45. STELLAR CLASSIFICATION (CLASSIFICATION STELLAIRE)

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1. INTRODUCTION

This report covers research in the field of stellar classification in the period July 1993 to June 1996. It is divided into several sections which were written by experts in each subfield. I want to thank them for their effort and cooperation. To conserve space, all references are given with only one name followed by a + sign if there are additional authors.

1.1. MEETINGS

During the period covered by this report there was one meeting devoted completely to the subject of our Commission: The MK Process at 50 Years: A Powerful Tool for Astrophysical Insight". The meeting was sponsored by the Vatican Observatory under the chairmanship of Chris Corbally and was held in Tucson, (USA) in Sept 1993. The Proceedings of the meeting were published in the ASP Conference Series, vol.60 and the editors are C. Corbally, R.O.Gray and R.F. Garrison. Comm 45 has sponsored or so-sponsored the following IAU Symposia or Colloquia during the period:
Symp 162: "Pulsation, rotation, & Mass Loss in Early-Type stars" Juan-les-Pins Oct. 1993.
Coll 148: " Future Utilization of Schmidt Telescopes", Bandung, Mar 1994.
Symp 166: "Astronomical & Astrophysical Objectives of Sub-milliarsecond Optical Astrometry", The Hague, Aug 1994.
Symp 167:"New Developments in Array Technology & Applications", The Hague Aug. 1994.
Symp 177: "The Carbon Star Phenomenon, Antalya, May 1996.

2. CLASSIFICATION USING SLIT SPECTRA (R.O. Gray)

2.1. EARLY-TYPE STARS

2.1.1. *Wolf-Rayet and LBV Stars*
Wolf-Rayet (WR) stars both in the Milky Way and in other galaxies (see section2.9) continued to be subjects of intense study during this triennium. Hamann+ (AA 113, 459) presented a visual-region spectral atlas of nearly all single Galactic WR stars of the WN sequence. Hamann+ (58.114.003) analyzed these stars using NLTE models, and suggested that the WNE-w subclass continues the WNL subclass towards lower luminosities, whereas the WNE-s stars form a separate group with higher temperatures. Crowther+ (63.114.018, 63.114.019, AA 304,269, AA 305,541) in a series of papers analyzed a number of WR stars and showed, for instance, that the WNL stars fall into two groups, the WNL+abs and WN7 stars form a continuous sequence in spectral morphology from the Of stars, whereas the WN8 stars have some properties in common with LBVs, and they investigated the spectral morphol ogy of WR stars in the infrared. In addition, they discussed the spectral type of the WN/C star WR8. Nota (ApJS 102,383) found that the Ofpe/WN9 stars form a homogeneous group, between Of stars and B[e] stars. Smith (IAU 163,48) commented on the unsatisfactory state of the classification system for WN stars, and proposed a 3-dimensional system of classification. Kingsburgh+ (63.114.026) studied 5 WO WR stars using quantitative spectral-typing criteria. A number of new WR stars in the galaxy have been discovered using various techniques: Davidson+ (58.115.016) classified the spectrum of He 3-519 as Of/WN9. Cotera+ (ApJ 461,750) used K'-band spectra to show that a cluster, associated with galactic center thermal radio filaments, likely contains up to 13 late WN stars. Blum+ (63.155.095) reported on the discovery of a possible WR at the galactic center, showing similarities to WC9 stars, and Blum+ (63.114.025) used near-IR spectra of galactic center compact He I emission sources and early-type stars to

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5.3. ATLASES

Ayres+ (58.114.081) assembled an extensive, electronically accessible catalogue of low-dispersion far-ultraviolet spectra of chromospheric emission-line stars, observed with IUE. Bohlin+ (61.002.048) published a high-dispersion microfiche spectral atlas of OB stars obtained during the first 10 years of operation of the IUE satellite. Talavera+ (62.121.136) presented a preliminary catalog of observations of Herbig Ae/Be stars obtained with the IUE in the wavelength range from 1200-3300 =C5.

Walborn+ (63.002.099) published the "International Ultraviolet Explorer Atlas of B-Type Spectra from 1200 to 1900 =C5," completing the OB natural group to spectral type B3 on the main sequence and B8 at luminosity class Ia, in order to chart the gradual disappearance of the stellar-wind features in normal spectra as a function of spectral type and luminosity class.

Walborn+ (PASP 108, 477) presented an atlas of 27 OB spectra from Copernicus low-resolution (0.2 =C5) data; they demonstrated the pronounced luminosity effect in the S IV ll 1063, 1073 wind profiles, and described stellar wind effects in O VI, P V, Si IV, and C III.

5.4. INFRARED CLASSIFICATION

Volk (58.114.134) discussed the classification of mid-infrared spectra obtained by IRAS, with the goal of identifying rare types of spectra. He contrasted the original Low Resolution Spectrometer (LRS) Atlas classification, the AUTOCLASS automatic classification, and an empirical classification done by eye. Kwok (58.114.135) proposed a classification scheme for asymptotic branch stars that combines the photospheric spectral type (from ground-based data) with the circumstellar type (from IRAS data). Walker (62.114.057) used artificial intelligence techniques to derive a new classification system for sources in the IRAS LRS Atlas.

Using IRAS data, Parthasarathy (58.115.024) concluded that LS II +34=8326 is a low-mass, post-asymptotic branch B supergiant, and not a massive Population I B star located near the outer edge of the Galaxy. He also (62.115.044) detected a new class of stars from IRAS Point Source Catalogue (PSC) data. These objects, believed to have evolved from low-mass stars, have circumstellar dust shells similar to planetary nebulae, but their optical spectra resemble those of normal A-K supergiants.

6. Catalogues and Atlases (N.Roman)

N. Houk reports that Vol. 5 of her reclassification of HD stars will be out early in 1997. She hopes that the remaining volumes can be prepared more quickly.

V. V. Nesterov et al. have prepared a machine-readable version of vol. 112 of the Harvard Annals - the portion of the HDE for which only charts had been available. This version includes modern positions and proper motions and references to the General Catalog of Variable Stars and of Suspected Variables when appropriate. (in the Astronomical Data Centers as 3182).

R. F. Garrison has refined the MK spectral classification system for late B stars. He has established a self-consistent sequence of narrow and broadline standards. He has also reclassified a number of Bp stars. (AJ, 107, 1556, 1994)

Other papers and catalogs submitted to the Astronomical Data Centers which may be of interest to spectral classifiers include: ApJS,99, 135,1995, in which Abt shows that all highly rotating stars are normal while all very slow rotators are chemically peculiar. ApJS, 86, 453,1993 which classifies stars in a region in CVn (MacConnell+). 3183 Andrillat+ atlas of the 837.5-877 nm spectral region. 3181 Torres-Dodgen's atlas of infrared spectral of normal stars.

tra. Mean errors were less than one-half spectral subtype or one luminosity class. They also (61.114.101) discussed the role of Be stars in their ultraviolet spectral classification system. Penny+ (ApJ 460, 906) presented equivalent width measurements of ultraviolet photospheric lines that are useful as spectral type criteria; they showed that ultraviolet spectral typing leads to types that are consistent with optical types.

