

differs for giants and dwarfs, but in G sub-dwarfs the wave resembles that in giants. The departures of F5 stars from a black body seem small in the interval 4000–10 000 Å. From a comparison of infra-red brightness measurements by Johnson, at 22 000 Å, with the predicted brightness derived from the energy distribution at wavelengths less than 10 000 Å, Pilowski finds a confirmation of his temperature scale.

Pilowski, K. *Veröff. astr. Station, Technische Hochschule Hannover*, no. 5, 6 (1961–62).

APPENDIX 2: REPORT OF THE COMMITTEE ON STELLAR CLASSIFICATION

(prepared by William P. Bidelman, President)

General Comments

The present report, like that of three years ago, consists largely of a list of papers dealing with the concerns of this committee (see Bibliography). So many excellent review articles pertaining to stellar classification have appeared recently that any extensive report here would be superfluous. Special reference must be made to those by Keenan (306) and Strömgren (310) on qualitative and quantitative methods of classification, respectively, and to that by Blaauw (288) on calibration problems. Other summarizing articles that should be mentioned are those by Voigt (312), Greenstein (300), Herbig (302) and Joy (304). In addition, a transcript of a short conference on spectral classification held in December 1961 at the Kitt Peak National Observatory has recently appeared (296). The participants did not represent all points of view—spectrophotometric and wide-band photometric work were hardly discussed—but this publication should nevertheless prove of interest to all those working in stellar classification. Finally, it may be noted that work on the spectral classification of variable stars has been ably summarized by Herbig elsewhere in these reports (p. 372).

During the past three years new or increased activity has occurred in our field at many observatories in both hemispheres. The accompanying bibliography, which is rather similar to that included in the last *Draft Reports*, covers mainly the years 1961–63, but a few papers previously overlooked are also included. Some changes in arrangement have suggested themselves: papers dealing with spectrum scanning, multi-color photometry, and calibration problems have been listed separately. No attempt has been made, however, to be complete in the section on multi-color photometry; for example, few references are given to three-color wide-band stellar photometry. Unpublished work reported to the writer is recorded in the relevant sections of the Bibliography. It must be strongly emphasized, however, that these notes do not really reflect work in the field as a whole in any satisfactory fashion, for reports are missing from many individuals and institutions. It was nevertheless thought desirable to publish the information received.

In order to have a correct idea of the extent of present work in stellar classification one must refer not only to the Bibliography of the present report, but also to the several annual reports of the various observatories. And, for the southern hemisphere, reference must also be made to the very useful *Information Bulletin for the Southern Hemisphere*, edited by Sahade.

The triennium has seen advances in the classification of stars at both ends of the spectral sequence (236, 142), as well as a vigorous development of narrow-band photometric work

both in the United States (207) and also, notably, in Cambridge. The southern hemisphere observers have been very active in both objective-prism and slit work. Fehrenbach's investigation of the Large Magellanic Cloud (53, 55) deserves special mention in this connection. There has been much discussion of the effects of metal deficiency on the intensity of spectral lines and on wide- and intermediate-band colors. And there has been a continued interest in the problem of stellar rotation, both for its own sake and with regard to its influence on various methods of classification (246, 196). Two interesting developments that should not escape notice are an attempt to apply the Ca II emission-line-width method of luminosity determination to spectrograms of comparatively low dispersion (242) and a demonstration that metal deficiency can be quantitatively determined on spectrograms of much lower dispersion than those utilized in curve-of-growth analyses (268). But undoubtedly the most spectacular and significant recent result has been the discovery that direct indications of stellar age may be seen in the presence of lines of Li I (245, 271) and strong Ca II emission (182) in the spectra of young stars. It is difficult to exaggerate the importance of this discovery.

Spectral Atlases

Nassau and Velghe report that an atlas of infra-red objective-prism spectra of late-type and Wolf-Rayet stars has been submitted for publication. The spectra, obtained with the Burrell Schmidt, have a dispersion at the A band of $1700 \text{ \AA}/\text{mm}$, and the wavelength range covered is from 6800 \AA to 8800 \AA .

Work on the two spectral atlases mentioned in the last report may be summarized thus:

Jaschek: Production of a spectral atlas at the dispersion of $42 \text{ \AA}/\text{mm}$ given by the Bosque Alegre spectrograph is continuing in collaboration with Landi Dessy (140). The wavelength range covered is 3400 \AA – 4900 \AA . The Jascheks are undertaking the classification of stars of types earlier than F5, using criteria as similar as possible to the MK criteria, while Landi Dessy is responsible for the later-type stars. Two-thirds of the observational material is already available: about 500 spectrograms for the earlier-type stars and over 300 for those of later types. In the later-type stars it appears quite necessary to add a 'metallicity' parameter at this dispersion.

Meinel: The first section of the new grating spectral atlas initiated by Meinel and Morgan using the Kitt Peak 36-inch telescope is being prepared for publication. This section involves spectra taken with a dispersion of $125 \text{ \AA}/\text{mm}$ in the spectral region 3200 \AA – 5000 \AA . A discussion of line ratios and various classification criteria is included; no revision of the MK system is being made, but the addition of the ultraviolet makes it possible to extend the luminosity classification of the O stars to O7. It should be noted that the resolution of 9μ attained with the 36-inch spectrograph is too high to permit classification on the MK system without slight modifications in the designated appearance of certain blends useful in this system. Another consequence of the higher resolution is the difficulty encountered with stars of high rotation. While our recommendation would be to carry out MK classification programs with an instrumental resolution similar to that employed at Yerkes, namely, that given by a dispersion of $160 \text{ \AA}/\text{mm}$ with the KPNO spectrograph, it was felt important to proceed with publication rather than wait for a repetition of the observations. Little work has been done on pushing the observations to the red, but the entire observational program will be reactivated shortly after a new $160 \text{ \AA}/\text{mm}$ spectrograph is placed in operation at the Kitt Peak Station of the Steward Observatory.

Also nearing completion at the Steward Observatory is an *Astrophysical Atlas of Emission Lines in Astronomical Sources*, excluding the Sun and comets. This atlas will contain spectra and microphotometer tracings of a considerable number of emission-line objects and will also contain about 12 000 identifications of emission lines found in astronomical sources.

Information Centers and Data Compilations

Spectroscopic information centers are being maintained by the writer at Ann Arbor and by Jaschek at La Plata. Jaschek reports that his catalogue of all stars classified in the MK system (113) now contains some 16 000 entries, and that it will soon be published. Both Jaschek and the writer will be happy to answer inquiries concerning available spectral classifications. Buscombe, at Mount Stromlo, has already listed MK classification of southern stars contained in the FK₃ catalogue (107).

New Programs and Further Work

It is a pleasure to report that the classification of all of the southern stars brighter than mag. 6.5 will be undertaken at La Plata at a dispersion of 90 Å/mm; this will fill a real need. Further, a spectrograph intended for use in spectral classification is now under construction for the Kodaikanal 50-cm reflector. The dispersions given by this instrument are 100 and 230 Å/mm.

Several astronomers have raised the question of whether substantial observing programs devoted to procuring material for modern spectral classification of all stars in various catalogues (GC, AGK₂, etc.) should be undertaken, and if so, how these programs should be organized and co-ordinated. Perhaps some discussion of these matters should take place at the Hamburg meeting. There remains, of course, the question of how and to what level of accuracy such work should be done. The writer has been much impressed with the excellent quality of the 110 Å/mm spectra obtainable with the 10°-prism combination of the Curtis Schmidt and with the objective-prism spectra of similar dispersion obtained by Fehrenbach. There is no doubt that MK classification can be carried out very nearly as accurately with these instruments as with slit-spectrograph arrangements of somewhat lower dispersion, say 150 Å/mm, if sufficient care is taken with plate grain and observing conditions. It has also been found that it is not difficult to recognize stars of very low metal content on Curtis Schmidt plates (a new star of radial velocity - 390 km/sec has already been picked up in this way). The limiting magnitude for high accuracy on well-widened (0.8 mm) Schmidt plates appears to be near 9.5 pg, though Fehrenbach is now working at considerably fainter magnitudes.

The writer feels that a moderate-dispersion objective-prism survey of the entire sky should be initiated as soon as possible. There is no reason why all stars brighter than 9.0 or 9.5 pg should not be assigned accurate MK spectral types. Photo-electric and spectrophotometric methods will always, presumably, be limited to smaller numbers of stars of special interest.

The general question of the accuracy and reproducibility of two-dimensional classifications constitutes a large problem that more than ever deserves close attention. Detailed intercomparison of results by various observers using various techniques would be laborious, but would yield interesting and important results.

The Saltsjöbaden Symposium and the Hamburg Meeting

Most of the problems within the purview of this committee will be discussed at length at the IAU Symposium no. 24 to be held in Saltsjöbaden, Sweden, on 17-21 August 1964. However, it is also planned to hold one or more sessions of this committee at Hamburg during the General Assembly. The Executive Committee of the Union has announced that it will propose that a new Commission (no. 45) dealing with Spectral Classifications and Multi-Band Color Indices be created by action of the General Assembly; consequently, matters relating to this proposed change should be discussed at the Hamburg meeting.

