29. STELLAR SPECTRA (SPECTRES STELLAIRES)

PRESIDENT: M. W. Feast.
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ORGANIZING COMMITTEE: M. K. V. Bappu, G. Herbig, L. Houziaux, I. M. Kopylov, A. Przybylski, J. Sahade.

Material for this report was collected by the President, Vice-President and Members of the Organizing Committee. The President is, however, responsible for the form in which the report now appears. A number of special abbreviations in the references are explained in the report of Committee 27a. In addition, 3rd Harvard = 3rd Harvard-Smithsonian Conference on Stellar Atmospheres (1968). The field of Commission 29 overlaps particularly with those of 9, 27a, 36, 44 and 45 whose reports should be consulted. Since the last IAU meeting 29 has co-sponsored the following meetings: IAU Colloquium No. 4 on *Stellar Rotation* (Columbus, Ohio, September 1969); IAU Symposium No. 36, *Ultraviolet Stellar Spectra and Related Ground-Based Observations* (Lunteren, June, 1969); Second Trieste Colloquium, *Mass Loss from Stars* (September, 1968). We are also co-sponsoring IAU Symposium No. 42 on *White Dwarfs* to be held in Scotland (August, 1970). The thanks of the commission are due to their representatives on the organizing committees of these meetings. Reports from some working groups are appended. The working group with Commission 44 has not felt it necessary to submit a report (its main activity was the organization of Symposium No. 36). Miss Underhill (Chairman) recommends that the working group on Tracings of High Dispersion Stellar Spectra be dissolved.

GENERAL, INSTRUMENTATION, PRACTICAL MATTERS

Volumes containing relevant papers are: Liège, 1968, *Forbidden Transitions in Stellar Spectra*; Trieste, 1968, *Mass Loss from Stars*; Trieste, 1966, *Late-Type Stars*; Paris, 1967, *The Origin and Distribution of the Elements*; Tucson, 1968, *Beam Foil Spectroscopy*; Lunteren, 1969, *Ultraviolet Stellar Spectra and Related Ground-Based Observations*. Abundance work has been summarized (Cayrel, *Ann. Rev.*, **4**, 1; Kuchowicz, *N.E.I.C. Review Report*, No. 34, Warsaw, 1968. cf. also Pagel, *Q.J.R.A.S.*, **9**, 401). Theoretical work on rotational broadening is reviewed by Strittmatter (*Ann. Rev.*, **7**, 665). Allen (*M.N.R.A.S.*, **133**, 21; **139**, 367) advocates a statistical approach to stellar spectroscopy.

There has been widespread use of image intensification devices (Ford, *Ann. Rev.*, **6**, 1) and photoelectric spectrum scanners (Oke, *P.A.S.P.*, **81**, 11). Important results have been obtained from Fabry-Perot interference spectroscopy (Vaughan, *Ann. Rev.*, **5**, 139) and Fourier transform spectroscopy (Johnson *et al.*, L.P.L. **113**; Gebbie and Twist, *Rep. Prog. Phys.*, **29**, 729. Connes *et al.*, *Publ. Obs. Hte-Provence*, **9**, No. 6). Instrumentation completed includes: a high resolution spectrograph with two echelle gratings in series (Barannes *et al.*, *J. Observateurs*, **50**, 289); a high dispersion objective prism system (Treanor, *Vistas*, **11**, 147); application of pulse counting methods to magnetic field measurements (Severny, Dimov); a combined echelle-interferometer device (Wyller); a method for studying polarization effects in line profiles (Clark, Grainger, *Ann. Ast.*, **29**, 355). Under discussion have been: the conversion of line profiles into congruent radio frequency profiles for high resolution work (Van Bueren, *B.A.N.*, **19**, 97); the use of multislit spectrographs (Serkowski, *Observatory*, **87**, 259). Progress has been made in fully automating equivalent width reduction (e.g. Thompson, *Edin. Publ.*, **5**, 245). The determination of equivalent widths on a common (and if possible absolute) system remains a central problem (see 29b and e.g. Hartley, Powell, *Observatory*, **87**, 75). Uncertainties in oscillator strengths remain a problem (cf. Cowley, Warner, *Observatory*, **87**, 117; Garz, Kock, *Astron. Astrophys.*, **2**, 274).

