Thackeray (**63**) has shown that the [Fe II] lines observed during a remarkably deep minimum of S Dor fix the zero-point for radial velocity in the P Cyg contours shown by permitted lines. This radial velocity agrees closely with the mean velocity for the relevant part of the LMC.

Feast has obtained spectra of 10 planetary nebulae in the Large Cloud and obtained evidence of rotation and an indication of velocity dispersion from them (**64**).

Friedjung (**65**) has measured widths of emission lines in RR Tel and interpreted them in terms of his model for continuous ejection of gas from novae.

Slit spectra of stars discovered by the Fehrenbach group as having large radial velocity in the neighbourhood of the Large Magellanic Cloud have proved some of these stars to belong to the galactic foreground, e.g. two sub-dwarfs (**66**).

Daylight spectra of Comet Ikeya-Seki near perihelion showed large velocity shifts, corresponding to the motion towards the Sun for reflection from the nucleus, and to the motion of the comet relative to the Earth for cometary emission of Fe I, Ca II etc. (**67**).

In a recent note Thackeray reports a radial velocity for Proxima Centauri based on emission line measures. The mean value $-15{\cdot}7 \pm 3{\cdot}3$ km s^{-1}, is 7 km s^{-1} different from that of α Cen but this is not necessarily significant (**68**).

Thackeray has remeasured some B-type spectra with oscilloscope projection machines and finds that, at least for his measures of diffuse lines, two-way measures are essential to avoid systematic errors. This bears out the experience of Abt (**69**).

Observatoire de Toulouse

La recherche d'étalons pour la mesure des vitesses radiales des étoiles O, B, A signalée dans le précédent rapport a été poursuivie avec le spectrographe à fente, C, de l'Observatoire de Haute-Provence. Le nombre considérable de spectres à mesurer n'a pas encore permis, comme nous l'espérions, de publier des résultats. La méthode consiste en effet à comparer 2 à 2 les 14 spectres pris en quelques minutes sur une étoile brillante de type O, B, ou A. Dans le cas où la vitesse radiale relative est nulle, la mesure absolue de cette vitesse est alors faite sur les 14 spectres.

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Des variations inopinées de vitesse radiale ayant été mises en évidence sur plusieurs étoiles, il convient de contrôler ces variations à partir de nouveaux spectres.

Ce n'est que lorsque ce travail d'ensemble sera terminé que nous pourrons en faire connaître les conclusions.

En ce qui concerne les binaires spectroscopiques la mise à jour du catalogue complémentaire a été continuée. Comme les références correspondantes n'ont jamais été publiées dans les 'Draft Reports', une liste complète des contributions de Bouigue, Bouigue et Chapuis, et Pedoussaut (1952–64), est donnée, qui pourra rendre service aux utilisateurs (**70–77**).

U.S.S.R. observatories

Professor E. K. Kharadze reports as follows:

R. Kh. Salman-Zade of the astronomical observatory of Leningrad State University has proposed an improved sheme, suitable for large batches of material, for the calculation of corrections for the diurnal and orbital motions of the observer in the reduction of radial velocities to the Sun (**78**).

R. E. Gershberg and P. V. Shcheglov of the Crimean Astrophysical Observatory, developing a method used by Courtès, have used a Fabry-Pérot étalon, combined with an interference filter centred at Hα, and a contact image tube. They have determined radial velocities and internal motions in six gaseous objects, NGC1976, 6523, 6618, 7000, 7822 and IC1318a. The plates were standardized by means of images from a hydrogen discharge tube (**79**).

L. V. Mirzoyan and E. S. Kazarian have analysed radial velocity data for the O-B stars, long period cepheids and interstellar gas, and have found a negative K-term attributed to non-stationary motions in the Galaxy (**80**).

Sonnenborgh Observatory, Utrecht

Professor Anne B. Underhill reports a study of the O9 V star, 10 Lacertae, using a series of 30Å/mm spectrograms taken in rapid succession. An abstract by Underhill and van Helden has been published (**81**) and a more extended account will appear later (**82**). The spectra, taken at Victoria in November and December 1964 seem to show a rapid and erratic variation of velocity over a range of 10 km s^{-1} although the individual probable error of a single spectrogram is only 2 km s^{-1}. This is accompanied by rapid changes in the strength and shape of weak lines such as those of O II and Fe III. The radial velocities are dependent on measures of the strong lines, chiefly those of H and He I, and changes in them are not so easily observed because of saturation. From the astrophysical standpoint it seems important to repeat these observations with more powerful spectrographic equipment in order to discover what variations of velocity do occur within intervals of less than 10 minutes in the atmosphere of this standard, rather sharp-lined O9 V star.

De Groot, van Helden and Underhill hope to pursue further the radial velocity observation of stars in the direction of IC805 reported in preliminary form at Toronto (**1**).

Dominion Astrophysical Observatory, Victoria B.C.

General: Radial-velocity observations have continued of clusters, spectroscopic binaries and visual binaries. Results on clusters are being reported to Commission 37. Orbital elements have been determined for ξ^1 Ursae Majoris, υ Ophiuchi (**83, 84**); 47 Andromeda (**85**), and HD175544 (**58**). Radial velocities of visual binaries have not yet been published. At the suggestion of Dr Thackeray, a co-operative Victoria-Pretoria programme has been undertaken by Batten and Thackeray to determine radial velocities of 11 bright B8-B9 stars. The aim is to test the apparent correlation between K-term and quality of velocity-determination discussed

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by Boulon at the Hamburg General Assembly. Observations are complete, but measures have not yet been made. Derivation of galactic-rotation constants from the results of the B star radial-velocity programme was completed by R. M. Petrie before his death, and will be published.

