

45. STELLAR CLASSIFICATION  
(CLASSIFICATION STELLAIRE)

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I. INTRODUCTION

The years covered in this report (1979-81) have been active ones in the field of stellar classification, as is made obvious in the following sections. In addition to the individual references listed there, a number of symposia, colloquia, and workshops were held during the report period which included papers relevant to stellar classification. These include IAU Symposia 85 (Starclusters), 98 (Be stars), and 99 (Wolf-Rayet stars); IAU Colloquia 64 (Automated Data Retrieval in Astronomy) and 68 (Astrophysical Parameters for Globular Clusters); and the Dudley Observatory Workshop on Problems of Calibration of Multicolor Photometric Systems (1979).

II. CLASSIFICATION USING SLIT SPECTROSCOPY (R. F. Garrison)

(a) O- and B-type Stars.

Identifications and classifications of X-ray and extreme UV stars have been made by several groups including Cowley, Crampton and Hutchings (21.114.566, 22.142.052, 22.142.047, 25.142.048, 26.116.008), Giangrande et al. (27.114.126), Walborn and Panek (PASP 92, 803, 1980), and Hammerschlag-Hensberge et al. (25.114.150). Lundström and Stenholm have classified 19 faint WR stars (25.113.013). Turner, Lyons and Bolton (22.114.501) have found a new Be star and Jaschek et al. have classified 5000 spectra of 140 Be stars taken over 20 years (28.114.050). Slettebak recently completed classification of all Be stars brighter than 6.0. Swings (A&A 98, 112, 1981) has classified CPD-52<sup>o</sup> 9243, an IR excess star with P-Cygni lines. Hirata (22.123.035) has noted that 88 Her is a shell star of Pleione type. Hydrogen deficient subdwarfs have been studied by Hunger and Kudritzki (28.126.003) and Drilling (21.114.563, 28.114.135) while Kaufmann and Theil have provided an atlas (27.114.190). Bisiacchi et al. have suggested that HD 93521 is a population II supergiant (22.114.574) and Walborn (ApJ 243, L37, 1981) has noted variations in the spectrum of the well-known star  $\theta^1$  Orionis C. Forte and Orsatti (AstrJ 86, 209, 1981) have classified OB stars in the field of the Carina Nebula. Muzzio and Levato have classified a distant supergiant in Norma (27.114.143) and Chromey has classified some faint stars in the anti-center direction (25.114.068, 28.114.027). Morgan has given revised distances for OB stars in the north galactic pole region.

(b) A- and F-Type Stars.

Morgan et al. have studied the Hertzsprung gap supergiants (ApJ 243, 894, 1981). Classifications have been carried out by A. Cowley and Bidelman of 310 bright FO-G5 stars north of -25<sup>o</sup> (25.114.127). Garrison has classified HD 219150 (28.113.002). Drilling has illustrated two hydrogen deficient A stars (25.114.057). Some high-latitude blue variables have been classified by Bond (22.122.209). "Numerical taxonomy" of Ap and Am stars has been carried out by C. Cowley and Henry (26.114.046) and  $\delta$  Scuti stars have been classified by Pena et al. (PASP 93, 234, 1981) and by Burke and Mayor (A&A 97, 4, 1981). Bp and Ap stars have been classified by Glagolevsky and Kopylov et al. (Sov. Astron. Letters

7, 366; Comm. Special Ap. Obs. No. 30, 32; and Izvest. Special Ap. Obs. 13, 3).

(c) Late-type Stars.

This was a rich period for studies of late-type stars. Keenan and Pitts have given revised types for 552 stars (27.114.188). Strobel has given quantitative 3-dimensional classifications of FGK stars (26.114.131). A revised system in the red for S stars has been presented by Ake (26.114.089) while Keenan and Boeshaar have classified 101 S and SC stars on the revised MK system (27.114.075). A more accurate HR diagram for the cooler stars has been given by Keenan (22.114.012), M stars have been classified in the near infrared by Solf (22.114.055) and Bidelman has classified stars of the Cal Tech two-micron survey (27.114.180). Metal weak stars have been studied by Bessell (21.114.546), Bessel and Ianna (21.126.034) and Foy (26.114.042). VV Cephei systems have been studied by Forte and Orsatti (27.119.042) and by Drilling (25.119.003). Fernie and Garrison (PASP 93, 330, 1981) have reclassified HD 179315 as a Cepheid of early type and Bouw has devised a system of classification for middle-type supergiants in the photographic IR (PASP 93, 45, 1981).

(d) Binaries.

Corbally and Garrison carried out classifications for 30 close visual double stars (28.118.023) and Corbally is extending the study. New types for spectroscopic binaries have been given by Hendry (21.119.013, 21.119.017), Keenan (28.114.149), Conti et al. (27.120.030), Hutchings et al. (22.142.047), and Bopp et al. (26.120.015). Hot companions for supergiants have been classified by Parsons (ApJ 245, 201, 1981).

(e) Variable Stars.

Gauthier and Crowe, working with Garrison, are studying the spectra of Cepheids and Miras (respectively) around their cycles. Romanov et al. have studied RR Lyrae (28.122.096).

(f) Clusters and Associations.