P CYG STARS, SHELL STARS, WR STARS

De Groot (*B.A.N.*, **20**, 225) made a detailed study of P Cyg including line identifications, atmospheric structure and mass loss (2×10^{-4} $M_{\odot}$/year). Hutchings (*M.N.R.A.S.*, **144**, 235) rediscussed Beal's velocities with similar results. Spectrophotometric gradients, velocities, line profiles and (normal) abundances were derived by Luud *et al.* (*Tartu Publ.*, **35**, 196; **36**, 202, 221; *Budapest*, 197; *Astr. Zu.*, **44**, 269; *Astrophys.* **3**, 391), and abundances in four similar stars. Hutchings (*Observatory*, **87**, 289; *Budapest*, 191; *Columbus*, 1969) found rapid variation in line profile for Be and P Cygni stars. In γ Cas this may be related to stellar rotation (period ~ 0.7 days). Rapid changes were also studied by Delplace *et al.* (*Budapest*, 223) and Popova, Dokuchaeva (*Alma Ata*). Ivanova *et al.* (*Budapest*, 215) studied long term continuum changes in γ Cas. The P Cygni star HD 51 585 shows [O I], [O III], [S II], [Fe II] emission (Andrillat, Houziaux, *Liège*, 1968, 343).

Work on shell stars includes: changes (and periodicities) in ζ Tau (Underhill, v.d. Wel, *Toronto*, 251; Delplace, *Publ. Obs. Ht-Provence*, **9**, No. 31; Hack *et al.*, *Trieste Publ.*, 373, 392); variations in 48 Lib (Faraggiana, *Astr. Astrophys.*, **2**, 162); changes in 4 shell stars (including A-type shell stars) (Cowley, Hiltner, *P.A.S.P.*, **80**, 685); velocities and abundances in o And (Galeotti, Pasinetti IB 301, *Pubbl. Oss. astr. Milano-Merate*, 283, 300); variations in HR 2142 (Peters, *Los Angeles*).

The problem of the WR stars has been comprehensively reviewed by Underhill (*Ann. Rev.*, **6**, 39). A symposium on WR stars has been published (Nat. Bur. Stand. Special Pub., 307) and summarized by Thomas (*Astrophys. Letters*, **2**, 147). Kuhi's scanner observations of V444 Cyg have been published (*Ap. J.*, **152**, 89). He finds great differences in the eclipse curves of different emission lines. In the continuum the depth of the secondary eclipse increases with increasing wavelength. Continuum and line intensities show rapid erratic fluctuations. Underhill (*B.A.N.*, **19**, 173) discussed the spectrum of HD 191 765 in detail. Identifications and equivalent widths are given. It is suggested that electron scattering is not important for the line profiles. Bracher (*P.A.S.P.*, **80**, 165) discussed violet displaced He I 3889 in HD 211 853; the velocity varies in phase with the B component. A revised spectral classification scheme for WR stars is proposed by Lindsey Smith (*M.N.R.A.S.*, **138**, 109). Bertola and Ciatti have observed the brightest WR stars in the 1 μ region at 500–800 Å mm^{-1}. Nugis and Luud (*Tartu*) studied HD 191 765, 192 103, 192 163 for effective temperature, bolometric correction and emission line intensity corrections. They find the stars to lie to the left of the main sequence (near the helium main sequence). Galkina (*Izv. Krym. astrofiz. Obs.*, **39**, 44) studied the close binary HD 190918 (WN 5·5 + O9). Detailed studies of the contour of He II 4686 emission lead to an orbital period of 105 days.

The report on Be stars is the responsibility of a special working group.

Additional material supplied by Dr. Bappu is as follows. P. Swings and J. P. Swings (*Beam-Foil Spectroscopy*, Ed. S. Bashkin) confirm the assignment of 5806 Å to C IV in WN stars. Aller has in progress an observational programme at Cerro Tololo of a number of Of stars that are either the nuclei of planetary nebulae or are prototype stars. Aller and Lindsey Smith have in press a paper on the classification of emission line spectra of planetary nebulae. Underhill (*Astrophys. Space Sci.*, **3**, 109, 1969) has discussed the mass loss characteristics of WR stars. Deutsch finds that the He I 3888 absorption line which is the strongest absorption feature in the spectra of WN-B stars shows time dependent variability of intensities and velocities. He points out that the displaced absorption line of 3888 Å is found only in those WC stars that are known spectroscopic binaries or that have nebular lines in their spectra. L. V. Kuhi and L. F. Smith are working on an atlas of WR line profiles. Bappu and Scaria are engaged on an atlas of intensity tracings of bright WR spectra obtained at 10 Å mm^{-1} and 20 Å mm^{-1} dispersion. Jones, Evans and Catchpole (*Observatory*, **89**, 18, 1969) find the nucleus of Henize 99 to be a WC 9 star with emission bands at 4651 (C III, C IV 4650 Å), 4267 (C II 4267 Å) 4186, 4121, 4070 (C III 4069 Å), 3920, 3757 Å.