BIBLIOGRAPHY (1961-1963)

1a. *Classifications Employing Visual Inspection of Objective-Prism or Slitless Spectrograms: Emission-Line Stars*

1. Apriamashvili, S. P. Two new Wolf-Rayet stars. *Astr. Cirk. U.S.S.R.*, **222**, 23, 1961.
2. Blanco, V. M. A catalogue of H α -emission objects in the galactic center region. *Contr. Bosscha Obs.* no. 13, 1961.
3. Blanco, V. M. Faint H α -emission objects in Cepheus IV. *Publ. astr. Soc. Pacif.*, **74**, 330, 1962.
4. Dolidze, M. V. Stars with H α in emission. *Astr. Cirk. U.S.S.R.*, **193**, 22, 1958.
5. Dolidze, M. V. New emission stars near CO Orionis. *Astr. Cirk. U.S.S.R.*, **202**, 12, 1959.
6. Dolidze, M. V. New Wolf-Rayet stars in Scutum. *Astr. Cirk. U.S.S.R.*, **202**, 13, 1959.
7. Dolidze, M. V. On the peripheral nebula S153. *Astr. Cirk. U.S.S.R.*, **211**, 23, 1960.
8. Dolidze, M. V. Emission objects in high northern galactic latitudes, *Astr. Cirk. U.S.S.R.*, **212**, 7, 1960.
9. Dolidze, M. V. New emission stars connected with Barnard's great loop. *Astr. Cirk. U.S.S.R.*, **212**, 8, 1960.
10. Dolidze, M. V. On the distribution of components in mixed O- and T-associations. *Astr. Cirk. U.S.S.R.*, **213**, 11, 1960.
11. Dolidze, M. V. Results of a survey of the region containing S258 and S298. *Astr. Cirk. U.S.S.R.*, **213**, 12, 1960.
12. Dolidze, M. V. Cool stars and emission galaxies in Virgo. *Astr. Cirk. U.S.S.R.*, **215**, 16, 1960.
13. Dolidze, M. V. Spectral survey of the western part of S153. *Astr. Cirk. U.S.S.R.*, **217**, 7, 1960.
14. Dolidze, M. V. New emission stars near IC 443 and S40. *Abastumanskaja astrof. Obs. Bjull.* no. 25, p. 105, 1960.
15. Dolidze, M. V. On the system S147. *Abastumanskaja astrof. Obs. Bjull.* no. 25, p. 111, 1960.
16. Dolidze, M. V. A group of emission stars in S10. *Astr. Cirk. U.S.S.R.*, **228**, 12, 1962.
17. Dolidze, M. V., Efremov, Yu. N. Emission objects in high northern galactic latitudes' *Astr. Cirk. U.S.S.R.*, **205**, 11, 1960.
18. Herbig, G. H., Kuhi, L. V. Emission-line stars in the region of NGC 2068. *Astrophys. J.*, **137**, 398, 1963.
19. Hidajat, B. Faint H α -emission stars near ρ Ophiuchi and σ Scorpii. *Contr. Bosscha Obs.* no. 11, 1961.
20. Hidajat, B. Objects with H α emission in the southern Coalsack. *Contr. Bosscha Obs.* no. 16, 1962.
21. Hoffmeister, C. Ein System von Dunkelwolken bei ϵ Chamaeleontis. *Z. Astrophys.*, **55**, 290, 1962.
22. Lindsay, E. M. A new catalogue of emission-line stars and planetary nebulae in the Small Magellanic Cloud. *Astr. J.*, **66**, 169, 1961.
23. Lindsay, E. M. Second list of emission-line objects in the Large Magellanic Cloud. *Irish astr. J.*, **6**, 127, 1963.
24. Lindsay, E. M., Mullan, D. J. First list of emission-line objects in the Large Magellanic Cloud. *Irish astr. J.*, **6**, 51, 1963.
25. McCuskey, S. W. Emission objects near S.A. 158. *Publ. astr. Soc. Pacif.*, **73**, 264, 1961.
26. Perek, L. New planetary nebulae. *Bull. astr. Inst. Csl.*, **11**, 256, 1960.
27. Perraud, H. Listes et classifications d'étoiles à émission, S et C. *J. Observateurs*, **44**, 149, 1961.
28. Razmadze, N. A. New H α -emission stars in Monoceros. *Abastumanskaja astrof. Obs. Bjull.* no. 25, p. 119, 1960.
29. The, P.-S. H α -emission stars in the vicinity of NGC 6334 and NGC 6357. *Contr. Bosscha Obs.* no. 10, 1961.

30. The, P.-S. H α -emission objects in a dark region in Aquila and Scutum. *Contr. Bosscha Obs.* no. 14, 1962.
31. The, P.-S. On faint H α -emission stars in Lupus and Scorpius. *Contr. Bosscha Obs.* no. 15, 1962.
32. The, P.-S. Faint H α -emission objects in nebulosities surrounding the star m Cen. *Contr. Bosscha Obs.* no. 17, 1962.

Unpublished Work

(Henize): The approximately 2000 new emission-line stars discovered during the Michigan-Mount Wilson southern H α survey will be published shortly.

(Pesch): Following Herbig's discovery that the infra-red Ca II triplet is present in emission in T Tauri stars, this feature has been detected in Case spectra of a number of the brighter objects of this class. Further work on fainter stars is in progress.

(Stephenson): A survey along the galactic plane for Wolf-Rayet stars brighter than $m_{pg} = 15.5$ is about 30% complete. The spectra cover the range 4600Å–4900Å at a dispersion of about 600Å/mm. Assignment to either the WC or WN sequence appears possible for more than half of the objects found thus far.

(Westerlund): A comprehensive study of 58 Wolf-Rayet stars of the Large Magellanic Cloud is in press (*M. N. RAS*).

1b. Classifications Employing Visual Inspection of Objective-Prism or Slitless Spectrograms: General Work

33. Alaniya, I. F. The spectral classes of 10 RR Lyrae-type stars. *Abastumanskaja astrof. Obs. Bjull.* no. 25, p. 127, 1960.
34. Albers, H. A study of selected regions in the Scutum Cloud by means of infra-red stellar spectra. *Astr. J.*, **67**, 24, 1962.
35. Alden, H. L., Osvalds, V. Relative proper motions of long-period variable stars. *Publ. Leander McCormick Obs.*, **11**, 109, 1961.
36. Apriamashvili, S. P. The open cluster Tr 35. *Abastumanskaja astrof. Obs. Bjull.* no. 28, p. 157, 1962.
37. Barbier, M. Structure de la galaxie dans la région de P Cygni. *J. Observateurs*, **45**, 57, 1962.
38. Barbier, M. 7^e liste de vitesses radiales déterminées au prisme objectif à vision directe. *J. Observateurs*, **46**, 115, 1963.
39. Bartaya, R. A., Kharadze, E. K. Results of a spectroscopic survey of stars in three sections of the Milky Way. *Abastumanskaja astrof. Obs. Bjull.* no. 25, p. 155, 1960.
40. Bartaya, R. A., Kharadze, E. K. Spectra of stars in the neighborhood of four diffuse emission nebulae. *Abastumanskaja astrof. Obs. Bjull.* no. 28, p. 161, 1962.
41. Blanco, V. M. Late-type stars in young clusters. *Astrophys. J.*, **137**, 513, 1963.
42. Bouigue, R., Boulon, J., Pédoussaut, A. Contribution aux recherches de photométrie photoélectrique dans la Galaxie. *Publ. Obs. Hte-Provence*, **5**, no. 49, 1961.
43. Boulon, J., Fehrenbach, C. 4^e liste de vitesses radiales déterminées au prisme objectif à vision directe. *J. Observateurs*, **42**, 149, 1959.
44. Brodskaya, E. S. Spectra, photographic magnitudes and color indices of 3206 stars in Cassiopeia. *Izv. Krym. astrof. Obs.*, **24**, 160, 1960.
45. Cowley, A. P., Cowley, C. R. A search for Ba II stars. *Publ. astr. Soc. Pacif.*, **74**, 79, 1962.
46. Dolidze, M. V. Group of carbon stars in high northern galactic latitudes. *Astr. Cirk. U.S.S.R.*, **215**, 16, 1960.
47. Dolidze, M. V. Peculiarities of the red part of the spectrum of S stars. *Astr. Cirk. U.S.S.R.*, **224**, 15, 1961.
48. Dolidze, M. V. Some data on nebulae and star clusters. *Astr. Cirk. U.S.S.R.*, **224**, 18, 1961.
49. Dolidze, M. V. New C and S stars. *Astr. Cirk. U.S.S.R.*, **228**, 13, 1962.