Considerable work has been published during this period, especially by Abt and Levato who are continuing their important series of studies (27.153.054, 27.153.052, 26.153.030, 25.114.020, 25.153.048, 21.114.062, 22.114.011, and 28.153.002). Abt has also classified 865 components of visual multiple stars (ApJ Suppl 45, 437, 1981). Garrison and Schild classified stars in NGC 6231 down to A0 on the main sequence (26.153.003). Van Rensbergen et al. search 5 clusters for Ap stars (21.153.012). FitzGerald et al. have studied many southern clusters using image tube spectra (26.114.024, 26.153.002). Pilachowski and Bonsack have studied yellow giants in open clusters (22.114.034). Individual clusters have been studied by Rydgren (27.152.004), Marraco and Rydgren (AstrJ 86, 62), Claria and Rosenzweig (21.153.023), Perry et al. (21.153.025), Harris and Harris (22.153.036), Turner et al. (22.153.026, 25.153.083, 27.152.001, 28.152.003, 28.153.008, PASP 92, 840, 1981), Feinstein et al. (27.153.066), and Barry et al. (26.153.011). Individual stars in globular clusters have been classified by Canizares et al. (21.154.017), West and Bartaya (26.154.009), and Remillard et al. (25.126.031). Barry (25.120.020) has found a possible RS CVn star in the coma cluster and has studied differences between solar type stars and the Sun (21.114.004). Herbst et al. have classified newly formed stars in Canis Major RI (21.152.005).

## (g) Stars in Galaxies.

With new detectors, individual stars in nearby galaxies are being observed in greater numbers. Crampton (25.159.017) has classified 25 OB stars in the LMC and Walborn (22.132.009) has found an O4 star in the SMC. WR stars have been classified by Melnick (22.114.549), Azzopardi and Breysacher (25.159.016), and Breysacher and Westerlund (21.114.570). Late type stars in the clouds have been classified by Humphreys (25.159.008, 25.159.022), Feast (25.114.027), and Elias et al. (28.114.134). Carbon stars have been classified by Richer (ApJ 243, 744, 1981), Richer and Frogel (28.114.133), and Lloyd-Evans (28.114.047).

Cowley et al. (21.114.010) have classified giant stars in distant satellites of the Galaxy, while Humphreys (27.158.238) and van den Bergh and Humphreys (25.158.149) have studied the most luminous stars in NGC 6822 and IC 1613. Humphreys has also classified stars in M 31 (26.158.196) and in M 33 (28.158.168) as well as M 101 and NGC 2403 (28.158.196).

## (h) General.

Morgan et al. have made some important philosophical comments in their paper on the Hertzsprung gap supergiants (ApJ 243, 894, 1981). Morgan has also published remarks in the HR diagram symposium (22.115.010) and in the Vatican Colloquium (25.114.090). Slettebak et al. have considered the effects of rotation on classification (28.114.131). Abt et al. have classified stars with unusual photometric indices (25.113.050) and the Jascheks have classified stars with satellite UV spectral peculiarities (28.114.051). Allen has classified Stephenson-Sanduleak emission-line stars (22.114.021) and Bychkov et al. (21.119.009) have studied classification in the IR. Komarov and Tsymbal have studied classification criteria theoretically (28.064.044).

### III. OBJECTIVE-PRISM SPECTRAL CLASSIFICATION AND CLASSIFICATION INVOLVING AUTOMATIC METHODS (D. J. MacConnell)

N. Houk continues her important work of classifying the southern HD stars on plates taken with the Curtis Schmidt telescope (108 Å/mm at H $\gamma$ ). Volume 3 (Dec. -40° to -26°) will be in press by early 1982 and may be accompanied by a more extensive atlas, arranged by temperature class, than that which accompanied Volume 1. Plate-taking on this program north of Dec. +30° is continuing with the new 10° prism on the Burrell Schmidt telescope recently relocated at Kitt Peak; these plans are discussed by Houk and Bidelman (25.114.167), and Williams and Houk (25.114.171) present some statistics on over 4000 peculiar HD stars in 15 categories. Bidelman (AstrJ 86, 553, 1981) has found 154 peculiar stars (HD and fainter) on 130 plates (Dec. 0° to -20°) taken for the HD reclassification program and is searching a group of 54 similar plates along the southern galactic plane which are deeper than those previously surveyed by him. He will also do the "early result" search for astrophysically interesting stars on the new northern plates prior to Houk's HD classification.

In other large projects, Stock continues his measures of the positions, radial velocities, classifications, and magnitudes of stars in an intermediate latitude zone (see 27.155.062, 28.031.548). The catalogue now contains about 10,000 stars in the region R.A. 11<sup>h</sup>47<sup>m</sup> to 15<sup>h</sup>23<sup>m</sup>, Dec. -30° to -35°; it will be published in the Rev. Mex. Astron. Astrophys. Bartaya (27.002.038) has presented a catalogue of types and luminosity classes for 10,396 stars in the Kapteyn areas 2 to 43 using the 70-cm Maksutov telescope at Abastumani; the dispersion is 166 Å/mm at H $\gamma$ . This work will be extended to SA 44-115 and to stars down to  $m_{\text{og}}$  13. Henize, Wray, Parsons, and Benedict have presented a catalogue (25.002.067) of 500 stellar spectra in the wavelength region  $\lambda\lambda$ 1300-5000 taken during the 3 manned

Skylab missions. The spectra have been measured and reduced to absolute fluxes; most of the stars are of type B.