The current survey for luminous stars in the Southern Milky Way by Stephenson and Sanduleak has turned up 3 to 4 new WR stars. One of these appears to be a visual binary companion to a G-type supergiant (*IAU Circ.*, No. 2143, 1969). Sanduleak has published (*IAU Circ.*, No. 2150, 1969) data concerning a new Wolf-Rayet star showing O VI 3840 as strong as the 4670 Å blend. He has also (*P.A.S.P.*, **80**, 470, 1968) called attention to a previously known WR star in the Small Magellanic Cloud which has this property and which may also have a variable spectrum. Only about half a dozen such high excitation WR stars are known and two of them have been inconclusively suggested to be X-ray sources. D. C. Morton has derived the ratio of Lyman-continuum to visual fluxes for six WN stars from the free-free radio emission of surrounding nebulae and the apparent magnitudes of the stars. Comparison with the theoretical ratios obtained from model atmospheres which omit the emission lines, but include ultraviolet line blanketing where appropriate, gives estimates of the effective temperatures. Values around 50000K are found for WN4·5 and WN5 35000° for WN6 and 25000° for WN8. Bappu and Ganesh (*M.N.R.A.S.*, **140**, 71, 1968) have measured line intensities of the hydrogenic transitions of C IV using coude spectra of dispersion 10 Å mm^{-1}. Assuming LTE, excitation temperatures have been derived for WC6, WC7 and WC8 spectral types. Van Blerkom and Castor (*M.N.R.A.S.*, **143**, 461, 1969) question the validity of these values, and claim that they cannot be identified with physically meaningful electron temperatures of WR envelopes. Kuhi is currently observing HD 50896 and HD 191765 with scanner and high dispersion spectrograph to detect possible periodicities. Scanner observations of CV Ser as a function of phase are also being obtained.

M. K. V. Bappu and K. S. Ganesh (*Kodaikanal Obsv. Bull.*, No. 183, Series A, 1967) assign a period of 78·5 days for the binary γ_2 Vel. V. N. de Monteagudo and Sahade using Cordoba spectra confirm this value and improve it to 78·5002 days. They have studied the changes in structure of the He I 3888 line in absorption as well as emission which can be interpreted in terms of emitting material located between the two stars and moving from the WR star towards its companion. D. C. Morton, E. B. Jenkins and N. H. Brooks (*Astrophys. J.*, **155**, 875, 1969) have examined far-ultraviolet spectra of γ_2 Vel. Stepien has carried out *UBV* photometry of the WR eclipsing system CV Ser in 1967 and finds no evidence of eclipses. This interesting observation needs confirmation and extension. T. Kogure is measuring radial velocities of the He II lines in V444 Cyg from spectrograms obtained at Okayama. E. D. Carlson (Doct. thesis, Northwestern University, U.S.A., 1969) has studied the spectra of the two southern Of stars HD 148937 and HNZ 759. HD 148937 is a very high luminosity nucleus of the planetary nebula, NGC 6164–5, with a spectrum that displays the Pickering series in addition to He II 4686 and N III 4634, 4640. D. C. Morton, E. B. Jenkins and N. H. Brooks (*Astrophys. J.*, **155**, 875, 1969) have studied the far-ultraviolet spectrum of ζ Pup. P. S. Conti has in progress a detailed study of O and Of stars using high dispersion spectra. Equivalent widths, line profiles and measures of the line broadening parameter are being measured for different spectral types. E. N. Walker has found that HD 153919, on the outskirts of NGC 6281 is a high velocity O7f star. He has also detected weak Of characteristics in the binary supergiant HD 152667 which is probably a member of NGC 6231. Walker has derived a spectroscopic orbit for this star. Small amplitude light variations with two minima and a period of 7·84 days have been detected at the Cape Observatory for this star. Slettebak (*IAU Colloquium on Variable Stars*, Budapest, 1968) has observations of variability of the spectral features of the Of stars λ Cep, 9 Sag, HD 34656, HD 190429N and 29 CMa.