Slettebak (61.114.102, 62.112.172) used equivalent widths of 16 lines in IUE spectra, plus centroid and edge velocities of Si IV and C IV lines, to study the differences in the strengths and composition of the stellar winds in Be versus the B standard stars.

Niedzielski+ (62.114.119) measured equivalent widths, FWHM and line fluxes for 94 single Wolf-Rayet stars based on low-resolution IUE spectra, which were used for spectral classification in the ultraviolet region and for investigating correlations among the emission lines of different ions. Kingsburgh, Barlow+ (63.114.026) used optical and IUE ultraviolet spectrophotometry of Wolf-Rayet stars to define quantitative spectral typing criteria for WO subtypes from WO1 to WO5.

Hasen+ (61.114.127) discussed morphological aspects of HST spectra of massive hot stars in the Magellanic Clouds and M31. McNeil+ (63.114.010) examined the ultraviolet spectral morphology of a sample of B supergiants in the Small Magellanic Cloud (SMC). Their analysis included a tabulation of ultraviolet spectral features, evaluation of their variation with spectral type and luminosity class, and comparison with IUE sequences of standard stars.

Vieria+ (63.036.330) compared two methods for the automated classification of low-dispersion IUE spectra of normal O3-G5 stars. They concluded that a classification method based on artificial neural networks permits the determination of spectral classes with an accuracy of 1.1 spectral sub classes. Gulati et al. (Bull. Astr. Soc. India 24, 21) devised schemes based on artificial neural networks for classifying IUE low-dispersion ultraviolet spectra. They compared results from a single-level network and from a multi-level tree network, and found both to be satisfactory.

5.2. INDIVIDUAL OBJECTS

Tovmasyan+ (58.152.010) continued observations at 1640 =C5 with the Glazar space telescope, on board the Mir space station. They identified three groups of early-type stars in the vicinity of Canis Major. They also (AJ 111, 299) observed 217 young OB and early A stars in the direction of the stellar association Cru OB1. From 1640 =C5 - V colors, they derived "latest possible spectral types" for nine of the stars, which had no published types.

Bagnuolo+ (61.120.016) analyzed the UV photospheric lines of 29 CMa and used a tomography algorithm to produce separate spectra of the two component stars, which they classified as O7.5-8 Iab and O9.7 Ib, respectively. Penny+ (61.120.027, 61.120.031) reported similar tomographic studies for seven O-type binary stars, while Bagnuolo et al. (61.117.373) used the tomographic technique on i Ori as well as 29 CMa. Thaller+ (ApJ 448, 878) used this method with high-dispersion IUE spectra to separate the spectra of the Be binary f Per into a B0.5 III-Ve primary and a hot O-type subdwarf secondary.

Blondel+ (62.112.197) decomposed the low-resolution IUE spectra of several Ae stars from the Herbig-Bell catalogue into contributions from an F-type emission-line star, a small source of type B9, and a cool disk. Wesemael+ (62.126.008) combined low-dispersion IUE spectra with optical spectra to classify two DAB stars as unresolved, composite systems.

Heap+ (62.114.121) used the COSTAR-corrected GHRS on HST to study two stars in the dense center of the 30 Doradus ionizing cluster. They classified R136a5 as O3f/WN and R136a2 as WN4-w. Bianchi+ (62.157.256) classified the supergiant star in NGC 206-277 in M31 as B1.5 Ia on the basis of a UV spectrum from FOS on HST, combined with an optical blue spectrum. Drissen+ (AJ 110, 2235) presented spectrograms of 14 individual luminous stars in HD 97950, the core of the dense galactic starburst NGC 3603, obtained with the HST/FOS. They classified three of the spectra as WN6+abs; the others were O3-O8 stars. Walborn+ (PASP 107, 104) obtained HST/FOS and ground-based spectra of 18 OB stars in the LMC and SMC, and compared wind characteristics with spectral types.

Walborn+ (ApJ 454, L27) performed a survey of the far-UV (900-1200 =C5=) spectra of O stars in the Magellanic Clouds, observed with the Hopkins Ultraviolet Telescope (HUT) during the Astro-2 mission. The survey included four O3 stars (one of which is the current candidate for the most massive star known), a pair of O4 If supergiants with remarkably different CNO strengths, and SMC objects with systemic metal deficiency.

and luminosity classes Ia - V, reporting accuracies comparable to human classifiers working with 2 Å resolution photographic spectra.

Gulati+ (ApJ 426, 340; ADASS IV, 253) report application of chi-square and ANN methods to 158 digital spectra of 5 Å resolution. Both methods gave similar results, with better than 0.99 correlation between each method and optical classifications.

Vieira+ (A&AS 111 393) apply both unweighted metric-distance methods and ANN to an atlas of 163 low-dispersion IUE spectra of normal stars. They find that both methods give good and strikingly similar results, but the ANN gave somewhat better (mean error 1.1 subtypes) results than the simple unweighted metric distance algorithm (!.4 subtypes).

Von Hippel+ of Cambridge (MNRAS 269, 97) report their application of ANNs to 500 digitized spectra from Michigan Survey plates. Bailer-Jones is continuing this work with an expanded dataset of 5200 spectra and reports (Personal communication) mean (1 sigma) errors of 0.86 subtypes when applying a two-layer ANN to data "compressed" through principal components analysis (PCA). This represents a considerable improvement over the results of the Cambridge group's earlier one-layer programs. In addition Bailer-Jones reports some progress in luminosity classification, with about 90classifying spectra classified by Houk as luminosity class III or V; he is much less successful in classifying luminosity class IV spectra, to the extent that he suggests that IV may not be spectroscopically distinct from classes III and V at this resolution. Luminosity classes I and II were too poorly represented in his sample data for any classification to be attempted. A paper is in preparation;; an abstract appears in BAAS 188, 87.04.

Paisan+ (Athens meeting on Large Scale Spectroscopy) continue their work investigating the properties of the LMC using low and moderate resolution objective prism spectra. They are supplementing their criterion evaluation methods with ANN techniques.

Grosbol (Athens meeting) has analyzed 60,000 early type objective prism spectra in the southern galactic cap using synthesized colors and hydrogen line photometry.

LaSala & Kurtz continue application of weighted metric-distance techniques to MK resolution slit spectra obtained by Garrison and are exploring a collaboration with Bailer-Jones and the Cambridge group. LaSala presented a review of techniques at Future Possibilities for Astrometry from Space.

Two masters' theses were produced in the field. Christlieb (Hamburd) examined low=resolution Schmidt spectra, and Zhu (Toronto) gave a thorough review of the entire field of automated MK classification.

At this point it seems that several methods (ANNs, weighted metric distance, chi-square) are capable of deriving temperature classes with internal and external consistency at least as good as human classifiers working with data of similar resolution. The work of Weaver & Torres-Dodgen and of Vieira & Ponz suggests that this is true even for spectra obtained over completely different wavelength regions from the MK standard, a not entirely expected result. No one has yet demonstrated a reliable automatic luminosity classification. The work of Bailer-Jones and of Weaver & Torres-Dodgen seems currently most promising in this regard. This is clearly the area for further effort.