Henize, Wray, and Parsons (ApJ, in press) present a classification system for O-B2 stars based on the resonance lines of CIV  $\lambda 1549$  and SiIV  $\lambda \lambda 1394, 1403$ . They find that the Si/C ratio discriminates well for luminosity in the O stars and for temperature among the O9-B2 stars of lower luminosity. Using Curtis Schmidt plates taken at the southern galactic pole by Slettebak, McNeil and Schiller have conducted surveys at  $580 \text{ \AA/mm}$  at H $\gamma$ . McNeil (Bull. Amer. Astron. Soc. 13, 357, 1981) catalogued over 2200 G5-M stars to limiting magnitude  $V = 13.5$  in an 81 square-degree region and used the data to discuss the percentage dwarf distribution with apparent magnitude and the space density distribution of giants to  $z = 2$  kpc. Schiller (M.S. thesis, Ohio State University) surveyed plates covering 840 square degrees finding 183 M giants to limiting B-magnitude 14.5.

Drilling and Landolt (25.115.157) have classified over 600 secondary UVB standards of Landolt at  $280 \text{ \AA/mm}$  at H $\gamma$ , and Johansson (27.113.059 and A&A Suppl 44, 127, 1981) has classified about 800 stars on ADH Baker-Schmidt plates of about the same dispersion. In another of his series of papers on loose stellar clusterings in the southern Milky Way, L. Loden (A&A Suppl 44, 155, 1981) has classified 68 stars near 2 suspected clusterings. Cardon, McCarthy, and Treanor (27.115.048) have given coordinates and charts for several hundred stars in 4 Kapteyn areas which were separated into the natural groups dA and gK at  $800 \text{ \AA/mm}$  at H $\gamma$ . Fehrenbach and Burnage (A&A Suppl 43, 297, 1981) and Amieux and Burnage (A&A Suppl 44, 101, 1981) have given radial velocities and types for 713 stars in 4 fields and for 169 stars in the field of NGC 3114, respectively. Orsatti and Muzzio (27.114.046) and Forte and Orsatti (AstrJ 86, 209, 1981) have found about 200 OB stars along the southern galactic plane on thin-prism plates taken at CTIO, and Martinez, Muzzio, and Waldhausen (28.114.069) have given approximate types for 139 H $\alpha$  emission stars in the Coalsack region.

Doyle and Butler (26.114.116) and Krug, Morton, and Tritton (27.114.018) have given outlines for the classification of spectra on plates from the ADH and UK 1.2m Schmidt telescopes, respectively. Bidelman (27.114.180) has presented a catalogue of classifications of stars in the Caltech  $2\mu$  survey and has completed the classification of stars in the AFGL infrared catalogue. In several short papers (27.123.045, 28.114.110, 28.118.001, 28.122.312) Bidelman has classified individual M stars of special interest. Fuenmayor (28.155.012) has surveyed areas near the galactic center and anti-center for carbon stars finding 129 new ones. He finds that the space density of C stars toward the anti-center is three times that toward the center and that there are concentrations at 5 kpc, toward the center and at 0.5 and 5.5 kpc toward the anti-center. Stephenson (Bull. Amer. Astron. Soc. 11, 365, 1979 and 13, 463, 1981) continues a yellow-red survey north of  $-25^\circ$  and above galactic latitude  $+10^\circ$  searching for emission objects and C and S stars. He has published (28.114.151) details on a new weak-banded, probable C star with bright H $\alpha$ . Sanduleak (27.114.179) has found a very faint C star possibly associated with the Magellanic stream, and Kurtanidze and co-workers have presented 38 new C stars on plates taken with the 70 cm Maksutov telescope at Abastumani (27.114.022, 27.114.111, 27.114.157, 28.114.158). Platais, Alksnis, and Alksne (27.114.113, 27.122.132 and Investig. of Sun and Red Stars 12, 19 and 24, 1981) have published new C stars in several fields found on the Latvian Schmidt plates; the number of C stars found at the Baldone Obs. is now 245. MacConnell (26.114.086 and A&A Suppl, in press) has found 46 C stars and 328 S/MS stars on Curtis Schmidt plates in the visual-red region and has discovered (A&A Suppl 44, 387, 1981 and in press) nearly 900 new H $\alpha$ -emission stars on the same plates. Cardon is preparing lists of H $\alpha$ -emission stars in the northern Milky Way found on Vatican Schmidt plates and Sanduleak and Bidelman (27.114.144), Bidelman (PASP 93, 129, 1981), and Welin (27.114.149) have given short lists of new, northern emission stars. Spectrophotometry from objective-prism plates has been

done for 4 He stars by Wegner (27.114.176), for the variable emission object HM Sge by Dokuchaeva and Esipov (25.122.049) and for cool stars in the near I-R by Nandy, Smiriglio, and Buonanno (25.114.201). Other peculiar emission stars have been studied by Alvarez (26.122.029) and by Altamore et al. (28.114.082).