O AND B TYPE STARS

Hack, Stalio, Aydia (*AI*, **39**, 1; **40**, 7) determine temperatures, gravities and abundances in O stars. Underhill (*B.A.N.*, **19**, 500) compares 10 Lac (O9) with model atmospheres and finds non-LTE effects important and helium abundances suspect. Problems of Of stars were reviewed (Slettebak, *Budapest*; Feast, *Lunteren*). There is evidence for mass loss and rapid spectral variations (Hutchings; Slettebak; Brucato (Northwestern); Battistini, *Pubbl. Oss. astr. Univ. Bologna*, **9**, No. 9).

Spectrophotometric data on B stars is given by Aller, Jugaku (*Mich. Publ.*, **9**, 203) and Buscombe (equivalent widths, central depths, $v \sin i$, Balmer profiles *M.N.R.A.S.*, **144**, 1, 31, etc.).

Messerschmidt *et al.* (*Z. Astrophys.*, **66**, 246) find theoretical profiles for diffuse series He I lines fit τ Sco satisfactorily. Observed and computed equivalent widths of Si II 4128, 4130 indicate that the adopted *gf*-values are 6 times too large (Underhill, *Ap. J.*, **151**, 765). Underhill attributes a discrepancy between observed and computed Balmer line profiles in Ia supergiants to an underabundance (×1000) of hydrogen. Smit (*B.A.N.*, **20**, 274) and Svolopoulos (*Ann. Astr.*, **29**, 29) studied βOri (B8 Ia) and Kikuchi (*P.A.S.J.*, **20**, 190) its variable (PCygni) Hα. High dispersion spectra and spectral scans of τHer (B5IV) are used in a detailed study by Heintze. He also discusses the A stars Vega and Sirius A (which may be a binary). In addition he deduces effective temperatures for 42B stars using a relation between Balmer discontinuity and U−B (*B.A.N.*, **20**, 1, 154). Other detailed studies of B stars at Utrecht are: ζDra (Visser), εOri (Lamers), o^2CMa (Van Helden), ηCMa, 67Oph (Underhill). Snijders (*Astr. Astrophys.*, **1**, 452) following Warner uses Fe III in ζCas, γPeg (B2) and finds an Fe abundance three times larger than previously supposed. Other work includes: abundances in B supergiants (Luud, Sitska, Nugis, *Tartu*, **36**, 210, 194); photoelectric Hβ profiles and comparison with models (Brucato, *P.A.S.P.*, **80**, 263); Hγ equivalent widths in eight associations (Walker, Hodge, *P.A.S.P.*, **80**, 290); continuum scans of 10 stars (Karetnikov, Medvedev, *Astrophys.*, **4**, 303); Scans and radial velocity changes in B3V stars (Kodaira).

In IC4665 the rotational velocities of B8-A3 stars are comparable with Pleiades stars: Those of B4-B7 stars are much smaller (Abt, Chafee, *Ap. J.*, **148**, 459). In Sco-Cen the B0-B6 stars rotate slower than general field stars; the B7-A0 stars faster. In Per I the normal giants rotate faster than those in the general field (Slettebak, *Ap. J.*, **151**, 1043; **154**, 933). Contrary to earlier work, Hyland finds that there is no dependence of atmospheric helium abundance on rotation (*Nature*, **214**, 899). Friedjung (*Ap. J.*, **151**, 779) calculates the effect of gravity darkening on measured rotational velocities. Departures from LTE are not necessary to explain the helium singlet-triplet anomaly (Norris, *Ap. J.*). Mass loss with outward acceleration is found in some OB supergiants (Hutchings, *M.N.R.A.S.*, **141**, 219, 329, etc.).