5. Classification of Extra-Atmospheric Spectra (J. Rountree)

The bulk of extra-atmospheric spectral classification continues to be based on data from the International Ultraviolet Explorer (IUE), but the Goddard High Resolution Spectrograph (GHRS) and the Faint Object Spectrograph (FOS) on the Hubble Space telescope (HST) are beginning to be used. Infrared classification is still confined to data from the Infrared Astronomy Satellite (IRAS).

The publication of "The MK Process at 50 Years: A Powerful Tool for Astrophysical Insight" (62.012.096) a workshop of the Vatican Observatory held in September 1993, included many papers of interest to specialists in extra-atmospheric spectral classification. Walborn (62.114.177) reviewed current and near-future ground- and space-based progress for the classification of O3 stars. Corbally (62.114.182) discussed the extension of the MK process to wavelength regions other than from the Ca K line to $H\beta$. Rountree+ (62.002.172) reviewed their atlas of B-type spectra from the IUE, based on the ultraviolet classification system. Walborn+ (62.002.173) reported progress on their atlas of ultraviolet B-type spectra.

5.1. METHODOLOGY

Rountree+ (BAAS 26, 1447) compared the ultraviolet and optical classification of B stars, and concluded that there were no systematic differences, either in temperature type or luminosity class, for B0-B5 spec-

hemisphere. See MK50 for more details.

3. Objective-Prism and Slitless Classification (Jack MacConnell)

3.1. IN THE GALAXY

3.1.1. *General and galactic-latitude independent*
During the triennium, two meetings, "The MK Process at 50 Years: a powerful tool for astrophysical insight" (62.012.096) and "The Future Utilisation of Schmidt Telescopes" (ASP Conf. Ser. 84; IAU Coll. 148), were held in which a number of review and research papers on stellar classification and surveys for particular groups of stars were presented.

The major work in MK classification from objective-prism plates continues to be that of Houk at The Univ. of Michigan. She is preparing remarks on her classification of the HD stars that will form Volume 5 of the Michigan Spectral Catalogue which will include stars in the declination range -12 to +5 deg. The hard-copy version should be distributed in mid-1997 with an electronic version available some months earlier; between 33000 and 34000 stars are included. Classification has started for Volume 6 which will reach to about +32 deg and be based on plates taken with both the Burrell (north) and Curtis (south) Schmidt telescopes.

There are many on-going surveys, with both plates and large-format CCDs, behind objective-prisms to search for QSOs and uv-excess galaxies on which interesting groups of stars are found. Examples are the Kiso UV-Excess Survey, the Hamburg/CfA and Hamburg/ESO QSO surveys, the KPNO International Spectroscopic Survey for emission-line galaxies, the Calan-Tololo Survey, and the Case Low-Dispersion Northern Sky Survey. There have been many follow-up studies of stars found in this material, e.g. a new PG1159 star with H (Dreizler+, A&A 309, 820).

3.1.2. *In the Galactic plane*
Drilling+ (PASP 107, 846) have extended the Case-Hamburg OB star survey to b +/- 30 along the southern galactic plane and found 234 early stars and others with peculiar spectra.

Beers+ (AJ 108, 268) presented 158 emission-line objects found in the northern HK interference filter/objective-prism survey of which 31 have previous identifications; most are late dwarfs or cool, giant variables. Petterson+ (A&AS 104, 233, 1994) have searched for emission objects towards the HII regions RCW 27, 32, and 33 and the NW parts of the Vela Molecular Ridge finding two new large associations of T Tau stars. Kun+ (62.131.171) detected 13 H-alpha emission stars within the area of the dark cloud Lynds 1340. Briceno+ (58.121.011) used the Venezuelan 1-m Schmidt to find a dozen new T Tau stars in the Tau-Aur star-forming region.

3.1.3. *Out of the plane*
Rodgers+ (58.155.007) presented several hundred early-type stars found on UKST plates in two orthogonal halo fields. These were classified at 600 A/mm at H-gamma on the basis of the H and K and Balmer lines. Pesch+ (63.002.062) presented faint, blue stars from plates taken with the Burrell Schmidt.

3.2. WORK IN THE MAGELLANIC CLOUDS

Kontizas+ (62.156.012) have classified luminous stars in 15 LMC associations from UKST plates that give evidence for continuous star formation. Kontizas+ (A&A 307, 359 and 308, 40) have classified OB stars in a number of LMC stellar aggregates, and Morgan (MNRAS 279, 301) has found a new symbiotic star in the LMC of type M4 making it of the latest type and the first M-type donor identified there. Morgan+ (A&AS 113, 539) have identified 1185 new C stars in the outer parts of the SMC from UKST plates.

4. Automatic Spectral Classification (J. LaSala & M.J.Kurtz)

No conferences or workshops focusing on Automated Spectral Classification were held between GA XXII and GA XXIII. Several important parers have been published in the interval, howver, and the principal groups active in this area report the status of their work.

Weaver+ (ApJ 446, 300; BAAS 187, 19.01) extend their application of artificial neural networks (ANNs) to moderate (15 A) resolution near-IR spectra to the full range of temperature classes O - M

(62.117.292) and Barba+ (63.117.269) commented on the remarkable long-term changes in the spectrum of the SMC WR system HD 5980. Meyssonnier (63.156.024), in a survey of peculiar emission-line objects in the SMC discovered one possible Be supergiant. Szeifert+ (58.122.057) have found that R40 in the SMC has changed its spectral type from B8 Ia to A3 Ia-0 during the past decade. This suggests R40 is the first LBV known in the SMC. Hambly+ (61.114.033) obtained spectra of two B-type stars between the Magellanic clouds. Bianchi+ (62.157.256) used both UV and optical spectroscopy of a B supergiant star in M31 to classify this star as B1.5 Ia. Herrero+ (62.157.039) observed a number of the most luminous A & B supergiants in M31 and M33, and have determined their spectral types. Two of the stars are hypergiants. Ocy+ (61.132.025) have studied two giant Hα bubbles in M33, and the single dominant O9 star centrally located in each. Smith+ (AA 302,830) classified the very late WN star MCA1-B in M33 as WN9. McCarthy+ (ApJ 455,L135) analyzed spectra of two A-type supergiants in M33; one is clearly metal-poor whereas the other has P Cygni-like profiles. McCausland+ (58.157.266), in a search for young stars in the halo of M31, have identified one object gravitationally bound to M31 that appears to be a G0 star. Giovagnoli+ (61.122.043) presented spectrophotometry of 36 LPV in M33. Most are M supergiants, two are carbon stars; no strong S stars are seen. Brewer (PASP 108,379) discussed a photometric and spectroscopic survey of AGB stars in M31. A spectrum of the first confirmed S-star in M31 was presented. Drissen+ (62.132.013) deduced from broad stellar emission lines in the optical spectrum of a small cluster in the post-starburst galaxy NGC 1569 the presence of a late-type WN star.