The objective-prism technique has been used for a number of studies of the Magellanic clouds: Breysacher and Azzopardi (25.114.072) have found 4 new WNs in the SMC and 13 WRs in the LMC; Westerlund, Olander, and Hedin (A&A Suppl 43, 267, 1981) give types for 532 possible M supergiants in the LMC; Nandy is using UKSTU plates to map the distribution of OB stars in parts of the LMC down to  $V = 16.5$ . Nandy and Thompson are deriving spectral classes on these plates with measures using the COSMOS machine. Sanduleak continues his massive cataloguing program of members of both Clouds. Together with Philip, he is classifying OB stars and early-type supergiants to a limiting magnitude of  $V = 16$ , and with Shore he is searching for spectral variations in peculiar OBe stars. Together with Albers, Sanduleak is searching Curtis and UK Schmidt plates for C stars in the SMC.

In the field of automated classification, Weis, Uppgren, and Dawson (AstrJ 86, 246, 1981) present types, radial velocities, magnitudes, and colors of 1014 stars in Stock's program using PDS scans. Near Tartu, Maliuto, et al. (W. Struve Observ., preprint A-2, 1981) are carrying out quantitative classification of FGK stars in a number of areas. Simien at Haute-Provence has developed an automated technique the results of which are in good accord with the visual method. In Italy several groups are active. Rusconi and Sedmak (26.031.572) and Pasian, Rusconi, and Sedmak (28.021.041) report on an interactive procedure for processing spectra using digitized PDS measures. Their software package performs linearization, background removal, analysis of line parameters, and radial velocity determination. Mottola (26.031.570) and Bonoli, Bortoletto, and Falomo (26.031.571) describe use of the Reticon spectrophotometer at Asiago, and Coluzzi et al. (26.031.573) report on the automatic reduction of  $350 \text{ \AA/mm}$  spectra taken with the Campo Imperatore Schmidt. DeBiase et al. (28.031.582) present an interactive method which they apply to PDS scans of echellograms of Arcturus.

#### IV. CLASSIFICATION USING MULTICOLOR PHOTOMETRY (V. Straizys)

An important event during the report period was a workshop "Problems of Calibration of Multicolor Photometric Systems" held at Dudley Observatory on March 16-17, 1979. The volume of the workshop proceedings (25.012.043) contains extensive reviews of most photometric systems which are in use and a number of papers on the problems of calibration of the systems in spectral types, absolute magnitudes, temperatures, gravities, and metallicities. A book by V. Straizys "Metal-Deficient Stars" (1981, Mokslas Publishers, Vilnius, Lithuania) contains detailed descriptions of multicolor photometric investigations of globular cluster stars, subdwarfs, metal-deficient giants, horizontal branch stars, blue stragglers, RR Lyrae-type stars, W Virginis-type stars, RV Tauri-type stars, yellow semiregular stars, CH and barium stars. The photometric properties of cluster stars are considered in a monograph by P. N. Kholopov "Star clusters" (Moscow, Nauka, 1981), in the proceedings of a NATO Advanced Study Institute "Globular Clusters" (28.003.008), in the proceedings of IAU Symposium No. 85 "Star clusters" (27.012.007), and in the proceedings of IAU Colloquium No. 68 "Astrophysical Parameters for Globular Clusters" (Dudley Observatory, October, 1981). Photometric classification problems in the infrared have been discussed in IAU Symposium No. 96 "Infrared Astronomy" held in Kona, Hawaii, 1980. The mean energy distribution curves of different MK types published earlier by Straizys and Sviderskiene (09.114.090, 12.114.153) proved to be very important in calibration work. These curves are now extended both into the ultraviolet (Sviderskiene, 28.114.167) and into the infrared (Straizys et al., Bull Vilnius Obs 57, 9, 1981). The mean energy distribution curves of subdwarfs and metal-deficient giants have

also been published (Bartkevicius and Sviderskiene, Bull Vilnius Obs 57, 35, 1981). Straizys and Kuriliene (Astrophys Space Sci 1981, in press) have published a new calibration of MK spectral types in  $M_V$ ,  $M_{bol}$ ,  $T$  and  $\log g$ . Meylan and Hauck (A&A Suppl 1981, in press) have investigated<sup>e</sup> the relations between photometric temperature parameters in different photometric systems.

(a) Wide-Band Systems.

New determinations of intrinsic color indices of the system UBVRI have been published by Kron (22.131.108), Gutierrez-Moreno (26.113.005), and Dubois (26.113.019). Theoretical calculations of UB $\bar{V}$  colors and different photometric parameters for model atmospheres have been published by Buser and Kurucz (22.113.041) and by Gustafsson and Bell (25.064.050). Solar UB $\bar{V}$  system colors have been investigated by Hayes (25.071.033), Clements and Neff (25.113.037), Hardorp (28.080.006; 28.114.088), and Chmielewski (A&A 93, 334, 1981). Kholopov (27.115.004) has determined ZAMS in the U-B, B-V diagram.

RI systems of Kron, Johnson, Cousins-Bessell and Washington T<sub>1</sub>T<sub>2</sub> system have been intercompared by Straizys et al. (Bull Vilnius Obs 57, 9<sup>1</sup>, 1981). They presented some considerations on the selection of an optimum international red-near infrared system. The systems used by Cousins (22.113.029; 28.113.004; 28.113.033; 28.113.035), Bessell (25.113.068; 25.126.002; 26.113.045), Canterna and Harris (25.113.065; 26.113.036), Moffett and Barnes (25.113.031; 25.113.051), and Wade et al. (25.113.034) are most perspective. Color indices V-R and R-I have been calibrated in temperature by Gustafsson and Bell (25.064.050) and in surface brightness by Bell and Gustafsson (27.064.024).