Much interest attaches to Bidelman's helium variable star HD125823 (Jascheks, Morgan, Slettebak, Norris, *Ap. J.*, **153**, L87; *P.A.S.P.*, **79**, 70; *Nature*, **219**, 1137, 1342). The spectrum varies regularly ($8^d.8$ period). At some phases the star is like the weak He stars of Population I and II. At others it is close to a normal B2V. Similar stars are under study (Jaschek, Arnal, *P.A.S.P.*), HD 191980 (Bp) may be a related object (Keenan *et al.*, *Astrophys. Letters*, **3**, 55). Whilst searching for Ap stars in young clusters (NGC2264, 2362, IC5146) Bernacca, Ciatta found some helium-variable cluster members. Two helium weak (Bp) stars in Orion, HD36916, HD37058 have affinities to the Ap stars (Hack, *Astrophys. Space Sci.*; Sievers, *P.A.S.P.*, **81**, 33, 288). Conti (in press) was unable to confirm the magnetic fields reported in the latter star and the similar HD36629 (Sargent, Strittmatter, *Ap. J.*, **147**, 1185). HD19216 (B9V) may be related to the Ap's (Preston, *Ap. J.*, **156**, 1175). The microturbulence in 3Cen A was revised downwards (<2 km s^{-1}) and abundances redetermined (Hardorp *et al.*, *Z. Astrophys.*, **69**, 429). The neon abundance is normal (Sargent *et al.*, *Ap. J.*, **157**, 757). Preston is surveying a large number of B0-B5 stars to determine the frequence of 3Cen A-like stars. Jaschek, Aquilar (*P.A.S.P.*, **81**, 170) find P II etc. in HR3817 and compare it to 3Cen A. Thackeray (*Observatory*) notes that the peculiar lines are weak and seem mainly associated with the fainter component of the 2″ double. HD96248 (B1 Iab) and HD14443 (B2 Ib) are probably nitrogen deficient (Jaschek, *Ap. J.*, **150**, 355).

HIGH LATITUDE B STARS, HORIZONTAL BRANCH STARS AND RELATED OBJECTS

Amongst 30 Feige high latitude stars are: 7 normal A dwarfs; 7 normal B dwarfs, probably runaway stars and one normal B giant; 4 sdO's (Balmer lines strong for colours); 4 sdB's (Balmer lines broad for colours, some have He I weak); 6 Bw's (Balmer lines normal, He I weak); one Aw (metals weak for colours) (Sargent, Searle, *Ap. J.*, **153**, 443). Walker, Hodge (*P.A.S.P.*, **80**, 238) give Hγ equivalent widths for Feige stars. Blue HB stars in globular clusters have weak He I (Sargent, *Ap. J.*, **148**, L147). Barnard 29 (3^m above H-B in M13) is not helium weak (Stoeckly, Greenstein, *Ap. J.*, **154**, 909). Other elements are underabundant and the mass only 0·3 $M_\odot$; it may be a binary. Work on H-B stars in NGC6397 was revised (Newell *et al.*, *Ap. J.*, **156**, 597); the masses are $\sim$0·6 $M_\odot$; the helium abundance is unknown. Atmospheric parameters from spectra and scans of blue H-B stars in M67 suggest the masses are about solar (Sargent, *Ap. J.*, **152**, 885). For

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these stars $\langle v \sin i \rangle \sim 70$ km s^{-1} and one is a single-lined binary (Deutsch). The field H-B B2 star Feige 86 is like 3Cen A (P II etc.) (Sargent, Searle, *Ap. J.*, **150**, L33). The He weakness in these stars seems unrelated to abundances in the prestellar material. The anticorrelation of P II and He I may be due to non-LTE effects (Underhill, *B.A.N.*, **19**, 537).

Baschek and Norris interpret the He singlet-triplet anomaly in the hot subdwarf HD 205 805 as due to high gravity and low He abundance. The high velocity B star HD 214 539 has a normal He/H ratio; other elements are deficient 10 to 30 times (Przybylski, *M.N.R.A.S.*). Abundances in the metal deficient H-B A stars HD 161 817, HD 86986, HD 109995 are similar to those in HD 122 563 (metal poor giant); C and O have high abundances (Kodaira *et al.*, *Ap. J.*, **155**, 525; *P.A.S.J.*, **19**, 550). HD 6870, a rapidly rotating metal deficient star, seems to be a member of the σPup group (Rodgers, *Ap. J.*, **152**, 109); it may be a close binary. For $+39°$ 4926 Kodaira *et al.* find $T = 7500°$ $\log g = 1$ $M_v \sim -3$ and 775 day period velocity variations; metals are 0.01 solar but C, N, O are normal. HD 125 924 (B2) may be one of the brightest halo stars (Hill *Obs.*, **88**, 163). HZ 29 seems to be a hot star with a helium spectrum (Wampler, *Ap. J.*, **149**, L101). OB subdwarfs are easily found in the Paris system (Berger, Fringant). Davis Phillips observed 40 H-B stars spectroscopically.