2.10. GENERAL

A number of spectral atlases were published this triennium. In addition to those already mentioned, the following are of note: Dallier+ (AASS 116,239) have published a library of H-band stellar spectra, Andrillat+ (AASS 112,475) published an atlas of the infrared spectral region (8375-8770) for O - G0 stars of all luminosity classes and Torres-Dodgen+ (58.114.025) have published an atlas of low-resolution, near-IR spectra of normal stars, and showed that the stars follow well-defined morphological sequences in both temperature and luminosity. Allen+ (63.114.078) presented a grid of stellar classification spectra of moderate resolution in the 5600 - 9000 region, Danks+ (61.114.037) published an atlas of 126 MK southern standard stars in the 5800 - 10200 region, and Corral+ (MK50) presented low resolution spectroscopy of standard stars in the region 4000 - 9000 . Other papers of general interest include Taylor (ApJS 102,105) on the SMR stars, Bo r (AA 305,835) on spectral types of objects detected in the ROSAT HRI X-ray error box and Kilkenny (ApSS 230,53) on various types of hydrogen-deficient stars. Also of interest are the following papers: Keenan (MK50) on problems and developments of current spectral classification, with special reference to Barium, S and Carbon stars, Gray+ (61.114.002) on a Teff calibration of MK spectral types through the classification of synthetic spectra, Garrison (62.113.029) and Olsen (MK50) on the complementarity between photometry and MK spectral classification, Gray (MK50) on the role of precision spectral classification and the definition of localized third dimensions to the existing MK spectral classification system, Corbally (MK50) on the extension of the MK system to third dimensions and to other wavelength regions, and Meyers-Rice+ (MK50) on a method they have developed to estimate MK spectral types from 10 resolution spectra in the optical region. Walborn continues to work on the spectral classification of OB stars in this galaxy and beyond; much of his previous work is discussed in sections 2.1.2 and 2.9 above, and most of his ongoing work deals with optical classification of compact multiple systems using HST (see below - section 5). He is currently completing a major classification study of 100 stars in the 30 Doradus nebula; further high-quality classifications in 30 Dor will become available from a current program led by A. Moffat. In addition, he is investigating 4 LMC B supergiants with CNO peculiarities. Corbally and Gray have just completed spectral classification and analysis of about 60 Field A-type HB stars (AJ in press), and are embarking on classification and analysis of a number of A-type HB stars in M3, M13 and 92. Abt and Corbally have classified the primaries of 268 possible Trapezium systems. Garrison, as a followup to his 1994 list of Anchor points for the MK System is compiling a list of the most reliable and convenient standards, to be used as Primary Standards of the MK System. Garrison and Corbally are extending their 1993 study of the Halo metallicity gradient with photometric observations and MK classifications of selected candidate G-dwarfs. Gray has embarked on a study of the physical basis of luminosity classification in the late A, F and G-type stars. Paunzen & Gray are currently involved in an extensive search for λ Boot is stars both in the field and in open clusters, and have significantly increased the number of known members of this class. Lloyd Evans has completed observations on his long-running survey of the spectra of about 50 R and 200 N stars in the southern

the spectroscopy of suspected variable stars, Castelaz+ (63.122.087) were able to classify Miras S Leo and U Cnc at minimum light, Koen+ (MNRAS 277,217) discovered 9 new d Scuti stars, one of which appears spectroscopically to be a l Bootis star, and Bernstein+ (63.122.092) reported on the discovery of a pulsating field star of spectral type late A or early F which may be a new SX Phe variable.

2.8. CLUSTERS AND ASSOCIATIONS

Garmany (61.152.004) published a useful review paper on OB associations in which the spectral types of some of the more luminous stars in OB associations are discussed. Spectral types in OB associations and other star-forming regions were published in the following papers: Garcia (58.152.006), 105 stars in the field of Carina OB2; Hodapp+ (58.131.299) K-band spectral types in L1641 North cluster; Hughes (62.131.015) Ha emission stars in the Lupus dark cloud complex, and Levato+ (MK50) MK spectral types for 350 stars in the Orion OB1 association, including lists of Am and Ap stars. Many papers include spectral types of stars in open clusters, including the following dedicated to lower main sequence stars: Prosser (61.153.014) in the a Persei cluster; Stauffer+ (62.153.003) in the Hyades and the Pleiades; Williams+ (62.153.016) late K and M dwarf candidate members of Praesepe; Hambly+ (63.153.017) very low mass members of Praesepe, all of which turn out to be M dwarfs; Steele+ (63.153.013) a sample of low mass stars in the Pleiades, and Steele+ (MNRAS 275,841) used low-resolution IR spectra in the study of low mass stars in the Pleiades. Their identification of the two faintest proper motion members as Brown Dwarfs is strengthened. Zapatero Osorio+ (AA 305,519) studied 7 very low mass stars in a Per, and Bryja+ (61.153.001) classified 7 of the lowest mass stars in the Hyades. Other papers dealing with open cluster stars include: Nesci+ (AA 300,126) 10 brightest stars in the young cluster NGC 366; Beauchamp+ (62.153.021) B supergiants in the heavily reddened cluster NGC 7419; Harris+ (58.153.020) 80 stars in the field of NGC 2287; Hillenbrand+ (58.153.040) early-type stars in NGC 6611; Turner+ (61.153.016) spectral types for a number of stars in the cluster associated with the Cepheid V1726 Cygni; Munari+ (MNRAS 277,1269) grism spectral types for 5 early-type stars in Bochum 2, a cluster in the galactic anticenter direction. In two interesting papers, Liebert+ (61.153.013) presented optical spectra of seven faint blue subdwarfs along with one possible post-HB or AGB manqu star in the open cluster NGC 6791 and Peterson+ (BAAS 27,1438) presented a spectrum of the metal-rich early F-type HB star in NGC 6791. Reimers+ (61.153.036) classified 7 WD candidates in the open cluster NGC 6633; most turn out to be sdO and sdB. Moehler+ (63.154.034) presented spectra of a number of stars along the BHB of M15; they found that the "blue vertical tail" of the BHB of M15 consists of stars similar to the HB B-type stars in the field rather than sdB stars. Wenderoth+ (62.114.017) presented spectra of an extremely blue star in globular cluster NGC 2298. The spectrum appears to be similar to the He-sdO stars found in the galactic halo. Gray+ (BAAS 26,1489) classified a number of A-type HB stars in M3 and M13.