The Washington system was described and standard stars given by Canterna and Harris (25.113.065; 26.113.036). The fifth bandpass (Johnson's V) was added to the system. Harris (AstrJ 86, 707 and 719, 1981) has investigated cepheids and W Virginis-type stars in the system.

A new far infrared system with  $\lambda_p = 40, 52, 100, \text{ and } 160 \mu$  has been realized with the Kuiper Airborne Observatory by Harvey (25.032.533).

(b) Medium-Band Systems

(i) The uvby system

This system was intensively used to classify stars of spectral types B-A-F-G in two or three dimensions. Frequently the narrow band index  $\beta$  was used to supplement the system for better luminosity classification of B-type stars in the conditions of interstellar reddening. The number of stars measured in uvby now exceeds 20 000 (Hauck and Mermilliod, 27.002.006). A very extensive program is being realized by Olsen who has measured about 14 000 A5-G0 stars down to  $V = 8.3$ ) (27.114.032; 26.113.010; BAAS 12, 194, 1980). Other catalogs of stars measured in uvby have been published by Knude (A&A Suppl 44, 225, 1981), Loden et al. (27.113.060), Kilkenny (25.113.026; 27.113.049), Twarog (28.155.037), Heck and Manfroid (28.113.021), Albrecht and Maitzen (28.131.081), Heck and Mersch (27.113.024; 27.114.133), Philip and Egret (27.113.026), Sinnerstad (27.113.038), and Massa (28.113.043) have classified stars in two or three dimensions. A number of papers have been concerned with the selection and classification of stars with different peculiarities in their spectra: Ap stars (Vogt and Faundez, 25.113.030; Renson and Manfroid, A&A Suppl 44, 23, 1981), field HB stars and hot subdwarfs (Brown and Kilkenny, 25.113.026), white dwarfs (Wegner, 26.126.011),  $\delta$  Del stars (Kurtz, 26.113.008), metal-deficient giants (Bond, ApJ Suppl 44, 517, 1980), and hydrogen-deficient and helium-weak stars (Walker and Kilkenny, 27.113.002). The system was calibrated in temperature and  $\log g$  by Philip (25.113.055), Kurucz (25.064.083; 26.064.004), Gustafsson and Bell (25.064.050), Philip and Relyea (26.064.044), and Crawford (25.113.054; 26.113.043). In all the cases for calibration theoretical model atmosphere energy distributions were used. Unfortunately, these calibrations may have systematic errors, as Kurucz model

atmosphere energy curves show good correspondence with real stars only for all B-type stars and for A-F type main sequence stars, but not for A-F-G giants and supergiants. Nissen (A&A 97, 145, 1981) has investigated the sensitivity of the parameter  $m_1$  to metallicity and microturbulence.

(ii) The Geneva system

Golay (27.113.074) has published a review of the Geneva system. Rufener (A&A Suppl, in press) has prepared a third issue of the Geneva photometric catalogue containing 15 000 stars. The system has been calibrated in  $T_e$  and  $\log g$  by Golay et al. (25.113.060), Golay and Nicolet (25.113.061), and North and Hauck (25.113.063). North and Cramer (A&A Suppl, 43, 395, 1981) have calibrated the system by theoretical age and mass for early-type stars. Grenon and Golay (25.113.062) have described the empirical calibration of G and K type stars. Cramer et al. (25.115.017; 26.115.003) have developed a method of three-dimensional classification of B-type stars. North (27.116.011) and Cramer and Maeder (28.116.001; 27.116.026) have used the 5200 Å depression in Bp and Ap stars to estimate their magnetic field strengths. Hauck and Curchod (26.002.036; 28.113.040) have investigated the photometric properties of Am stars. North and Cramer (23rd Liege Symp., 1981) have detected a number of Ap stars in open clusters. Meylan et al. (28.113.013) have determined intrinsic color indices. Fracassini et al. (27.115.010) have calculated apparent and absolute radii, visual brightness, and  $T_e$  on the basis of Geneva photometry of B5-F5 V stars. Hauck and Philip (A&A Suppl<sup>e</sup> 43, 191, 1981) have derived photometric parallaxes for nearby stars. Hauck (A&A 99, 207, 1981) has determined new photometric distance moduli of the Hyades, Coma Berenices and Praesepe clusters. Hauck (1981, in press) has investigated the photometric properties of the red horizontal branch stars.