50. Dolidze, M. V. S stars in the vicinity of emission nebulae. *Astr. Cirk. U.S.S.R.*, **230**, 14, 1962.
51. Dolidze, M. V., Guseva, N. N., Retivaya, T. V., Kundzinya, B. A. Red and infra-red spectral classification of M stars in Cygnus IV. *Abastumanskaja astrof. Obs. Bjull.* no. 28, p. 137, 1962.
52. Duflot, M. Les vitesses radiales obtenues à l'aide d'un grand prisme objectif de 40 cm de diamètre. *J. Observateurs*, **44**, 97, 1961.
53. Duflot, M., Duflot, A., Fehrenbach, C. Reconnaissance d'étoiles appartenant au Grand Nuage de Magellan à l'aide d'un prisme objectif à champ normal. *J. Observateurs*, **46**, 109, 1963.
54. Fehrenbach, C. 5^e liste de vitesses radiales déterminées au prisme objectif à vision directe. *J. Observateurs*, **44**, 233, 1961.
55. Fehrenbach, C., Duflot, M. La reconnaissance des étoiles brillantes faisant partie des Nuages de Magellan. *C.R. Acad. Sci. Paris*, **254**, 1380, 1962.
56. Fehrenbach, C., Rebeiro, E. 6^e liste de vitesses radiales déterminées au prisme objectif à vision directe. *J. Observateurs*, **45**, 349, 1962.
57. Fehrenbach, C., Rebeiro, E. Les vitesses radiales obtenues à l'aide d'un grand prisme objectif de 40 cm de diamètre. *J. Observateurs*, **46**, 145, 1963.
58. Friedemann, C. Dreifarben Photometrie eines Milchstrassenfeldes in Auriga., *Astr. Nachr.*, **287**, 85, 1963.
59. Götz, W., Wenzel, W. Spektraltypen von Veränderlichen. *Mitt. ver. Sterne*, 503-6, 529-30, 569-71, 626-9, 701-3, 1960-62.
60. Haffner, H. Über die Wahl eines Prismas beim Schmidt-Spiegel. *Astr. Nachr.*, **286**, 28, 1960.
61. Harwood, M. The variable stars in the Scutum Cloud. *Ann. Sterrew. Leiden*, **21**, 387, 1962.
62. Iwaniszewski, H. Interstellar extinction and distribution of stars in the Aquila field. *Bull. astr. Obs. N. Copernicus Univ. Torun* no. 30, 1962.
63. Kharadze, E. K., Bartaya, R. A. Two-dimensional spectral classification using an objective prism. *Abastumanskaja astrof. Obs. Bjull.* no. 25, p. 139, 1960.
64. Kharadze, E. K., Bartaya, R. A. Spectra of stars near NGC 6604, NGC 6913, and Tr 1. *Abastumanskaja astrof. Obs. Bjull.* no. 26, p. 35, 1961.
65. Kiladze, R. I. Radial velocities of stars in the II Persei association. *Abastumanskaja astrof. Obs. Bjull.* no. 27, p. 40, 1962.
66. Lisicki, A. Interstellar extinction and distribution of stars in the Aquila-Sagitta field. *Bull. astr. Obs. N. Copernicus Univ. Torun* no. 33, 1963.
67. Lodén, L. O. A polarimetric investigation of 1300 stars. *Stockh. Obs. Ann.*, **21**, no. 7, 1961.
68. McCarthy, M. F. Fifty carbon stars in a region in Cygnus. *Ric. astr. Spec. Vatic.*, **6**, 301, 1960.
69. McCarthy, M. F., Rubin, V. C. Classification of late-type stars in the near ultra-violet from objective prism spectra. *Astr. J.*, **68**, 285, 1963.
70. McCuskey, S. W., Mehlhorn, R. Late M-type stars near the galactic center. *Astr. J.*, **68**, 319, 1963.
71. Nassau, J. J., Stephenson, C. B. Spectral classifications for new or unclassified emission-line, carbon and S, long-period variable, and double stars. *Astrophys. J.*, **133**, 920, 1961.
72. Nassau, J. J., Stephenson, C. B. A survey of stars of high luminosity in the northern Milky Way. *Scientia*, **97**, 48, 1962 = *Warner and Swasey Obs. Repr.* no. 117.
73. Perraud, H. Listes et classifications d'étoiles M, S, C. *J. Observateurs*, **44**, 247, 1961.
74. Perraud, H. Mesure des vitesses radiales au prisme objectif dans le champ des Hyades: δ Tauri. *J. Observateurs*, **45**, 361, 1962.
75. Pesch, P. Dwarf M stars in the Pleiades. *Astrophys. J.*, **133**, 1085, 1961.
76. Pesch, P. Photometric and objective-prism observations in three galactic clusters. *Astrophys. J.*, **134**, 602, 1961.
77. Pronik, I. I. Photographic magnitudes and color indices of 79 early O-B2 stars in an area centered at $\alpha = 18^h 54^m$, $\delta = +5^\circ$. *Izv. Krym. astrof. Obs.*, **25**, 37, 1961.

78. Pronik, I. I. Spectral types and stellar magnitudes of 1492 stars in an area centered at $\alpha = 18^{\text{h}} 54^{\text{m}}$, $\delta = +5^{\circ}$. *Izv. Krym. astrof. Obs.*, **26**, 351, 1961.
79. Richter, G., Schaifers, K., Wenzel, W. Neue Veränderliche mit spätem Spektraltypus. *Mitt. ver. Sterne*, 436, 474, 526-8, 591, 1960-61.
80. Rohlfs, K. Spektral- und Leuchtkraftkriterien für G- und K-Sterne nach Spektren kleiner Dispersion. *Z. Astrophys.*, **52**, 279, 1961.
81. Roslund, C. A survey of O and B stars in a region of Scutum. *Ark. Astr.*, **3**, 97, 1963.
82. Schaifers, K. Spektraltypen roter veränderlicher Sterne. *Mitt. ver. Sterne*, 385-6, 430-2, 506-7, 533, 1959-61.
83. Seitter, W. C. Zweifarbendiagramme und Fragen der Stellarstatistik. *Veröff. Univ.-Sternw. Bonn* no. 64, 1962.
84. Stephenson, C. B. Possible M-star members of NGC 6838. *Astr. J.*, **66**, 85, 1961.
85. Stephenson, C. B. A spectroscopic search for new white dwarfs. *Publ. astr. Soc. Pacif.*, **74**, 210, 1962.
86. Stephenson, C. B., Hobbs, R. W. A list of new OB stars near the galactic nebula M 17. *Astr. J.*, **66**, 186, 1961.
87. Stephenson, C. B., Nassau, J. J. Classification of composite spectra. *Astrophys. J.*, **134**, 222, 1961.
88. Stephenson, C. B., Nassau, J. J. *Luminous stars in the northern Milky Way. IIa. Identification charts*. Cleveland: Warner and Swasey Obs., 1962.
89. Stephenson, C. B., Nassau, J. J. *Luminous stars in the northern Milky Way. IVa. Identification charts*. Cleveland: Warner and Swasey Obs., 1963.
90. Stock, J., Nassau, J. J., Stephenson, C. B. *Luminous stars in the northern Milky Way. II. Hamburg-Bergedorf: Hamburger Sternwarte and Warner and Swasey Obs.*, 1960.
91. Straizhis, V. Catalogue of O-Fo stars in the southern part of the Orion association. *Bull. astr. Obs. Vilnius Univ.* no. 7, 1963.
92. Uppgren, A. R., Jr. A list of relatively cool stars in the vicinity of the north galactic pole. *Astr. J.*, **65**, 644, 1960.
93. Uppgren, A. R., Jr. A list of new high-velocity stars. *Publ. astr. Soc. Pacif.*, **74**, 241, 1962.
94. Uppgren, A. R., Jr. The space distribution of late-type stars in a north galactic pole region. *Astr. J.*, **67**, 37, 1962.
95. Uppgren, A. R., Jr. Space distribution of stars of intermediate spectral type in a north galactic pole region. *Astr. J.*, **68**, 194, 1963.
96. Vorontsov-Velyaminov, B. A. A method for classifying very narrow stellar spectra. *Astr. Zu.*, **37**, 1122, 1960 [*Sov. Astr.*, **4**, 1053, 1961].
97. Westerlund, B. An infra-red survey of the Magellanic Clouds. I. *Uppsala astr. Obs. Ann.*, **4**, no. 7, 1960.
98. Westerlund, B. Population I in the Large Magellanic Cloud. *Uppsala astr. Obs. Ann.*, **5**, no. 1, 1961.
99. Westerlund, B. An infra-red survey of the southern Coalsack. *Ark. Astr.*, **2**, 429 and 451, 1961.
100. Yoss, K. M. Spectral and luminosity classifications and measurements of the strength of cyanogen absorption for late-type stars from objective-prism spectra. *Astrophys. J.*, **134**, 809, 1961.

Unpublished Work

(Bartaya): Additional work, largely in press, includes the classification of some 8000 stars in selected areas in Taurus and Aquila by Kalandadze and Apriamashvili, further extensive work by Kharadze and Bartaya, and the red and infra-red classification of numerous M stars in various galactic regions by Dolidze and Apriamashvili.

(Bidelman): A survey of 10^{m} and 30^{m} exposures of 106 fields for which high-quality Curtis Schmidt 10° spectral plates exist has resulted in the discovery of 111 metallic-line and 62 peculiar A stars, of which 96 and 44, respectively, are believed to be new. There appears to be little difficulty

in the recognition of the more unusual objects of these types at the dispersion of 110 \AA/mm at $H\gamma$ given by the 10° -prism combination. Most of the new discoveries are brighter than mag. 9.0. Numerous additional metallic-line stars have been found by C. R. and A. P. Cowley (Yerkes Obs.) on similar plates obtained by them.

(Blanco): A new ultra-violet-transmitting objective prism has been acquired for use with the Burrell Schmidt for the investigation of very faint stars. The dispersion will be about 6000 \AA/mm at the A band.

(Henize): Some 300 southern carbon stars were found during the Michigan-Mount Wilson $H\alpha$ survey; it is possible to classify these in the C system of Keenan and Morgan, but this has not yet been done.

(Lodén): Classification of high-luminosity, emission, and late-type stars along the southern Milky Way, using plates obtained with the ADH Baker-Schmidt telescope, is in progress.

(McCarthy): The Cygnus region previously studied is now being surveyed for M-type stars; also in progress is an infra-red study of late-type stars in the south galactic pole cap, using plates taken with the ADH Baker-Schmidt. The study of the near ultra-violet will be extended to stars of later type with the 4° and 12° objective prisms. Also it is planned to investigate the possibility of improving the classification of the carbon and M stars by use of the latter prism.