2.9. STARS IN GALAXIES

Walborn+ (63.114.039) published an atlas of HST and CASPEC spectra of 18 stars ranging from O3 to B0.5 Ia, equally divided between the LMC and the SMC. Intercomparisons between stars of the two galaxies were made. Walborn+ (58.114.063) have classified two companions of SN 1987A in the LMC; both are B2 although luminosity classifications are not possible. Testor+ (58.152.008) presented spectral types for stars in two clusters in OB association LH 90 in the LMC; the clusters contain WR stars, O stars and an M3 supergiant, and Testor(IAU Sym 163,81) observed 6 WR stars in LMC associations LH 101 and LH 104. Crowther+ (63.114.018) investigated 4 LMC Ofpe/WN9 stars. They revised the types of these stars to either WN9 or WN10. Laval+ (62.112.041) presented optical and UV spectral types for the exciting star of N120 A in the LMC. Heydari-Malayeri+ (58.153.022) have found that HDE 269828 in the LMC is actually a massive star cluster. They found and classified 8 new O stars. Gummersbach+ (AA 302,409) presented UV and optical spectra of a number of newly discovered B[e] stars in the LMC. Della Valle (62. 066.016) found, from observations of a MACHO lensing-event star that it is a late-F/early G giant in the LMC. Morgan (MNRAS 279,301) classified N19 in the LMC as an M-type symbiotic star. Cowley+ (62.134.028) showed that the central star of the LMC planetary N66 is beginning to show more pronounced WR characteristics. Pe a+ (61.134.076) presented optical and UV spectra of the central star of PNLM1-64 in the LMC and Pe a+ (63.134.023) reported on recent spectacular changes in the WR spectrum of the central star of PN LMC-N66. Koenigsberger+

system is composed of two M3e dwarfs. Cutispoto+ (AA 306,278) discussed spectroscopy of Einstein X-ray sources; they turn out to be binaries with F - K dwarf components. Scarfe+ (61.118.007) revised the spectral type of the evolved star in the triple system HR 6469. Welty+ (63.120.016) monitored the optical spectrum of 17 Lep from 1991 - 94. They determined the secondary's spectral type to be gM4. Gizis+ (AJ 111,365) reclassified both components of GJ 1230, Yoon (61.119.015) derived "quantitative" spectral types for 19 Algol secondaries, Casares+ (58.117.297) classified the secondary of V404 Cyg, a black hole candidate, and Welsh+ (MNRAS 275,649) estimated the spectral type of the mass-donor star in AE Aqr. Dougherty+ (MNRAS 280,963) presented a blue spectrum of WR 146, which shows absorption lines attributable to an OB-type companion to the WC6 star. Hambly+ (62.118.033) presented spectra of the possible faint companion to PG 0832+676, a high-latitude B star. The star is early G, probably a dwarf, and appears to be metal-weak. Griffin+ (58.119.001) isolated and classified the individual spectra of 22 Vul and Griffin+ (62.120.004) classified the components of the composite spectrum binary 9 Cyg. Simon+ (61.120.002) wrote on the disentangling of composite spectra of well-detached binaries. Chen+ (MNRAS 275,100) presented spectra of EC11575-1845, a non-eclipsing binary consisting of an sdO primary and late M secondary. Welty+ (AJ 110,776) classified the components of V773 Tau as dwarf K PMS stars. Dobrzycka+ (AJ 111,2090) analyzed optical and UV spectra of the recurrent nova RS OPH. The cool component is M0-M2, the hot component is probably a B-type star. A number of papers dealt with stars with one or more degenerate components: Vennes+ (62.117.029) Feige 24; Thorstensen+ (62.117.030) EUVE 2013+400; Schmidt (AJ 110,398) GD 245; Jomaron+ (58.120.012) RE1016-05; Napiwotzki+ (58.126.014) WD HZ 43A; Kellet+ (63.116.004) RE 0044+09; Liebert+ (ApJ 441,424) BE UMa, Hutchings+ (PASP 107,931) new DA WD & dM binary, and Catal n+ (MNRAS 275,153) RE J1629+780.

2.7. VARIABLE STARS

Symbiotic stars and cataclysmic variables (CV) dominated the literature dealing with spectral types of variable stars this triennium. Van Winckel+ (58.002.051) published an atlas of high resolution line profiles of symbiotic stars, and set up a classification system of Hα line profiles in which the starlike (S) and dusty (D) symbiotics are each classified into three spectroscopic subtypes. Medina Tanco+ (63.117.280) classified a sample of 45 symbiotic stars in the direction of the galactic bulge. Other papers dealing with symbiotic or symbiotic-like stars include: Schmid+ (61.117.108) barium-rich symbiotics; Van Winckel+ (61.117.073) V417 Cen; Cieslinski+ (62.117.044) and Huang+ (62.117.063) classification in near-IR; Kaler+ (57.134.051) central star of PN with symbiotic-like spectrum; eier+ (AJ 110,476) MWC 560 and Guti rrez-Moreno+ (63.117.260) Bl 3-14. Smith+ (Cataclysmic Variables, Kluwer 1994, p 115) discussed a low-dispersion spectroscopic survey of 22 CVs, which are classified using spectra into U Gem, Z Cam, SUUMa, pre-cataclysmic, AM Her, intermediate polar (DQ Her), nova-like systems and unknown types. Dhillon+ (MNRAS 275,89) presented the results of an IR spectros copic survey of CVs; they used neutral metallic lines from the secondary star to determine their spectral types. Warner (ApSS 232,89) discussed the spectral types of secondaries of CVs, and how they can be obtained. Other papers dealing with CVs include: Silber (61.117.121) eclipsing nova-like CV, with estimate of spectral type of secondary; Garnavich+ (62.117.249) new magnetic eclipsing CV; Shafter+ (63.117.209) eclipsing magnetic CV; Drissen (61.117.093) faint CVs; Downes + (AJ 110,1824) spectra of objects in CV catalog without published spectra; Hakala+ (58.117.032) new AM Her system discovered by ROSAT; Buckley+ (58.117.299) new CV detected by HEAO-1; Osborne (62.117.081) new AM Her system and Ferrario+ (63.117.162) AM Her system. Clayton (PASP 108,225) gave a valuable review of R CrB stars, including information on their spectral types and the variablility of their spectra. Leuengagen+ (61.122.023) discussed the spectrum of the hot R CrB star V348 Sgr, and Benson+ (62.122.004) showed that Z UMi shows spectral similarities to an R CrB star. St we+ (62.121.118) classified the veiled T Tauri star CY Tau and Hamilton+ (BAAS 28,883) determined spectral types and luminosity classes of T Tauri stars in the Orion Nebula Cluster. Semi-regular variables were studied by Kerschbaum (58.122.064) who used optical and IRAS low-resolution spectra to separate SRa and SRb stars into groups of defined chemistry - in particular C- and O-rich stars, and Koen+ (63.122.107) classified the red-variable star V 973 Oph. Benetti+ (63.155.130) presented a low-resolution spectrum of a 20th magnitude star in the direction of the galactic bulge that underwent a microlensing event. This star appears to be a K0 IV star. Bragaglia+ (63.117.256) studied LQ Sgr and Wakuda's peculiar variable in Sgr, which they classified as F5 Iab-Ia with Hα, Hβ and the Calcium IR triplet in emission. Downes+ (PASP 108,134) reported on