(iii) The Vilnius and Vilgen systems

Straizys (25.113.027; 25.113.066) has published the reviews of current status of research in the system. North (28.002.002) has published a catalogue of observations in the Vilnius system of 1879 stars. A new calibration of the system in spectral type,  $M_V$ ,  $T_e$  and  $\log g$  has been published by Straizys et al. (Bull Vilnius Obs 56 and 59<sup>e</sup>, 1981). A number of areas were investigated through two-dimensional photometric classification of stars and determination of their interstellar reddening: SA 44,49,59,64, and 110 (Acta Astron 31, 93, 1981; 25.113.035), Nova V 1500 Cyg region (26.113.025), the NGP region (26.113.026), the SGP region (Bull Vilnius Obs 58, 1981), open clusters IC 4665, NGC 6633, and M39 (Bull Vilnius Obs 57, 3, 1981), Taurus dark clouds (Acta Astron 30, 541, 1980; 31, 85, 1981), North America Nebula region (Astron Zh, in press). Bartkevicius et al. (27.002.027; 27.113.031; 27.114.114; 27.126.017; A&A, in press) have discovered and investigated a number of metal-deficient giants and subdwarfs, including the giant BD -18°5550 with  $[Fe/H] = -3$ . A photometric method to determine  $T_e$ ,  $\log g$ ,  $[Fe/H]$ , and  $E_{B-V}$  for G-K metal-deficient giants has been developed. A catalogue of observations of 378 metal-deficient stars has been published (Sperauskas et al. Bull Vilnius Obs 58, 1981). Some stars probably belonging to the red horizontal branch of the galactic field have been discovered (Straizys et al. A&A 99, 152, 1981). Zdanavicius has measured and analyzed 40 globular clusters in integrated light.

Preliminary calibration of the Vilgen system in spectral types and absolute magnitudes has been made by Straizys et al. (Bull Vilnius Obs 59, 1981), North et al. (A&A in press, 1982) have shown that Am- and Ap-type stars, subdwarfs and metal-deficient giants can be separated from the normal stars in different diagrams of the Vilgen system.

(iv) DDO system

McClure (25.113.057) has made a review of the system. Janes (25.113.058) and

Osborn (25.113.059) have calibrated the system in  $T_e$ ,  $\log g$ , and  $[Fe/H]$ . The system was used to investigate G-K giants in the galactic field (Janes, 25.155.021; Yoss and Hartkopf, 26.113.015), barium stars (Ll and Upgren, 25.113.004; Ll and Sawyer, 25.113.042), RV Tau and SRd stars (Dawson, 26.122.050), giants in open clusters (Janes, 25.155.021; Hardy, 25.153.011; Claria, 26.153.024; 28.153.013; Bol. Asoc. Astr. Argentina, 25, 1980) and in globular clusters (McClure 25.154.018); Hartwick and McClure, 27.113.001). Clark and McClure (26.113.017) have supplemented the system by one more magnitude measuring the MgH + Mg<sub>b</sub> bands. Theoretical interpretation of CN indices has been given by Gustafsson and Bell (25.064.050), Bell et al. (25.154.011), Dickens et al. (26.154.005).

(v) Walraven system

Python (26.002.037) has described the catalogue in CDS on magnetic tape containing observations for 2687 stars. The system was used to investigate physical parameters of supergiants and cepheids in the Magellanic Clouds (van Genderen, 26.113.020; 26.113.40; 28.122.026; Wamsteker, A&A Suppl 43, 127, 1981; Pel et al. A&A 99, L1, 1981), RR Lyrae-type stars (van Genderen, 27.122.020), and field cepheids (Sollazo et al. A&A 99, 66, 1981).

(vi) Other systems

In the Arizona 13-color system Schuster (26.113.012; 27.113.033; 27.113.034) has published observations and determined metallicities of 118 subdwarfs.

(c) Narrow-Band Systems

The results of  $\beta$  photometry can be found together with uvby photometry. Separately, the  $\beta$  index has been measured by Lynas-Gray and Hill (26.113.034) and Kilkenny (MN 194, 927, 1981). The  $\beta$  index has been studied theoretically by Schmidt and Taylor (26.031.514) and Schmidt (26.064.043). Mermilliods (28.002.041) prepared a compilative catalogue of photometric data on Balmer lines. Strauss and Ducati (A&A Suppl 44, 337, 1981) have published a list of standard stars for H $\alpha$  photometry. Mendoza (25.113.003; 26.113.016) continued to measure intensities of H $\alpha$  and OI lines. The OI triplet has also been measured by Eriksson and Toft (25.114.007) and Hopkinson and Humrich (MN 195, 661, 1981). Maitzen (27.113.025; 27.113.039; 27.114.045; 28.113.010; 23rd Liege Symp 1981) and Joncas and Borra (28.114.117; A&A 94, 134, 1981) have studied the 5200 Å depression in Ap stars. Gerbaldi and Morguleff (23rd Liege Symp., 1981) have measured another depression in Ap stars at 4200 Å. Frogel et al. (25.154.004; 27.154.002; 27.154.045; 28.154.001; 28.154.011; 28.154.034) continued to measure infrared indices CO and H<sub>2</sub>O together with JHK magnitudes. Jones (MN 194, 403, 1981) has used a 4-color system with  $\lambda$ 6076, 6830, 7100, 7460 to classify M-type stars.

V. CALIBRATION OF SPECTRAL TYPES IN TERMS OF PHYSICAL  
PARAMETERS OF THE STARS (P. C. Keenan)

A review of the calibration work carried out through 1979 has been prepared by Straižys and Kuriliene (Astr Space Sci 1981, in press). Similar tables to appear in Landolt-Börnstein (1981) have been completed by Schmidt-Kaler. For types O through F the data of the Hauck-Mermilliod Catalogue of Homogeneous Four-Color Data were analyzed statistically by Philip and Egret (27.113.026).