(McCuskey): Spectral types and luminosity classes have been determined for 1684 stars in the region of S.A. 158, for some 3000 stars near $l^{\text{II}} = 0^\circ$, $b^{\text{II}} = 0^\circ$, and for 1895 stars near $l^{\text{II}} = 75^\circ$, $b^{\text{II}} = -29^\circ$ by McCuskey, K. Purbosiswojo, and A. G. D. Philip, respectively. In collaboration with Blanco, faint stars of types M5 and later near the clusters NGC 2168, 2158, and 2129 are under study.

Very low dispersion spectra can be obtained by using two objective prisms with their dispersions nearly opposed. Exposures taken on Kodak I-N emulsion cover the region $3600 \text{ \AA} - 8800 \text{ \AA}$; the smallest usable dispersions are approximately 1000 \AA/mm in the infra-red. One promising application of this technique appears to be the study of the integrated spectra of moderately faint galaxies. Plates have been taken of a number of clusters including Virgo and Coma. On these one can easily estimate colors for most galaxies to $m_{\text{pg}} = 15$. An index has been devised, based on the density of the image in four spectral regions, to arrange the galaxies in order of increasing redness. This research is being pursued by A. G. D. Philip and N. Sanduleak.

The possibility of the detection and classification of Ap and Am stars on objective-prism spectra having a dispersion of 280 \AA/mm at $H\gamma$ has been explored by W. E. Brunk. The detection probability depends very critically on seeing conditions and length of exposure time. In only 70% of the stars studied was it possible to distinguish with confidence between the Ap and the Am stars.

(Nassau): Work on the high-luminosity star survey, carried on jointly with the Hamburg Observatory, is being continued in collaboration with Stephenson. Results for the region $l^{\text{II}} = 14^\circ$ to 46° , $b^{\text{II}} = \pm 28^\circ$ are now in press, while the region $l^{\text{II}} = 192^\circ$ to 215° , $b^{\text{II}} = \pm 12^\circ$ is now being investigated. Many interesting objects other than OB stars have been encountered in this survey, particularly through the aid of $H\alpha$ plates.

The program of spectroscopic observation in the infra-red of 51 S- and M-type variables is being continued. A list of the stars involved is given in *Trans. IAU*, 10, 413, 1958.

(Pesch): A survey is under way for M-dwarf members of the Hyades. Both red and near-infra-red spectral plates are being used.

(Westerlund): A 10° -wide belt along the southern galactic plane from $l^{\text{II}} = 230^\circ$ to $l^{\text{II}} = 10^\circ$ has been surveyed for red stars brighter than $I = 13$ mag. using infra-red plates taken with the Schmidt telescope of the Uppsala Southern Station. 1326 C stars and 87 S stars were found. The region of S.A. 193 has also been studied in the infra-red, while 31 OB stars have been found near the long-period Cepheid RS Puppis.

In other Schmidt work approximately 600 possible M supergiants and 400 possible carbon stars have been noted in the Large Magellanic Cloud.

2. *Classifications Employing Visual Inspection of Slit Spectrograms*

101. Abt, H. A., Golson, J. C. Interstellar absorption in the north equatorial polar region. *Astrophys. J.*, **136**, 363, 1962.
102. Bahner, K., Hiltner, W. A., Kraft, R. P. Colors and magnitudes for 45 Cepheids of the northern Milky Way. *Astrophys. J. Suppl.*, **6**, 319, 1962 (no. 59).
103. Bell, R. A. Observations of some southern white dwarfs. *Observatory*, **82**, 68, 1962.
104. Bennett, N. W. W., Evans, D. S., Laing, J. D. Orbital elements of the double-lined spectroscopic binaries HD 3405, 6619, and 155 555. *R. Obs. Bull.* no. 61, 1962.
105. Blaauw, A., van Albada, T. S. Radial velocities of B-type stars in the nearest associations. *Astrophys. J.*, **137**, 791, 1963.
106. Buscombe, W. The Scorpio-Centaurus association. III. Radial velocities of 70 additional stars. *Mon. Not. R. astr. Soc.*, **124**, 189, 1962.
107. Buscombe, W. Spectral classification of southern fundamental stars. *Mount Stromlo Obs. Mimeog.* no. 4, 1962.
108. Buscombe, W. Photometric and spectroscopic data for southern OB stars. *Mount Stromlo Obs. Mimeog.* no. 7, 1963.
109. Buscombe, W., Kennedy, P. M. Two B-type spectroscopic binaries. *Publ. astr. Soc. Pacif.*, **74**, 323, 1962.
110. Buscombe, W., Kennedy, P. M. Supergiant B stars in the Small Magellanic Cloud. *J. Roy. astr. Soc. Can.*, **56**, 113, 1962.
111. Buscombe, W., Morris, P. M. Radial velocities of fundamental southern stars. II. *Mon. Not. R. astr. Soc.*, **123**, 233, 1961.
112. Chopinet, M. Contribution à l'étude des nébuleuses planétaires grâce à la caméra électronique. *J. Observateurs*, **46**, 27, 1963.
113. Conde, H., de Sierra, A. C. E. Catalogo de estrellas clasificadas en sistema MK. *Asoc. Argent. astr. Bol.* no. 4, p. 85, 1962.
114. Cousins, A. W. J., Stoy, R. H. Photoelectric magnitudes and colours of southern stars. *R. Obs. Bull.* no. 64, 1963.
115. Deeming, T. J. Spectrographic work on subdwarfs. *Observatory*, **81**, 120, 1961.
116. Deeming, T. J. Some new southern subdwarfs. *Mon. Not. R. astr. Soc.*, **123**, 273, 1961.
117. Deutsch, A. J. D-line intensities in the spectra of galaxies. *Astr. J.*, **68**, 535, 1963.
118. Eggen, O. J. Space-velocity vectors for 3483 stars. *R. Obs. Bull.* no. 51, 1962.
119. Eggen, O. J. Luminosities, colors, and motions of the brightest A-type stars. *Astr. J.*, **68**, 697, 1963.
120. Evans, D. S. Observation of twenty-four single-lined variables. *R. Obs. Bull.* no. 44, 1961.
121. Evans, D. S., Menzies, A., Stoy, R. H., Wayman, P. A. Fundamental data for southern stars (fourth list). *R. Obs. Bull.* no. 48, 1961.
122. Feast, M. W. The long period variables. *Mon. Not. R. astr. Soc.*, **125**, 367, 1963.
123. „ The galactic cluster NGC 4755 (κ Crucis). *Mon. Not. R. astr. Soc.*, **126**, 11, 1963.
124. Feast, M. W., Stoy, R. H., Thackeray, A. D., Wesselink, A. J. Spectral classification and photometry of southern B stars. *Mon. Not. R. astr. Soc.*, **122**, 239, 1961.
125. Feinstein, A. The southern galactic cluster IC 2391. *Publ. astr. Soc. Pacif.*, **73**, 410, 1961.
126. Feinstein, A. Spectroscopic observations of M 7. *Publ. astr. Soc. Pacif.*, **73**, 452, 1961.
127. Fredrick, L. W. The red o,o CN bands in late-type giants. *Publ. astr. Soc. Pacif.*, **75**, 182, 1963.
128. Fujita, Y., Yamashita, Y. The spectrum of V Aql in the visual and infra-red regions. *Publ. astr. Soc. Japan*, **12**, 267, 1960.
129. Henize, K. G. Emission-line stars in an obscured region in Chamaeleon. *Astr. J.*, **68**, 280, 1963.
130. Herbig, G. H. Spectral classification of faint members of the Hyades and Pleiades and the dating problem in galactic clusters. *Astrophys. J.*, **135**, 736, 1962.
131. Herbig, G. H., Haro, G. A wide pair of Me dwarfs. *Bol. Obs. Tonantzintla y Tacubaya*, **3**, 118, 1962.