post-AGB star and Smith+ (61.112.069) concluded V1853 Cyg, a high-latitude B-supergiant, is a hot post-AGB star. Kilkenny+ (61.002.209) reviewed the Edinburgh-Cape blue object survey, which combines UBV photometry and low-dispersion slit spectroscopy; objects discovered include hot subdwarfs, WDs, etc. Theissen+ (57.126.081) classified 18 hot subdwarf stars. Drilling+ (61.114.115) discussed follow-up spectroscopy of very hot sdO stars discovered in the Case-Hamburg-LSU and Beers+ objective-prism surveys. Dreizler+ (61.114.118) reported on follow-up spectroscopy of stellar candidates in the Hamburg Schmidt survey; in addition to the usual mix of sdO, sdB and WD stars, the authors discovered two new PG1159 stars. Hu+ (57.112.099) classified IRAS 17150-3224, type G2 I, as a PPN, Hu+ (58.133.003) presented optical spectral types of 42 IRAS selected PPN candidates, Hrivnak (63.112.004) presented the spectra of 6 PPN, all of which show G supergiant spectra. but also features due to molecular carbon and s-process elements. Tamura+ (58.134.073) examined the Hα profiles of F supergiants with the aim of identifying PPN candidates and Hrivnak+ (61.134.012) presented low resolution IR spectra of 16 PPN. Parthasarathy+ (AA 300,L25) found that the central star of the very young PN SAO 244567 was B1 I in 1971; since then it has turned into a PN. Kaler+ (58.134.027) found the nucleus of PN NGC 2371 to be an O VI star, on the system of Smith and Aller. Napiwotzki+ (62.134.050) analyzed the spectrum of BD+33o2642, the coolest central star known. Tylenda+ (58.134.040) presented classifications for 77 emission-line central stars. Napiwotzki+ (AA 301,545) & Napiwotzki (58.134.053) classified 38 central stars of old PN. They examined more closely the classification of helium and carbon-rich central stars. Other papers dealing with PNN include: Acker+ (AA 305,944), central star of M1-25 = [WC 6]; Harrington+ (58.134.043) PNN of IRAS 18333-2357 in M22 resembles an sdO star; Leuenhagen+ (61.114.026) V348 Sgr = [WC 12]; Tweedy+ (62.134.016) the displaced central star of Sh 2-174; Heber+ (58.134.052) K648, PNN in M15; Kondrat'eva (62.134.009) classified 8 central stars of low-excitation PN and Kondrat'eva (58.134.074) studied the rapid evolutionary changes of Th 4-4. Kelly+ (63.114.077) presented near IR spectra of a sample of evolved stars ranging from Mira variables to PN; an evolutionary sequence is visible. Finally, the papers dealing with the discovery and classification of WDs are almost too numerous to mention. Of note is Liebert (MK50) who gave an historical review of the development of spectroscopic classification schemes for WDs, and suggested changes to the presently used system. Wesemael+ (58.126.009) published an atlas of optical spectra of WD stars, including all major spectral classes and subclasses and discussed the spectral classification system for WDs. Barstow+ in a series of papers (61.126.058, 61.126.059, 62.126.066, 63.117.151, 63.117.192, MNRAS 277,971) reported on the discovery and classification of a number of WDs, many as a result of ROSAT observations. Included was the hottest known highly magnetic DA. Werner+ (63.126.043) reported on the discovery of two hot DO white dwarfs exhibiting ultra-high-excitation a Absorption lines, possibly prototypes of a new DO subclass. Other papers on the discovery and/or classification of WDs include: Darling+ (AJ 111,865), Darling+ (62.114.158) & Wegner+ (58.114.004) presented spectral types for stars from the Kiso UV excess survey - the stars include subdwarfs and WDs; Everett+ (PASP 107,1059) 124 objects from Case Low-dispersion Northern Sky Survey; Mason+ (63.142.075) spectroscopy of EUV sources from the ROSAT Wide Field Camera; Jordan+ (57.126.068) type DAB; Danzinger+ (58.117.038) type DC as a companion of a pulsar; Werner+ (AA 284, 907), hottest known He-rich WD; Reimers+ (61.126.042) new magnetic DA; Dreizler+ (61.126.067) hot DO; Dreizler+ (AA 303,L53) 4 hot WDs with ultra-high excitation features in their spectra; Liebert+ (61.126.025) C star with WD companion and a highly magnetic degenerate star; Koester+ (61.126.041) new spectra of DAB prototype GD 323; Liebert+ (61.134.037) DA nucleus of PN WDHS 1; Wesemael+ (62.126.008) two hybrid DAB stars; van Kerkwijk+ (ApJ 454,L141) WD companions of radio pulsars; Craig+ (AJ 110,1304) & Craig+ (BAAS 28,945) spectral types of WDs from EUVE surveys; Ruiz (AJ 111,1267) 6 new cool degenerate stars; Tytler+ (58.159.008) UV excess objects and Lamontagne+ (61.126.192), Feige 55. Cowley+ (PASP 107,927) reported on the discovery of a new hot PG 1159 star and Hambly+ (ApJ 448,628) identified a degenerate star in the halo of our galaxy.

2.6. BINARIES AND MULTIPLES

Binary stars, ranging from chromospherically active stars to degenerate pairs were the subject of active research this trienniem. Fekel+ concentrated mostly on chromospherically active stars in binary systems: (57.116.019) HD 212280; (58.120.008) g Gem; (58.120.016) chromospherically active giants; (62.120.002) ADS 11060; (62.116.005) HD 30957. Bopp+ (58.116.063) studied an extremely active RS CVn star; Jeffries+ (58.116.078) studied a chromospherically active late-type binary system, detected by ROSAT; the

region. Kirkpatrick+ (61.118.022) pres ented spectral types of components in low-mass binary systems in order to find a mass-spectral class relationship for cool dwarfs. Jones+ (61.114.010) presented an IR spectral sequence from M2V to beyond M9 V, showing the importance of H2O bands, which are used in a temperature calibration, Baraffe+ (ApJ 461,L51) derived a mass-spectral class relationship for M dwarfs, and Leggett+ (ApJS 104,117) published an atlas of low-resolution IR spectra for red dwarfs which they used to establish a temperature scale. The following papers presented new spectral types for cool dwarfs: Soderblom+ (ApJ 460,984) and Fekel+ (58.114.108) HD98800; icela+ (63.117.270) dMe; Mathioudakis+ (AA 302,422) dMe; Jeffries+ (AA 305,L45) active K2 V; Martin+ (AASS 116,467) 63 late dwarfs; Fekel (63.116.065) HD181943 ; Brosch+ (61.111.011) uncataloged dM3; Ruiz+ (63.114.085) high proper motion dM and cool degenerates; Jeffries+ (62.116.016) rapidly rotating dK and Jeffries+ (62.116.071) dMe. Brown dwarf (BD) candidates also received much attention: Mart n+ (62.115.041) presented spectra of 10 BD candidates in the general field; st rong Li absorption was found in all 10. Basri+ (ApJ 458,600) published high resolution spectra of PPL 15, a BD candidate; the authors discussed its spectral type and noted that it shows the lithium absorption feature. Ianna+ (63.115.008) reported on the parallax and spectral type of BD candidate ESO 207-61 and Mould+ (61.114.048) presented a spectrum of the BD candidate PC0025+0447, more likely a late dM. Rebolo+ (63.114.098) discussed the ability of the presence of Li absorption to confirm BD status and summarized the search for Li in many BD candidate s. Finally, this triennium saw the confirmed discovery of two brown dwarfs. Rebolo+ (Nature 377,129) announced that Teide 1, a low-mass star in the Pleiades was clearly substellar. An optical spectrum was presented and given a spectral type of M9, although the lithium feature could not be detected in the 6 resolution spectrum. Oppenheimer+ (Science 270,1448) presented an IR spectrum of the cool brown dwarf Gliese 229B (identified as a BD by Nakajima+, Nature 378,463) which had strong affinities with the spectrum of Jupiter, in particular methane absorption features, leading to a Tsurface 1000K. Other papers concerning the classification of late-type stars include: Bhatt+ (62.114.029) SAO75669, gM; Groenewegen+ (AA 305,475) AFGL 2477 - likely a composite spectrum M6S+C; Kipper+ (AA306,489) 5 metal-weak late-type halo carbon stars; Fekel+ (ApJ 462,L95) HDE233517; Leeber+ (ApJ 463,L25) IRAS 13568-6232 = M6-8 III; Stpie+ (58.116.097) HR1362; Chan (58.112.069) J stars; Cohen+ (AJ 111,1333) C stars which are IRAS sources; Evans+ (61.114.031) HR 9053 = G8 Ib; Christian+ (BAAS 28,941) late-type stars from Rosat detections and Winfrey (BAAS 26,1382) cold IRAS supergiants.