Wavelengths: Selection of wavelengths suitable for velocity measures of G and K spectra was completed by R. M. Petrie shortly before his death, for the highest dispersion (2·1 Å/mm), available at the coudé focus of the 48-inch (122 cm) telescope. It is planned to extend this work to earlier spectral types as soon as possible. J. M. Fletcher is studying the selection of wavelengths, suitable for all spectral types, at the dispersion of 5 and 10 Å/mm, also available at the coudé focus. A. H. Batten has been studying the problem of wavelengths in O-type spectra, mainly with reference to the Victoria IM dispersion (30 Å/mm at Hγ). A preliminary report has been published (**86**) and the work is continuing.

Accuracy of coudé-spectrographs: Study of the problems reported by Dr Petrie at Hamburg was continued by him until his death, and since then, by Fletcher. Fletcher reported on his progress at the Toronto Symposium (**1**). It appears that the relatively large external errors encountered in coudé spectrographs are due, at least partly, to non-uniform illumination of the collimator arising from failure to achieve exact focus of the stellar image on the slit, or possible from imperfections in the primary mirror of the telescope. It is also important to maintain long-term stability of all parts of the spectrograph. Investigation is continuing to try to estimate the relative importance of these two effects and to ensure that the maximum accuracy of which the spectrograph appears to be capable (m.e. of single plate $\sim \pm 0{\cdot}07$ km s^{-1} for solar-type spectra) is available at all times.

Systematic Errors in Measurement of Double-Line Spectroscopic Binaries: Reports on this work have been presented by Petrie and Andrews (**87**) and by Petrie, Andrews, and Scarfe (**1**). It appears that systematic errors may be made in the measurement of double-line binaries, especially when oscilloscope devices are used to measure the plates. In extreme cases, errors of up to 50% may occur in the determination of the total mass of a binary system.

CONCLUSION

To all appearances the work covered by the field of the Commission is in a healthy state, but in spite of this there is some cause for concern. The determination of radial velocities yields fundamental astronomical data, without which our theoretical understanding of stellar motions and galactic structure would be paralysed. It is essential that this work be continued, and the discussions at Toronto, and the content of the foregoing report, make it clear that those active in the field are well aware of what needs to be done for objects ranging from the brightest stars to the faintest quasars, and of all population and morphological classifications.

Much of the work is still undertaken by classical methods, using photographic plates and slit spectrographs. It is clear that this style of work will remain indispensable for a long time to come. It is a source of great satisfaction to see new methods introduced, such as the photoelectric method of Griffin, the application of image tubes by Lynds, Mrs Rubin and others, and the scanning technique of de Vaucouleurs. The invention of new methods is, however, of little significance unless they are applied on a considerable scale. The example of the work of Fehrenbach's school shows how much meticulous effort needs to be expended on the development of a new technique before it becomes fully productive.

The attendance roll at the Toronto Symposium demonstrated that radial velocity work is being supported by a rather small number of observatories in rather few countries. The analysis presented by Weaver shows, that, certainly when classical methods are employed, it is an essential condition for the production of accurate results that the work be planned on a large scale, and be long continued. Only when a number of observers cooperate, in a long programme, using a spectrograph of which the essential adjustments are left undisturbed, is it

usually possible to evaluate with certainty the various systematic and accidental errors for which corrections must be applied. If the equipment is especially designed so as to permit changes from one dispersion to another without modification of the basic adjustments, as is the case for example with the Haute-Provence coudé spectrograph, versatility of equipment can be reconciled with this basic requirement. If the design necessitates an actual removal and re-mounting of the dispersing elements each time a new dispersion is required, then there can be erratic changes of zero-point in the velocity system between one observing run and another, a matter stressed by Edmondson in his contribution to the Toronto Symposium.

These requirements of stability and continuity have meant that successful radial velocity work has usually been confined to those observatories, among which government observatories are the prime example, where long-term routine work can be undertaken. University observatories, catering for the needs of doctoral candidates, have often been less successful in this field. They are more often concerned with versatility in their equipment, and the provision of opportunities for the demonstration of originality on the part of their students within the time-limits for the production of their theses. The production of a considerable number of new and accurate radial velocities is an undoubted contribution to astronomy, but it may not be regarded as a sufficiently original contribution to an academic thesis.

Among astronomers influential in the formulation of astronomical policy there is sometimes a feeling that the two types of requirement are in conflict. It should be no harder to reconcile them in radial velocity work than it is in any other field of astronomy, or indeed, in any other field of science where a number of workers have to share large and expensive equipment. It is, however, highly desirable that some kind of solution be found within the field of work of Commission 30. Unless this is done, the number of observatories participating effectively in radial velocity work is unlikely to increase, and the recruitment of younger astronomers to an interest in the field is likely to suffer. A possible solution in the case of university departments would be for graduate students to pool their requirements in a common programme. They would also pool their observing resources, so that each observer contributed to the programme as a whole, and not merely to that section of it in which he was personally interested. When the individuals came to draw from the pool of results those pertaining to their own programmes, they would obtain measures made under the most favourable conditions all around the sky, and subject to the running statistical control on errors derived from a study of the entire pool.

Commission 30 shares with a number of others the characteristic that it is built round a single basic astronomical operation, of which the fundamental principles have been established for a very long time. The data produced are essential, and there is no question that the basic operations need to be continued for the forseeable future. There is a need to maintain them in institutions which are already active and to introduce them on the necessary scale into others.

DAVID S. EVANS
Acting President of the Commission

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