(a) Effective Temperatures

Both observational and theoretical work has continued the trend toward higher effective temperatures for late-type giants. The most direct evidence comes from

the steadily increasing number of angular diameters measured at lunar occultations (Ridgway et al. 27.114.007). The infrared flux method of Blackwell and Shallis (Blackwell et al., 27.031.519) has been applied by Tsuji (A&A 99, 48, 1981) in connection with his own models. The models of Johnson, Bernat and Krupp (27.064.074) were applied by Picirillo et al. (ApJ 246, 246, 1981) to account for the difference between color temperature and computed  $T_e$  in M-giants.

Among the stars of earlier type, the B-stars have had new values of  $T_e$  and  $\log g$  determined from photometry and models by Sinnerstad (27.113.038). For Ap stars temperatures were determined by Shallis and Blackwell (26.115.005) and Floquet (A&A 101, 176, 1981).

A comprehensive review of the effective temperatures for stars from type O to type M has been given by Böhmer-Vitense (Ann Rev Astron Astrophys 19, 295, 1981).

#### (b) Luminosities

A new calibration for  $M_V$  of giants of types G, K, and M, combining mean trigonometric and statistical  $\mu$  parallaxes, was carried out by Egret et al. (A&A 1981, in press). For Ap stars values of  $M_V$  and other parameters were determined by Babu and Shylaja (Astr Space Sci 79, <sup>V</sup>243, 1981). The identification of supergiant carbon stars in the Magellanic Clouds by various observers (McCarthy and Blanco, Physical Processes in Red Giant Stars, Iben and Ronzoni, eds., 1981; Mould and Aronson, 26.154.004) shows that these stars can reach bolometric magnitudes exceeding -5.

#### (c) Abundance

Among the great number of abundance analyses there is room here to mention only those dealing with the major spectroscopic groups. The Catalogue of [Fe/H] Determinations has been brought up to date by Cayrel de Strobel et al. (28.114.010) and now contains 628 stars. Seven stars have been analyzed by Komarov and Shcherbak (27.114.173). Composition characteristics have been investigated for metal-poor stars by Peterson (27.114.011) and Foy (27.114.142), and for metal-rich stars by Bonnell and Branch (25.114.060).

### VI. CATALOGUES AND ATLASES (C. Jaschek)

The number of catalogues and atlases increases regularly. Attention is called to the Reports of the Working Group of Commission 45 for the collection of photometric and spectroscopic data, which are published regularly in the Bulletin d'Information du Centre de Données Stellaires de Strasbourg. There the latest catalogs are listed, together with their availability on magnetic tape. Another similar publication is the Astronomical Data Center Bulletin NSSDC - NASA, Greenbelt, which also lists new catalogs.

Attention is called also to IAU Colloquium 64 on "Automated data retrieval" held at Strasbourg 1981, where a number of new developments were discussed (Proceedings; Reidel, 1982). Bidelman's data file has become available on magnetic tape (See Parsons et al. 27.002.026). M. Jaschek and D. Egret have prepared a "Catalog of Stellar Groups" (see Bull Inf C.D.S. 20, 36, 1981) which lists the membership in more than fifty spectral peculiarity groups (Be, Ap, Am, etc.) of about thirty thousand stars. Data are available on request.

In what follows, we have divided the catalogs into two groups, namely (A) long observing lists and (B) lists of objects drawn from different sources. The note (T) means that the catalog is only available on tape, from one of the various data centers. Lists of type (A) were only quoted if they contain more than 1000 objects. The number of stars listed is indicated, when useful. The section on "Atlases" includes spectrophotometric atlases. Work "in preparation" has been omitted, in the interests of brevity.

## (a) Catalogues of Type A; Spectroscopic

- R. A. Bartaya: Catalogue of spectral and luminosity classes of 10 396 stars in Kapteyn Areas NN 2-43 (27.002.038).
- H. A. Abt: Visual multiples. VII. MK classification (ApJ Suppl 45, 437, 1981).  
870 \*
- D. J. MacConnell: Discoveries on southern red sensitive objective prism plates. III. New stars having H $\alpha$  in emission (A&A Suppl 44, 387, 1981). 760 \*

## (b) Catalogues of Type B; Spectroscopic (including lists of standard stars)

- A. Curchod and B. Hauck: Second Catalog of Am stars with known spectral types (26.002.036). 1 300 \*
- W. P. Bidelman: Spectral classification for the stars of the Caltech two micron survey (Publ Warner and Swasey Obs 2 No 6, 1980). 5 600 \*
- P. C. Keenan and R. E. Pitts: Revised MK types for G, K, and M stars (27.114.188).
- P. C. Keenan and P. C. Boeshaar: Spectral types of S and SC stars on the revised MK system (28.114.075).
- W. Buscombe: Fourth general catalogue of MK spectral classification (27.002.037).
- D. Egret: Une liste d'etoiles classees supergeantes (Luminosity class I and II) (27.002.024). 5 000 \*
- A. Bartkevicius: The catalogue of metal-deficient F-M stars (27.002.040).
- G. Goy: Catalogue general d'etoiles de type O (4<sup>e</sup> edition) (28.002.023). 970 \*
- K. A. Van der Hucht, P. S. Conti, I. Lundström and B. Stenholm: The sixth catalogue of galactic Wolf-Rayet stars, their past and present (Space Sc. Rev. 28, 227, 1981).
- D. Egret, M. Jaschek: A list of early-type chemically peculiar stars (XXIII Coll. Liege, 1981). 3 710 \*
- H. Schneider: A catalogue and bibliography of Mn - Hg stars (A&A Suppl 44, 137, 1981).
- P. Kennedy: (T): MK extension catalog (1981). 32 500 \*
- M. Jaschek - D. Egret: Catalog of Be stars (IAU Symp 98, 261, 1982). 1 170 \*
- W. Buscombe: MK spectral classification. Fifth Catalogue (Northwestern University, 1981).
- B. Nicolet: Geneva photometric boxes (A&A Suppl, in press).