2.4. PRE-MAIN SEQUENCE STARS

Meyer (BAAS 26,1471) described a program of spectral classification in the J,H& K bands of YSOs, beginning with observations of many MK standards in these bands. Pravdo (ApJ 447,342) classified 10 new K and M PMS stars which are X-ray sources in the Orion star formation region, Greene+ (ApJ 450,233) presented spectral types of YSOs in the r Oph dark cloud (L1688), Kenyon+ (62.121.003) classified optical spectra of 60mm IRAS sources in the Tau-Aur molecular cloud; 9 are probably PMS stars. Simon+ (58.121.065) classified T Tauri stars in PMS binary systems and Strom+ (58.121.039) reported on the discovery of two FU Orionis objects in L1641. Walter+ (61.152.001) reported on follow-up spectroscopy of 28 low-mass PMS stars as counterparts of Einstein X-ray sources in the Upper Sco OB association. Jura+ (63.112.137) concluded from optical spectra that HR4796B is a PMS M2 star. Th + (61.002.025) published a new catalog of Herbig Ae/Be stars. Hillenbrand+ (63.131.241) determined the spectral types of stars associated with two Herbig Ae/Be stars. The following papers report the discovery and classification of new Herbig Ae/Be stars: Zavagno+ (61.121.006) YSO in S187; Aspin+ (61.121.011) V1318 Cyg; Hessman+ (AA 299,464) LkHa 349; Whitney (58.121.061) & Clayton+ (57.121.088) Z CMa; Block+ (57.153.043) Ae/Be & FU Orionis and Mel'nikov+ (AR 40,350) HD216629 & LkHa 350.

2.5. HIGHLY EVOLVED STARS

Compared to the previous triennium, the research into highly evolved stars - meaning for the purposes of this survey, post-AGB stars, sdO and sdB stars, proto-planetary nebulae (PPN), planetary nebula nuclei (PNN), and white dwarfs (WD) - horizontal branch stars are covered in other sections - has increased dramatically. Parthasarathy (MK50) reviewed the characteristics of post-AGB supergiants, Kendall (62.114.075) classified HD 177566 as a low-mass, hot post-AGB star, Riera+ (AA 302,137) found the spectrum of IRAS 17423-1755 dominated by emission lines with a few absorption lines, and concluded it is a massive post-AGB star, Van Winckel+ (AA 306,L37) found HD 187885 to be A2 Ib, and a likely

2.2. A- AND F-TYPE STARS

Abt+ (ApJS 99,135) published new MK classifications for 2000 A-stars in the BSC. The authors used the data to examine the relationship between rotational velocities and spectral peculiarities in A-type stars. They also found that many "normal" stars near A2 IV have spectral peculiarities. Rao (MK50) discussed these A2 IV stars. Torres-Dodgen (MK50) presented a 15.5 resolution near-IR spectral atlas of A-type stars, while Abou Elazm (58.114.077), Carquillat+ (62.120.003) and Carquillat+ (63.120.014) studied A-type composite spectra. Considerable effort has been expended on the λ Bootis stars this triennium. Gray+ (58.152.003) discovered one λ Bootis star in Ori OB1 plus 9 metal-weak A-stars in Orion OB1 and Lacerta OB1. Levato+ (MK50) as well found 3 λ Bootis in Orion OB1. Strenburg (58.114.027), in the process of analyzing most of Gray's list of λ Bootis) discovered a λ Bootis in a binary system and was able to confirm the classification of λ Bootis stars into peculiar and normal hydrogen-line classes. Iliev+ (58.114.079) also examined the hydrogen line profiles of the λ Bootis stars. Holweger+ (62.114.030) inestigated the 1600 absortion feature often used as an UV criteron for membership in the λ Bootis class and found it is due to a quasy molecular satellite of Lyman α; this feature is therefore not seen in normal A type spectra only becasue of the normally heady line blanketing . Andrillat+ (AA 299,493) examined the behavior of the l Bootis stars in the IR. North + (62.122.014) showed that HD37151 is not an Ap star and Catalano (MK50) discussed the spectral classification of upper MS chemically-peculiar stars. In the course of investigating F strong l4077 stars, North+ (61.114.007) discovered 8 barium dwarfs. Jones+ (58.115.015) classified IRC +10420 as a very luminous F supergiant (F8 Ia+) with emission lines. Gulliver+ (62.114.009) using high dispersion, high S/N spectra confirmed the suggestion that Vega is a rapid rotator seen pole-on. Coulson+ (63.112.136) classified a star in a dusty, organically rich environment to be F8 V. Kurtz+ (MNRAS 276,199) classified HD 40765 as a r Puppisstar, and found that it is a d Scuti variable. Denizman+ (58.112.098) described the spectrum of a stable shell star. De Medeiros+ (61.120.022) discussed the spectral type of HD101841. Hambly+ (AA 306,119) classified stars around a B-type halo star, and Flynn+ (63.002.108) presented a catalog of faint blue stars at medium to high galactic latitudes, and classified them as BHB or non-BHB stars. Bell+ (61.115.205) have obtained spectral types for 34 B9 to A5 stars at the NGP. Wilhelm+ (61.114.121) described a method to distinguish Field HB (FHB) stars from normal A-type stars. Corbally+ (61.114.120) discussed the appearance of FHB spectra. Lu (61.155.203) reported on a survey for F and G stars at the South Galactic pole and Garrison (61.114.130) discussed the MK classification of yellow supergiants in the halo.