132. Herman, R., Duval, M. Quelques nouvelles étoiles B à émission. *Ann. Astrophys.*, **25**, 9, 1962.
133. Hiltner, W. A., Morgan, W. W. Spectroscopic discriminant for O-type star clusters. *Astr. J.*, **68**, 281, 1963.
134. Jaschek, C., Jaschek, M., Kucewicz, B. Discovery and statistics of Be stars. *Asoc. Argent. astr. Bol.* no. 4, p. 37, 1962.
135. Johnson, H. L. The galactic cluster NGC 2244. *Astrophys. J.*, **136**, 1135, 1962.
136. Kinman, T. D. Observations of southern RR Lyrae stars. *R. Obs. Bull.* no. 37, 1961.
137. Klemola, A. R. Mean absolute magnitude of the blue stars at high galactic latitudes. *Astr. J.*, **67**, 740, 1962.
138. Kraft, R. P. Binary stars among cataclysmic variables. I. U Geminorum stars. *Astrophys. J.*, **135**, 408, 1962.
139. Kucewicz, B. Southern B stars with H α emission. *Publ. astr. Soc. Pacif.*, **75**, 192, 1963.
140. Landi Dessy, J., Jaschek, M., Jaschek, C. Clasificación espectral en 42 Å/mm. *Asoc. Argent. astr. Bol.* no. 4, p. 87, 1962.
141. Mayall, N. U. Advantages of electronic photography for extragalactic spectroscopy. *Ann. Astrophys.*, **23**, 344, 1960.
142. Merrill, P. W., Deutsch, A. J., Keenan, P. C. Absorption spectra of M-type Mira variables. *Astrophys. J.*, **136**, 21, 1962.
143. Minkowski, R. Problems of extragalactic spectroscopy. *Ann. Astrophys.*, **23**, 385, 1960.
144. Morgan, W. W. Classification of galaxies. *Sky and Telesc.*, **22**, 129, 1961.
145. Morgan, W. W. Some characteristics of galaxies. *Astrophys. J.*, **135**, 1, 1962.
146. Morgan, W. W., Mayall, N. U. Spectral types of galaxies. In *Problems of Extra-Galactic Research*, G. C. McVittie, ed. (*Symp. IAU* no. 15). Macmillan, N.Y., 1962, p. 22.
147. Morris, P. M. The Scorpio-Centaurus association. II. Spectral types and luminosities of 220 O, B and A stars. *Mon. Not. R. astr. Soc.*, **122**, 325, 1961.
148. Münch, G., Unsöld, A. Interstellar gas near the Sun. *Astrophys. J.*, **135**, 711, 1962.
149. Osawa, K. Spectral classification and three-color photometry of A-type stars. *Publ. astr. Soc. Japan*, **15**, 274, 1963.
150. Pesch, P. Spectrographic and photometric observations of some stars from the *Luminous Stars in the Northern Milky Way I and II* catalogues. *Astrophys. J.*, **137**, 547, 1963.
151. Petit, M. Catalogue et propriétés photométriques des étoiles naines rouges à spectre d'émission (dMe). *J. Observateurs*, **44**, 11, 1961.
152. Petrie, R. M., Pearce, J. A. Radial velocities of 570 B stars. *Publ. Dom. astrophys. Obs.*, **12**, 1, 1962.
153. Popper, D. M. Notes on the spectra of eclipsing binaries. *Publ. astr. Soc. Pacif.*, **74**, 129, 1962.
154. Preston, G. W. Low-dispersion spectra of RR Lyrae stars in globular clusters. *Astrophys. J.*, **134**, 651, 1961.
155. Preston, G. W., Krzeminski, W., Smak, J., Williams, J. A. A spectroscopic and photoelectric survey of the RV Tauri stars. *Astrophys. J.*, **137**, 401, 1963.
156. Przybylski, A. New southern subdwarfs. *Acta astr.*, **11**, 59, 1961.
157. Sandage, A. Photometric data for the old galactic cluster NGC 188. *Astrophys. J.*, **135**, 333, 1962.
158. Slettebak, A. The spectra and axial rotational velocities of the components of 116 visual double-star systems. *Astrophys. J.*, **138**, 118, 1963.
159. Slettebak, A., Bahner, K., Stock, J. Spectra and colors of early-type stars near the north galactic pole. *Astrophys. J.*, **134**, 195, 1961.
160. Spinrad, H. Stellar populations in the nuclei of galaxies. *Astrophys. J.*, **135**, 715, 1962.
161. Spite, F. Sur les deux variétés d'étoiles RR Lyrae 'libres' du type a. *C.R. Acad. Sci. Paris*, **251**, 204, 1960.
162. Svolopoulos, S. N. Spectral classification in open clusters. *Astrophys. J.*, **134**, 612, 1961 and **136**, 788, 1962.
163. Svolopoulos, S. N. Rotational velocities of faint stars of early spectral types. *Astr. J.*, **68**, 428, 1963.
164. Thackeray, A. D. Coude spectra of Magellanic Cloud supergiants. *Observatory*, **82**, 207, 1962.

165. Thackeray, A. D., Wesselink, A. J., Harding, G. A. The cluster NGC 6067. *Mon. Not. R. astr. Soc.*, **124**, 445, 1962.
166. Treanor, P. J. Stellar rotation in galactic open clusters. *Mon. Not. R. astr. Soc.*, **121**, 503, 1960.
167. Underhill, A. B. Spectroscopic observations of some WC stars. *Astrophys. J.*, **136**, 14, 1962.
168. Walker, M. F. Observations spectrographiques effectuées avec la caméra électronique d'étoiles en contraction gravitationnelle ayant un excès de rayonnement ultra-violet. *C.R. Acad. Sci. Paris*, **253**, 383, 1961 = *Lick Obs. Bull.* no. 571.
169. Walker, M. F. Studies of extremely young clusters. IV. NGC 6611. *Astrophys. J.*, **133**, 438, 1961.
170. Walker, M. F. A note on the spectral types of faint stars in NGC 6530. *Astrophys. J.*, **133**, 1081, 1961.
171. Walker, M. F. A possible interpretation of the ultra-violet excess stars. *Astr. J.*, **68**, 298, 1963.
172. Wallerstein, G. The radial velocity of NGC 6940. *Publ. astr. Soc. Pacif.*, **74**, 436, 1962.
173. Wallerstein, G. On the absolute magnitude and reddening of SS Cygni. *Astrophys. J.*, **137**, 991, 1963.
174. Wampler, J., Pesch, P., Hiltner, W. A., Kraft, R. P. A reinvestigation of U Sgr in M 25 (= IC 4725). *Astrophys. J.*, **133**, 895, 1961.
175. Warner, B. New southern Ba 11 stars. *Observatory*, **82**, 164, 1962.
176. Warner, B. Spectral classification of some southern late-type peculiar stars. *Mon. Not. R. astr. Soc.*, **126**, 61, 1963.
177. Wayman, P. A. Fundamental data for A-type stars near the south galactic pole. *R. Obs. Bull.* no. 36, 1961.
178. Wayman, P. A. Photo-electric magnitudes and colours of southern double stars. *R. Obs. Bull.* no. 50, 1962.
179. Westerlund, B. E., Danziger, I. J., Graham, J. Supergiant stars in the wing of the Small Magellanic Cloud. *Observatory*, **83**, 74, 1963.
180. Whiteoak, J. B. A study of the galactic cluster IC 2602. I. A photo-electric and spectroscopic investigation. *Mon. Not. R. astr. Soc.*, **123**, 245, 1961.
181. Whiteoak, J. B. An association of O and B stars in Ara. *Mon. Not. R. astr. Soc.*, **125**, 105, 1963.
182. Wilson, O. C. A probable correlation between chromospheric activity and age in main-sequence stars. *Astrophys. J.*, **138**, 832, 1963.

Unpublished Work

(Buscombe): Spectral classifications are now available for stars of the cluster IC 2391. In addition, A. Przybylski is continuing the classification of late-type stars having high radial velocity or high proper motion, or both, and Mrs P. M. Kennedy is working on the classification of A-type stars near the south galactic pole and O and B stars in various Milky Way fields.

(Evans): Work on the spectral types of southern stars is now being extended to faint objects by use of an $f/1$ camera giving a dispersion of 171 \AA/mm at $H\gamma$. It has been used mainly by G. A. Harding for the study of individual stars in ω Centauri, but in addition RR Lyrae variables in the south galactic pole cap and faint nearby stars are also being observed. A number of new subdwarfs have been discovered.

A fifth 'Fundamental Data' list containing 300 stars will be submitted for publication shortly.

(Keenan): A catalogue of spectral types of the Mira variables of types Me and Se in the northern sky is being prepared. Its purpose is to give a set of homogeneous types that refer to the phase of normal maximum brightness. As many as possible of the variables with m_v brighter than 10.0 at maximum (plus a few fainter ones) will be included.

Spectrograms used in this work have been obtained by various investigators at a number of observatories.

The catalogue will also include a group of stars intermediate in spectrum and light variation between the Mira variables and the red variables of small amplitude. This group includes practically all of the SRa variables. In addition we shall include a small number of variables that have less regular light curves but that still show hydrogen emission. These include the three known variables of small amplitude that have radial velocities exceeding 80 km/sec.

(Meinel): The spectral classification of galaxies is one of the problems to which the newly-rebuilt $f/0.8$ nebular spectrograph of the Steward Observatory is to be applied. This instrument yields a resolution of 10μ from 6800 \AA to 3500 \AA and a dispersion of 250 \AA/mm .

(Stephenson): N. B. Sanwal has begun a program of two-dimensional classification of close ($\leq 2''$) visual binaries having at least one member above the main sequence with the slit spectrograph of the new 36-inch reflector of the Warner and Swasey Observatory.