## (c) Catalogues of Type A; Photometric

- E. H. Olsen: Catalog of uvby photometry of A5 - G0 stars (A&A Suppl 37, 367, 1979). 950 \*

- K. Johansson: Colour excess and stellar distribution in five selected directions of the Milky Way (27.113.059). 1 090 \*
- B. A. Twarog: The chemical evolution of the solar neighborhood - I (28.155.037). 1 000 \*
- A. W. J. Cousins: VRI photometry of southern stars (28.113.035). 1 425 \*
- (d) Catalogues of Type B; Photometric
- M. Python: Photoelectric catalogue (T) (concerns Walravens system) (26.002.037). 2 700 \*
- J. Koorneef, M. R. Meade, P. R. Wesselius, A. D. Code and R. van Duinen: Picture Gallery: structured presentation of OAO-2 photometric data supported by UBV, ANS and TDI observations (Wisconsin Astroph N101, 1980). 530 \*
- B. Hauck and M. Mermilliod: uvby $\beta$  photometric catalog (27.002.006). 19 900 \*
- J. C. Mermilliod: UBV data from 1976 to 1979 (T) (28.002.040). 16 200 \*
- J. C. Mermilliod and M. Mermilliod: Catalog of Balmer lines photometry (28.002.041). 16 100 \*
- P. North: Vilnius photometric catalogue (T) (28.002.002). 1 900 \*
- J. R. Ducati: A Catalogue of Observations in H $\alpha$  (A&A Suppl 45, 119, 1980). 2 300 \*
- B. Hauck and J. C. Mermilliod: Photometric data for the nearby stars (T) (Inf Bull CDS 21, 35, 1981). 1 600 \*
- F. Rufener: Third catalogue of stars measured in the Geneva photometric system (A&A Suppl, in press). 14 600 \*
- G. Meylan: DDO photoelectric - photometric catalog (A&A Suppl, in press).
- (e) Atlases (including spectrophotometry)
- A. M. Hubert-Delplace and H. Hubert: An Atlas of Be stars (25.002.028).
- A. D. Code and M. R. Meade: An Atlas of ultraviolet stellar spectra (25.002.010).
- A. Cucchiaro, M. Jaschek and C. Jaschek: Atlas and Catalog of Stars classified from the ultraviolet line features of the S 2/68 experiment. Strasbourg (1979) (CDS, microfiche). 1 900 \*
- J. P. Kaufmann and U. Theil: Spectral atlas of helium rich stars (A&A Suppl 41, 271, 1980).
- N. R. Walborn: An Atlas of yellow-red OB spectra (ApJ Suppl 44, 535, 1980).
- A. Ardeberg and B. Virdefors: A catalog of stellar spectrophotometric data (27.114.127). 360 \*
- M. R. Meade and A. D. Code: Ultraviolet photometry from the Orbiting Astronomical Observatory XXXVIII. A second Atlas of Ultraviolet stellar spectra (27.114.051).

S. Sivertsen: A catalogue of low-resolution Wolf-Rayet Spectra (A&A Suppl 43, 221, 1981).

(f) Miscellaneous

- W. Gliese and H. Jahreiss: Nearby star data published 1969-1978 (26.002.035).  
 G. Cayrel de Strobel, C. Bentolila, B. Hauck and A. Curchod: A catalogue of Fe (H) determinations (28.114.010). 628 \*
- A. G. Davis Philip and D. Egret: An analysis of the Hauck-Mermilliod catalogue of homogeneous four color data II (27.113.026). 9 600 \*
- E. H. Olsen: Estimation of spectral classifications for bright northern stars with interesting Strömgren indices (27.114.032). 1 100 \*
- N. Cramer and A. Maeder: Catalogue of photometric data related to surface magnetic fields for B type stars (27.116.026).
- M. Fracassini, L. E. Pasinetti and F. Manzolini: Catalogue of apparent diameters and absolute radii of stars (A&A Suppl 45, 145, 1981). 4 200 \*
- A. Uesugi and I. Fukuda: Revised catalogue of stellar rotational velocities (T) (Proc Seventh Codata Conference, 1981). 6 500 \*
- G. Cayrel de Strobel, C. Bentolila, B. Hauck and D. Lovy: A catalogue of [Fe/H] determinations (A&A Suppl 45, 97, 1981). (T)
- D. Hoffleit with the collaboration of C. Jaschek: Fourth edition of the Bright Star Catalogue (Yale Univ Obs, 1982).

VII. CONCLUSION

It remains only to thank the authors of the above report sections for their careful and conscientious work.

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