2.3. LATE-TYPE STARS

Keenan (58.111.034) has published a revised MK classification scheme for red carbon stars, combining some of the features of the old R,N and C classifications with numerical abundance indices and Keenan+ (62.115.018) reviewed spectral classification of SMR, strong-CN and R stars. Barnbaum (61.002.007) has published a high-resolutiion atlas of Carbon stars. Ginestet+ (62.114.115) studied cool MK standards in the 8380 - 8780 region, Origlia+ (58.158.102) presented indices for spectral classification of cool stars in the 1.5-1.7 mm region, Mallik (61.114.015) found the Ca triplet lines to be strongly correlated with gravity and metallicity in cool stars, Ali+ (AJ 110,2415) presented an atlas of 2 mm spectra of cool dwarf stars, and MacConnell+ (MK50) discussed the classification features of cool luminous stars in low resolution spectra. Hammersley+ (61.114.008) demonstrated that near-IR CVF spectroscopy can be used to determine accurately the spectral type of K and M-type stars. Garrison+ (58.114.075) classified 299 faint early-G dwarf candidates in the direction of the galactic poles. Reid+ (AJ 110,1838) presented spectral types of 1746 stars in the 3rd catalog of Nearby Stars. Carballo+ (MNRAS 277,1312) derived spectral types for the brightest sources optically identified as ROSAT X-ray sources. These objects range from F7 to M1. The study of lower MS stars made important advances this triennium. Kirkpatrick+ (63.114.068) presented spectra for 20 dwarfs later than M7, and used them to set up a spectral classification scheme for types M7 to M9, Kirkpatrick (63.114.097) published a spectral sequence from K5 to M9 and Simons+ (58.114.090) reported on preliminary results from an IR survey with the purpose of establishing a spectral sequence from M0 - M10+ in the IR. 3 dwarfs were found to be later than M9 and have enhanced VO bands. Henry+ (62.114.011) presented spectral types for all known northern late dwarfs closer than 8 pc, Kirkpatrick+ (58.126.117) reported on a program to recognize missed low-luminosity dwarfs in the solar vicinity and Kirkpatrick + (62.115.026) assigned spectral types to color-selected targets from a deep CCD survey for cool dwarfs. Boeshaar+ (MK50) discussed the spectroscopic properties of M dwarfs in the 2 mm

show that these stars are OB giant/supergiants, WC or WN7-8 stars. Figer+ (ApJ 447,L29) discovered two new WR stars and an LBV in the quintuplet AFGL 2004 near the galactic center. Williams+ (MNRAS 275,889) presented near-IR spectra of two IRAS sources; one turns out to be a WC8-9 star, whereas the other is a luminous emission-line object, similar to h Car. New spectra of individual stars have yielded new classifications: Smith+ (61.122.013) reclassified He 3-519 and AG Car as WN11 instead of Ofpe/WN9, Nota (57.156.101) speculated, on the basis of new echelle spectra that S119, classified previously as Ofpe/WN9 is a new LBV, and Niemela+ (63.120.027) have reclassified HDE320102 as an O6 + WN binary system. Humphreys+ (62.122.031) presented a review paper on LBVs, including a useful description of their spectral characteristics.

2.1.2. *O- and B-type Stars*

Walborn (MK50) discussed the spectroscopic criteria which distinguish the O3 class in both the optical and UV wavelengths and has presented arguments which may lead to the definition of an O2 spectral class. Hanson+ (61.114.046) presented an atlas of 2 mm spectra of O and early B MS stars, which they used to set up a classification system useful in the investigation of hot stars embedded in shrouded II II regions. They applied their new classification system to 30+ stars in the region of M17 (BAAS 26,1390) and identified 7 new O-type stars. Hanson+ (ApJS in press) present an expanded spectral atlas of 180 OB stars with a further discussion of their classification system. Conti+ (63.114.043) presented K-band spectra of two Of stars which show emission-line morphology similar to WN stars. Vijapurkar+ (58.114.084) classified 291 stars identified as OB+ in the Case- Hamburg Luminous Star survey. Parker (58.152.001) presented new classifications for 54 stars in the 30 Doradus OB association; 24 of these stars are O-stars, and Walborn (BAAS 28,931) discussed the results of a number of spectral classification programs in 30 Doradus. Drilling (MK50) discussed his work in the discover y of more than 400 new O and B supergiants plus a number of astrophysically important peculiar stars through spectral classification. Reed+ (63.002.034) published a spectroscopic database for Stephenson-Sanduleak southern luminous stars. A total of 6182 classifications are listed. Underhill (57.120.027) discussed the spectral types of the components of Plaskett's star, Underhill (61.114.011) argued that the spectral type of HD 108 is O7fpe III, and is related to LBV and B[e] stars and Gies+ (58.118.018) showed that the secondary spectrum of 15 Mon gives a spectral type of O9.5 Vn for the companion. Bakker+ (AA 307,869) studied the peculiar supergiant HD101584, and concluded that it is not an F supergiant, but a B star with a strong stellar wind. Kaper+ (AA 300, 446) revised the spectral type of the B1 Ia+ companion of an X-ray pulsar, Gies (61.120.012) gave a spectral type for the B-type companion of HD 53975, and Coe (62.142.018) reported that the optical counterpart of GRO J1008-57 is an OBe star. Little+ (ApJ 447,783) derived basic parameters and spectral types for 6 blue stars in the galactic halo, Moehler+ (61.114.013) investigated PG 2120+062 and found it to be an apparently normal O9 star at high galactic latitude, Heber+ (AA 300,L33) have classified HS 1914+7139, an apparently normal B star far above the galactic plane as B2.5 IVn, Schmidt+ (AA 306,L33) discussed the spectrum of PG 0009+036, another rapidly rotating normal B-star in the galactic halo, Hambly+ (58.114.104) classified 6 high galactic latitude, presumably young, stars, and Kilkenny+ (MNRAS 276,906) presented classifications for 30 apparently normal high galactic latitude B stars; 11 appear to be normal B stars, the others are likely subdwarfs. Mitchell+ (61.114.114) gave preliminary classifications for a new sample of faint halo B stars. Dufton+ (58.119.021) classified the components of the high-latitude B-type binary SU Psc. Garrison+ (61.114.022) refined the MK system for the late B-type stars and presented spectral types for 200 stars on the revised system. Garrison+ (BAAS 27,1311) evaluated the C II 4267 line as a suitable spectral classification criterion.

2.1.3. *Be and Shell Stars*

Cote+ (58.112.003) reported on the discovery of 5 new Be stars and one new Oe star. Andrillat+ (61.112.022) studied 74 Be stars in the near IR, and noted a correlation of P7 emission with spectral type. The optical counterpart of a softg-ray repeater was revealed by van Kerkwijk+ (63.143.167) to have a spectrum similar to that of a B[e] star. Lawson+ (61.117.020) showed that HD183133 is a Be interacting binary. Menchenkova (58.112.101) reported on the spectrum of Pleione during 1990, and Singh+ (61.112.223) reported on the spectrum of f Per over an interval of 18 years. Denizman+ (62.112.286) described the spectrum of the Be/ Shell star V923 Aql.