3a. Classifications Employing Spectrophotometric Measurements: Narrow-Band Photo-electric Work

183. Bappu, M. K. V., Chandra, S., Sanwal, N. B., Sinval, S. D. Photo-electric measures of hydrogen-line absorption in early-type stars. *Mon. Not. R. astr. Soc.*, **123**, 521, 1962.
184. Baschek, B. Abhängigkeit des Strömgrenschen Index m und der Farbindices $U-B$, $B-V$ von der Metallhäufigkeit bei sonnenähnlichen Sternen. *Z. Astrophys.*, **50**, 296, 1960.
185. Beer, A. Galactic structure from photo-electric distances of early-type stars. *Astr. J.*, **67**, 268, 1962.
186. Borgman, J. Seven-colour photometry of O, B and A stars. *Bull. astr. Inst. Netherlds.*, **15**, 255, 1960.
187. Borgman, J. A study of the wavelength dependence of interstellar extinction. *Bull. astr. Inst. Netherlds.*, **16**, 99, 1961.
188. Borgman, J. Seven-colour photometry of A, F, G, K and M stars. *Bull. astr. Inst. Netherlds.*, **17**, 58, 1963.
189. Crawford, D. L. Photometry of G and K giants. *Astr. J.*, **66**, 281, 1961.
190. " " $H\beta$ photometry for the association I Lacertae. *Astrophys. J.*, **133**, 860, 1961.
191. Crawford, D. L. Photometry of the stars of the Cassiopeia-Taurus group. *Astrophys. J.*, **137**, 523, 1963.
192. Crawford, D. L. U , B , V and $H\beta$ photometry for the bright B8- and B9-type stars. *Astrophys. J.*, **137**, 530, 1963.
193. Crawford, D. L., Golson, J. C. $H\beta$ photometry of the Pleiades. *Astr. J.*, **66**, 42, 1961.
194. Gascoigne, S. C. B., Koehler, J. A. G-band photometry of globular clusters. *Observatory*, **83**, 66, 1963.
195. Griffin, R. F. Photo-electric measurements of the $\lambda 5250 \text{ \AA}$ Fe I triplet and the D lines in G and K stars. *Mon. Not. R. astr. Soc.*, **122**, 181, 1961.
196. Guthrie, B. N. G. The effect of rotation on Balmer line intensities of B-type stars. *Publ. R. Obs. Edinb.*, **3**, 81, 1963.
197. Gyldenkerne, K. Photo-electric three-dimensional spectral classification of G and K stars. *Astrophys. J.*, **134**, 657, 1961.
198. Hardie, R. H., Crawford, D. L. A study of the II Scorpii association. *Astrophys. J.*, **133**, 843, 1961.
199. Hilton, W. B., McNamara, D. H. The eclipsing star AW Pegasi. *Astrophys. J.*, **134**, 839, 1961.
200. McNamara, D. H. The dependence of hydrogen line intensities on rotational velocities in B-type stars. *Publ. astr. Soc. Pacif.*, **74**, 416, 1962.
201. McNamara, D. H. Axial rotation of Orion stars of spectral type B5–B9. *Astrophys. J.*, **137**, 316, 1963.
202. McNamara, D. H., Augason, G. The absolute magnitude of the Delta Scuti stars. *Astrophys. J.*, **135**, 64, 1962.
203. McNamara, D. H., Larsson, H. J. Axial rotation of Orion stars of spectral type B0–B3. *Astrophys. J.*, **135**, 748, 1962.

204. McNamara, D. H., Rogers, M., Huerta, R. Period-luminosity relation of the RR Lyrae variables. *Astr. J.*, **67**, 277, 1962.
205. Peat, D. W. Photo-electric spectrum measurements of the $H\alpha$ line. *Observatory*, **81**, 120, 1961.
206. Sharpless, S. Evolutionary effects in the Orion association. *Astrophys. J.*, **136**, 767, 1962.
207. Strömngren, B. Problems of internal constitution and kinematics of main sequence stars. *Quart. J. R. astr. Soc.*, **4**, 8, 1963.
208. Walker, G. A. H. Photo-electric measurements of the 3883 Å CN band. *Observatory*, **80**, 233, 1960.
209. Wampler, E. J. Observed variations in the law of interstellar reddening. *Astrophys. J.*, **136**, 100, 1962.
210. Wood, D. B. Narrow-band photometry of galaxies. *Publ. astr. Soc. Pacif.*, **74**, 414, 1962.

Unpublished Work

(Bappu): It is hoped to extend the $H\gamma$ photometry to more O and B stars in the southern hemisphere, using interference filters at first, but eventually a monochromator.

(Gyldenkerne): $H\beta$ measurements have been nearly completed for all northern A0 stars in the *Bright Star Catalogue*. Observations of $B-V$, Balmer discontinuity c and metallic-line index m have been carried out for a limited number of these stars.

An extensive paper on three-dimensional classification of bright northern giant and subgiant G and K stars by means of the indices k , n , and m is in press. This classification system has been extended to G and K stars in groups and to high-velocity stars brighter than mag. 7.5.

Recent tests of various classification indices for M stars appear very promising.

(McNamara): Intrinsic colors, luminosities, and chemical composition indices of short-period Cepheids have been recently determined by use of narrow-band photo-electric photometry. We have also completed an investigation of the luminosities and intrinsic colors of the brighter components of all of the brighter eclipsing systems in the northern hemisphere, and are currently working on the fainter components.

(Reddish): A fully automatic twin telescope for photo-electric photometry has been built at Edinburgh. This will be remotely operated by a taped program and will simultaneously observe two stars at about ten different wavelengths through narrow-band filters. The output, recorded on tape and reduced by computer, will give spectral and luminosity classification, reddening and interstellar absorption band strength, and information on composition, age, and rotation.

(Redman): Narrow-band photometry has been continued with the Cambridge 36-inch telescope. $H\alpha$ has been measured by P. J. Andrews in 700 northern B stars. Except for stars with $H\alpha$ emission, this line appears to give nearly as good a measure of luminosity as does $H\gamma$. This work has been continued at the Radcliffe Observatory.

D. W. Peat has measured $H\alpha$ in about 600 G5–K5 stars and the red Ca I triplet in about 400. $H\alpha$ appears to be slightly strengthened in the high-velocity stars, a result satisfactorily explained in terms of metal deficiency. The Ca I triplet's behavior closely resembles that of the Mg I b lines. Mr Peat has also measured a group of Fe I lines near 4957 Å in some of the same stars and has found them to be sensitive to absolute magnitude.

The 5250 Å Fe I triplet has been measured in about 500 G5–K5 stars by C. D. Scarfe, who has found that although these lines permit the assignment of luminosity classes to the stars, they are not sufficiently sensitive to luminosity to enable any closer estimate of absolute magnitude to be made. Mr Scarfe is now making rather more detailed measurements of two other Fe I multiplets, numbers 15 and 1146, of substantially differing excitation potentials.

M. J. Price has extended the work of Deeming and of Griffin on the Mg I b lines and the Na D lines in G and K stars. Using $B-V$ colors, which form a more suitable comparison parameter than spectral type, he confirms Deeming's conclusion that the Mg lines tend to be strong in high-velocity stars and has found that the D lines, on the other hand, tend to be weaker in those stars.

(Sinnerstad): Early-type stars in galactic clusters and associations are now being studied by narrow-band photo-electric techniques at the Stockholm Observatory.

(Westerlund): Various southern supergiants and the clusters in the 30 Doradus complex have been observed in Strömberg's four-color system. The 'break at the G band, CN absorption' system has also been utilized for the classification of a number of G- and K-type stars.

(Williams): Long-period Cepheid variables with l^{II} between 0° and 180° have been observed in Crawford's seven-color photometric system (189) in a search for possible differences in chemical composition among these stars. Population II Cepheids with periods greater than two days may be easily distinguished by their excessively bright violet and ultra-violet radiation as compared with Population I Cepheids of the same period, but there is considerable difficulty in distinguishing between the effects of temperature, interstellar reddening, and chemical composition for the Population I objects. The Cepheids in the Sagittarius spiral arm appear to be somewhat richer in metals than those within 1.5 kpc of the Sun, while the distant Cepheids in the Cygnus and Perseus arms appear to be somewhat metal-deficient. The effects observed are, however, not much larger than the observational errors, so these results must be considered tentative until further observations are obtained.

*3b. Classifications Employing Spectrophotometric Measurements:
Multicolor Work*

211. Becker, W. Applications of multicolor photometry. In *Basic Astronomical Data*, K. Aa. Strand, ed. University of Chicago Press, 1963, p. 241.
212. Golay, M. Les irrégularités du fond continu des spectres stellaires et leurs effets sur les mesures photoélectriques. *Publ. Obs. Genève A*, no. 59, 1959.
213. Golay, M. Essai de classification stellaire bidimensionnelle à l'aide d'une photométrie à large bande. *Publ. Obs. Genève A*, no. 64, 1963.
214. Hämeen-Anttila, K. A. The information content of astronomical multicolor photometry. *Astrophys. J.*, **135**, 85, 1962.
215. Johnson, H. L., Mitchell, R. I. A completely digitized multicolor photometer. *Comm. Lunar and Planet. Lab., Arizona*, **1**, 73, 1962.
216. Kron, G. E. Multiple colour photometry. In *Vistas in Astronomy*, Vol. 3, A. Beer, ed. Pergamon Press, London, 1960, p. 171.
217. Kron, G. E. The unusual colors of two globular clusters of the Magellanic Clouds. *Publ. astr. Soc. Pacif.*, **73**, 202, 1961.
218. Kron, G. E., Gordon, K. C. The unusual star HD 101 065. *Publ. astr. Soc. Pacif.*, **73**, 267, 1961.
219. Mianes, P. Étude des Céphéides par la photométrie en six couleurs. *Ann. Astrophys.*, **26**, 1, 1963.
220. Neff, J. S., Morgan, W. W. Color separation of giant and dwarf stars. *Astr. J.*, **68**, 288, 1963.
221. Tifft, W. G. Multicolor photo-electric photometry of bright galaxies. *Astr. J.*, **66**, 390, 1961 and **68**, 302, 1963.

Unpublished Work

(Blanco): The constancy of intrinsic $B-V$ colors among the M giants as compared with the marked increase in the $V-I$ color with advancing class has been used as a basis for detecting and classifying M stars by a photometric method. Initial tests show that the method gives a gain of about 2 mag. over the limiting magnitude that can be reached by spectroscopic infra-red classifications.

(Borgman): Work in the photometric system described in (215) is being continued. In collaboration with H. L. Johnson, considerable deviations from the usually adopted value of 3 for the ratio A_V/E_{B-V} have been found for the Orion Nebula region and for a number of young clusters. We are now attempting to use also K- and M-type giants for the determination of this ratio.

(Golay): A new seven-color broad-band photometric system has been developed at the Geneva Observatory; observations of 350 stars, including the brighter members of various galactic

clusters, have been made in this system with our 40-cm telescope on the Jungfrauoch. This system will be applied to the study of stars of known space velocity as well as to miscellaneous normal and peculiar stars. Equipment to be used includes both a new 72-cm telescope at our Jungfrauoch site and a 1-meter telescope at our new station in Haute-Provence. Several papers dealing with our present work in multicolor photometry are in press.

(Kron): Two programs of six-color photometry have been undertaken during the past three years. One, with K. C. Gordon and A. Feinstein, comprised 235 stars of both hemispheres, more than one-half of the observations having been made at the Mount Stromlo Observatory. Practically all of these objects are of special interest; several are in the Magellanic Clouds. The second program, under way in collaboration with J. Breckenridge, involves G and K dwarfs, visual double stars, and stars in clusters. Observations of about 125 stars have now been completed.

3c. Classifications Employing Spectrophotometric Measurements: *Spectrum Scanning*

222. Aller, L. H., Faulkner, D. J. Energy distributions in the integrated light of southern globular clusters. *Astr. J.* **68**, 69, 1963.
223. Cayrel de Strobel, G. A comparison of photo-electric and photographic spectrophotometry. *Ann. Astrophys.*, **24**, 509, 1961.
224. Code, A. D. Stellar energy distribution. In *Stellar Atmospheres*, J. L. Greenstein, ed. University of Chicago Press, 1960, p. 50.
225. Kuiper, G. P. Infra-red spectra of A0-B8 stars, 1-2.5 μ . *Comm. Lunar and Planet. Lab., Arizona*, **2**, 17, 1963.
226. Kuiper, G. P. Spectrophotometric records from 0.3-0.55 μ for some A and B stars. *Comm. Lunar and Planet. Lab., Arizona*, **2**, 33, 1963.
227. Oke, J. B. Absolute energy distributions in the spectra of galaxies. In *Problems of Extra-Galactic Research*, G. C. McVittie, ed. (*Symp. IAU* no. 15). Macmillan, N.Y., 1962, p. 34.
228. Oke, J. B. Photo-electric spectrophotometry of RR Lyrae variables. *Astr. J.*, **67**, 278, 1962.
229. Rodgers, A. W. Photo-electric spectrophotometry of O-type stars. *Mon. Not. R. astr. Soc.*, **122**, 413, 1961.
230. van den Bergh, S. Photo-electric spectrophotometry of stars. *Astr. J.*, **68**, 413, 1963.
231. van den Bergh, S., Henry, R. C. Photo-electric spectrophotometry of globular clusters. *Publ. David Dunlap Obs.*, **2**, 279, 1962.

3d. Classifications Employing Spectrophotometric Measurements: *Miscellaneous Methods*

232. Ahnström-Sandgren, B. The wavelength dependence of interstellar absorption in a region near β Cassiopeiae. *Ark. Astr.* **3**, 155, 1963.
233. Beer, A. Distances of southern B-stars and galactic structure from Hy luminosities. *Mon. Not. R. astr. Soc.*, **123**, 191, 1961.
234. Berger, J. Recherches sur les propriétés des étoiles doubles ou multiples largement séparées en relation avec les problèmes d'évolution. *Ann. Astrophys.*, **25**, 1, 77, and 184, 1962.
235. Bonsack, W. K. The abundance of lithium in T Tauri stars: further observations. *Astrophys. J.*, **133**, 340, 1961.
236. Botto, P., Hack, M. A two-dimensional classification for stars of class O. *Mem. Soc. astr. Ital.*, **33**, 159, 1962.
237. Buscombe, W., Morris, P. M. Supergiant B stars in the Small Magellanic Cloud. *Astr. J.*, **66**, 279, 1961.
238. Butler, H. E., Thompson, G. I. Spectrophotometric measurements of early-type stars. *Publ. R. Obs. Edinb.*, **2**, 225, 1961.
239. Cayrel de Strobel, G. Utilisation des intensités centrales des raies de Balmer pour déterminer les températures de surface, de brillance et le diamètre apparent de 33 étoiles. *Ann. Astrophys.*, **23**, 278, 1960.

240. de Vaucouleurs, G., de Vaucouleurs, A. A quantitative analysis of the composite spectrum of the Large Magellanic Cloud. *Lowell Obs. Bull.*, **4**, 58, 1959.
241. Elvius, T., Ekedahl, Y. An attempt to derive new intrinsic colour indices for the Stockholm spectral classes B-K. *Ark. Astr.*, **2**, 527, 1961.
242. FitzGerald, M. P. The use of calcium emission lines as a distance indicator. *J. Roy. astr. Soc. Can.*, **57**, 225, 1963.
243. Gunn, J. E., Kraft, R. P. An abundance analysis of two F-type stars in the galactic cluster NGC 752. *Astrophys. J.*, **137**, 301, 1963.
244. Hack, M. Absolute magnitudes of O-type stars. *Mem. Soc. astr. Ital.*, **34**, 3, 1963.
245. Herbig, G. H. Search for residual traces of the T Tauri phenomenon in normal stars: lithium in G-type dwarfs. *Astr. J.*, **68**, 280, 1963.
246. Kaler, J. Stellar rotation and luminosity classification. *Z. Astrophys.*, **56**, 150, 1962.
247. Kopylov, I. M. Electron densities in atmospheres of hot stars. *Izv. Krym. astrof. Obs.*, **26**, 232, 1961.
248. Kopylov, I. M., Belyakina, T. S., Vitrichenko, E. A. A quantitative spectral classification of 'metallic-line' stars. *Izv. Krym. astrof. Obs.*, **29**, 181, 1963.
249. Kraft, R. P., Hiltner, W. A. On the intrinsic colors and the Hess diagram of late-type supergiants. *Astrophys. J.*, **134**, 850, 1961.
250. Kumaigorodskaya, R. N. A spectrophotometric study of Of stars. *Izv. Krym. astrof. Obs.*, **24**, 91, 1960.
251. Kumaigorodskaya, R. N. A study of some emission lines in the spectra of Of stars. *Izv. Krym. astrofiz., Obs.*, **28**, 135, 1962.
252. Larsson-Leander, G. Photo-electric observations in SA 4 and comments on the intrinsic colours of the Stockholm spectral classification. *Ark. Astr.*, **3**, 51, 1962.
253. Lebon, M. Étude préliminaire du spectre de l'étoile 99 Her. *C.R. Acad. Sci. Paris*, **254**, 2141, 1962.
254. Ljunggren, B., Oja, T. Spectrophotometric classification of late-type dwarfs. *Ark. Astr.*, **2**, 583, 1961.
255. Ljunggren, B., Oja, T. The Uppsala spectral classification. *Uppsala astr. Obs. Ann.*, **4**, no. 10, 1961.
256. Malmquist, K. G. Investigations on the stars in high galactic latitudes. III. *Uppsala astr. Obs. Ann.*, **4**, no. 9, 1960.
257. Malmquist, K. G., Ljunggren, B., Oja, T. A spectrophotometric survey of stars along the Milky Way. II. *Uppsala astr. Obs. Ann.*, **4**, no. 8, 1960.
258. Martin, N. Détermination de magnitudes absolues par la méthode d'Öhman. *Publ. Obs. Hte-Provence*, **6**, no. 13, 1962.
259. Mustel, E. R., Galkin, L. S. A spectrophotometric study of hydrogen lines in the spectra of peculiar A stars. II. *Izv. Krym. astrof. Obs.*, **24**, 78, 1960.
260. Pasinetti, L. E. Confronto quantitativo di tre coppie di stelle a righe forti e a righe deboli. *Mem. Soc. astr. Ital.*, **32**, 155, 1961.
261. Pédoussaut, A. Contribution à l'étude spectrophotométrique des étoiles M. *J. Observateurs*, **45**, 257, 1962.
262. Petrie, R. M. The B stars and galactic exploration. *Sky and Telesc.*, **26**, 330, 1963.
263. Preston, G., Wallerstein, G. Properties of two late-type variable stars of the halo population. *Astrophys. J.*, **138**, 820, 1963.
264. Schalén, C. Infra-red and photographic absorption in a region near β Cassiopeiae. *Ark. Astr.*, **3**, 169, 1963.
265. Sinnerstad, U. Spectrophotometric measurements of absorption-line intensities in early-type stars. *Stockh. Obs. Ann.*, **21**, no. 6, 1961.
266. Sinnerstad, U. Quantitative spectral classification and luminosity determination of early-type stars. *Stockh. Obs. Ann.*, **22**, no. 2, 1961.
267. Spinrad, H. The stellar content of NGC 3379. *Publ. astr. Soc. Pacif.*, **74**, 146, 1962.
268. Spite, F. Résultats préliminaires sur l'évaluation de l'abondance en métaux de quelques étoiles. *Publ. Obs. Hte-Provence*, **6**, no. 29, 1963.
269. Tsuji, T. Spectrophotometric study of two S-type stars, HD 216 672 and 22 649, in the infra-red region. *Publ. astr. Soc. Japan*, **14**, 222, 1962.

270. Van't Veer-Menneret, C. Étude spectrophotométrique de quelques étoiles à raies métalliques, et détermination de la composition chimique de l'une d'elles, 63 Tauri. *Ann. Astrophys.*, **26**, 289, 1963.
271. Wallerstein, G., Herbig, G. H., Conti, P. Observations of lithium in main sequence stars in the Hyades and other F stars. *Astr. J.*, **68**, 298, 1963.
272. Wyller, A. A. Problems related to the spectral classification of carbon stars: vibrational temperatures and C¹³ abundances. *Astroph. Norv.*, **7**, 13, 1960.
273. Yoss, K. M. Relationship between CN anomaly and *U*, *V*, and *W* components of space velocity. *Astr. J.*, **67**, 757, 1962.

Unpublished Work

(Elvius): An investigation initiated by Malmquist on stars of the south galactic pole cap is being continued by P.-I. Eriksson. Results have been obtained for an area of 20 square degrees. The limiting magnitude is about 14.5. The spectrophotometric work of B. Ljunggren on a large area near the north galactic pole is nearly completed.

(Fujita): A comparative study of 25 M, S, and carbon stars is under way with special reference to classification problems. This work is being done in collaboration with Y. Yamashita, F. Kamijo, T. Tsuji, and K. Utsumi, and utilizes material obtained at the Dominion Astrophysical Observatory.

(Herman): Classification of Be stars, based on the central depths and equivalent widths of the Balmer lines, is in progress. The results are being carefully compared with H. Rojas' *U*, *B*, *V* data on the same stars.

(Ramberg): A spectrophotometric study of a region in Norma, based on plates taken with the ADH Baker-Schmidt, is nearly finished. Other southern Milky Way regions are also being investigated.

(Reddish): Quantitative classification work on early-type stars is in progress with the Edinburgh 40-cm Schmidt. The dispersion used is 1000 Å/mm at H γ . It is planned to extend the program soon to all spectral types.

(Wallerstein): Following an examination of infra-red spectra obtained by Sharpless, and at his suggestion, S. B. Parsons has studied quantitatively the variations with spectral type and luminosity of features observable in the infra-red on 200 Å/mm spectrograms of A-F stars. The central depth of the blend at 8542–5 Å (Ca 11 and P 15) was found to be directly proportional to absolute magnitude for a given spectral type, and when used in combination with the depth of P 14 permits the luminosity to be determined unambiguously. Both this feature and 7774 Å of O 1, which is extremely strong in the most luminous stars, should be very useful luminosity indicators on objective-prism spectra, especially for highly reddened objects.

(Yoss): Spectroscopic absolute magnitudes and CN-band intensities will be determined by spectrophotometry for the 1041 late-type stars for which radial velocities and MK types have been determined at the David Dunlap Observatory (Heard, 1956). It is planned to punch the microphotometer response directly onto cards through use of a peak detector.

4. *Papers Dealing with the Relation of Colors to Spectra*

274. Arp, H. *U*–*B* and *B*–*V* colors of black bodies. *Astrophys. J.*, **133**, 874, 1961.
275. Canavaggia, R. L'effet de serre et la position des sous-naines dans les diagrammes couleur-couleur et magnitude-couleur. *C.R. Acad. Sci. Paris*, **251**, 642, 1960.
276. Davidson, M., Pagel, B. The identification of subdwarfs from the color-spectral type relation. *Observatory*, **81**, 250, 1961.
277. Eggen, O. J., Sandage, A. R. On the existence of subdwarfs in the (M_{bol} , Log T_e)-plane. II. *Astrophys. J.*, **136**, 735, 1962.
278. Evans, D. S., Stoy, R. H. On the identification of subdwarfs. *Observatory*, **82**, 118, 1962.
279. Feinstein, A. Note on the interpretation of an effect found in late dwarfs. *Asoc. Argent. astr. Bol.* no. 4, 30, 1962.

280. Pagel, B. The influence of metal abundance on spectra and spectral classification in late-type dwarfs. *R. Obs. Bull.* no. 55, 1962.
281. Pagel, B. Colours, spectral types and the identification of subdwarfs. *Observatory*, **82**, 123, 1962.
282. Pagel, B. Abundances of metals in subgiants. *Observatory*, **83**, 133, 1963.
283. Spinrad, H. SU Draconis and line blanketing in the RR Lyrae stars. *Astrophys. J.*, **133**, 479, 1961.
284. Wallerstein, G. Abundances in G dwarfs. VI. A survey of field stars. *Astrophys. J. Suppl.*, **6**, 407, 1962 (no. 61).
- 284a Weidemann, V. Effektive Temperatur und Schwerebeschleunigung der Weissen Zwerge. *Z. Astrophys.*, **57**, 87, 1963.
285. Wildey, R. L., Burbidge, E. M., Sandage, A. R., Burbidge, G. R. On the effect of Fraunhofer lines on *U*, *B*, *V* measurements. *Astrophys. J.*, **135**, 94, 1962.
286. Wilson, O. C. An interpretation of the late main sequence. *Astrophys. J.*, **133**, 457, 1961.
287. Wilson, O. C. Relationship between colors and spectra of late main sequence stars. *Astrophys. J.*, **136**, 793, 1962.

5. Papers Dealing with Calibration Problems

288. Blaauw, A. The calibration of luminosity criteria. In *Basic Astronomical Data*, K. Aa. Strand, ed. University of Chicago Press, 1963, p. 383.
289. Johnson, H. L. On the luminosities of early-type stars. *Lowell Obs. Bull.*, **4**, 87, 1959.
290. Johnson, H. L., Iriarte, B. The luminosities of early-type stars. *Lowell Obs. Bull.*, **4**, 47, 1958.
291. Petrie, R. M. The Scorpio-Centaurus stream and the absolute magnitudes of the B stars. *Mon. Not. R. astr. Soc.*, **123**, 501, 1962.
292. Schmidt-Kaler, T. Ueberriesen Fo-K7 Ia-II in galaktischen Sternhaufen, Assoziationen und OB-Sterngruppen. *Z. Astrophys.*, **53**, 1 and 28, 1961.
293. Schmidt-Kaler, T. Eine neue Eichung des MK-Systems. *Mitt. astr. Gesells.* 1962, p. 67.
294. Upgren, A. R. OB spectral group classifications as distance indicators. *Astr. J.*, **67**, 588, 1962.
295. van den Bergh, S. The color-magnitude diagram of high-velocity stars. *Publ. astr. Soc. Pacif.*, **74**, 308, 1962.

Unpublished Work

(Borgman): A calibration of my early-type seven-color material (186) has been completed in collaboration with Blaauw and is now in press; the prediction accuracy of an individual distance modulus appears to be ± 0.27 mag. (m.e.), which includes all error sources except for a possible systematic zero-point correction arising from uncertainty in the distance of the Scorpio-Centaurus association.

6. General Papers

296. Abt, H. A., ed. A discussion of spectral classification. *Astrophys. J. Supp.*, **8**, 99, 1963 (no. 75).
297. Abt, H. A., Hunter, J. H., Jr. Stellar rotation in galactic clusters. *Astrophys. J.*, **136**, 381, 1962.
298. Babcock, H. W. Stellar magnetic fields. In *Stellar Atmospheres*, J. L. Greenstein, ed. University of Chicago Press, 1960, p. 282.
299. Buscombe, W. Photometric data for galactic clusters. *Mount Stromlo Obs. Mimeog.* no. 6, 1963.
300. Greenstein, J. L. Spectra of stars below the main sequence. In *Stellar Atmospheres*, J. L. Greenstein, ed. University of Chicago Press, 1960, p. 676.
301. Herbig, G. H. On the evolutionary interpretation of the M dwarfs. In *Symposium on Stellar Evolution*, J. Sahade, ed. La Plata, Observatorio Astronómico, 1962, p. 45.
302. Herbig, G. H. The properties and problems of T Tauri stars and related objects. In *Advances in Astronomy and Astrophysics*, Vol. 1, Z. Kopal, ed. Academic Press, N.Y.-London, 1962, p. 47.

303. Jaschek, M., Jaschek, C. Considerations on the evolution of peculiar and metallic-line stars. In *Symposium on Stellar Evolution*, J. Sahade, ed. La Plata, Observatorio Astronómico, 1962, p. 137.
304. Joy, A. H. Spectra of dwarf variable stars. In *Stellar Atmospheres*, J. L. Greenstein, ed. University of Chicago Press, 1960, p. 653.
305. Joy, A. H. Spectroscopic absolute magnitudes: a review. *J. Roy. astr. Soc. Can.*, **56**, 67, 1962.
306. Keenan, P. C. Classification of stellar spectra. In *Basic Astronomical Data*, K. Aa. Strand, ed. University of Chicago Press, 1963, p. 78.
307. Kraft, R. P. Cataclysmic variables as binary stars. In *Advances in Astronomy and Astrophysics*, Vol. 2, Z. Kopal, ed. Academic Press, N.Y.-London, 1963, p. 43.
308. McNamara, D. H., Hansen, K. Stellar rotation and Beta Canis Majoris stars. *Astrophys. J.*, **134**, 207, 1961.
309. Roberts, M. S. The galactic distribution of the Wolf-Rayet stars. *Astr. J.*, **67**, 79, 1962.
310. Strömgren, B. Quantitative classification methods. In *Basic Astronomical Data*, K. Aa. Strand, ed. University of Chicago Press, 1963, p. 123.
311. Struve, O. Some problems of stellar rotation. *Sky and Telesc.*, **20**, 326, 1960 and **21**, 21, 1961.
312. Voigt, H. H. Die Problematik der Leuchtkraftkriterien. *Mitt. astr. Gesells.* 1962, p. 17.
313. Vyssotsky, A. N. Spectral surveys of K and M dwarfs. In *Basic Astronomical Data*, K. Aa. Strand, ed. University of Chicago Press, 1963, p. 192.