A STARS INCLUDING PECULIAR AND MAGNETIC STARS

θLeo (A2 V) has normal abundances (Kriz, *B.A.C.*, **17**, 175), Taffara (*Asiago Contr.*, 184) obtained new atmospheric parameters and abundances for αCyg (A2 Ia). Andrillat, Baylac (*C. r.*, **268**, 1537) studied the variation of hydrogen P_{12} with type and luminosity. Houziaux (*3rd Harvard*) finds oxygen $\sim \frac{1}{4}$ solar in Vega and Sirius. Stromgren's m_1 depends on abundance rather than microturbulence and Ca abundance varies by a factor 2 for A stars near the sun (Henry, *Ap. J.*, **152**, L87). There is a good agreement in effective temperatures determined from the Balmer jump, the continuum and intensity interferometer measures (Wolff *et al.*, *Ap. J.*, **132**, 871 from scanner work). Rodgers (*Observatory*, **87**, 127) discussed spectrophotometry of γCen (A0). Scholz, Hardorp are studying Vega. Strom *et al.* (*Observatory*, **88**, 160) find that Sirius shows Am type abundance anomalies contrary to Warner's view. Conti, Strom (*Ap. J.*, **152**, 483; **154**, 975; **158**) continued work on abundance anomalies in early A stars and their relation to Am stars. γGem, θVir, HD 2421 are like Vega except for Ba, oPeg is like Sirius. The secondary (A4) of the double-lined binary ηVir has Am like deficiencies of Ca, Sc, Ti; the primary does not. Both have enhanced heavy metals. There are four early Am-like stars in the Pleiades; one a spectroscopic binary (*A.J.*, **73**, 348). Olson discusses the detection of metallism in early A stars (*P.A.S.P.*, **81**, 97). The λBoo group as originally defined is rather heterogeneous. A small group (including λBoo) seem to be young main sequence A stars with low turbulence and slight metal deficiency (Oke, Baschek, Searle, Kodaira, *Ap. J.*, **150**, 513; **155**, 537; *P.A.S.J.*, **19**, 556).

The conference on Magnetic and Related Stars (Cameron, Mono Book Corp.) has been published and much other work has appeared on these stars. A detailed study of Ap Stars (atmospheric parameters, abundances) is consistent with them being slow rotators, not pole-on stars (Wolff, *Ap. J.*, *Suppl.*, **15**, 21). Spectral scans show most Ap's have atmospheres like B stars (Jugaku, Sargent, *Ap. J.*, **151**, 259). The λ4200 and (possibly) the Mn Ap Stars are Ne deficient (Sargent *et al.*, *Ap. J.*, **157**, 757). Detailed analysis shows no signs of non-LTE effects in HD 204 411 (cool Ap) (*Ap. J.*, **157**, 1265). The micro-turbulence in γEqu (Ap) is less than previously supposed (Preston, Cathey, *Ap. J.*, **152**, 1113); correlation of microturbulence with spectral peculiarity is therefore unlikely. BD $+5°$2468 may be a halo population Ap star (Greenstein, Sargent). HD 1909 is like 53Tau (Mn); it has Hg II (Buscombe *et al.*, *M.N.R.A.S.*, **140**, 369). Several Ap Stars have Pt II (Dworetsky, *Ap. J.*, **156**, L101). Model atmosphere analyses of Mn Ap stars show atmospheres like 'normal' A's and with abundance differences from star to star (Strom, *Astr. Astrophys.*, **2**, 182). Si II 4128 is not always enhanced in λ4200 stars (Megessier, *Paris*) ιCrB (Ap) was studied by both Taffara and Hack (*Asiago Contr.*, 206, *Trieste*, 367). Other stars studied at Trieste are: HD 151 199 (Gokkaya, *Astrophys. Space Sci.*); γCap, 53 Cam, 78 Vir, θAur, ν_1 and ν_2Dra, βCrB (Farragiana, Hack) and stars found photometrically peculiar by Golay. Other work on Ap stars is; spectroscopy

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(Bertaud, Floquet, *J. Observateurs*, **50**, 425, *Astr. Astrophys.*); $U-V$ spectral classification (Nariai, *P.A.S.J.*, **19**, 180); model atmosphere study of 111 Her (Mn) (Luud, Kuush); α And, π Boo A (Mn stars) (Khokhlova, Aliev, Rudenko); 38 Dra (Mn) (Sargent, Adelman; ξ UMa, κ Psc (Rudenko, Aliev); β CrB, 21 Per (Polosuchlina); line identifications in HR 710 (Ir I present), HD 216533, 41 Tau (Jaschek, Brandi, Garcia); 73 Dra (Pt, Au, U, Os I and II present with CN and CH) (Jaschek, Malaroda); 73 Dra (Os/Fe $\geqslant 300\odot$) (Guthrie); spectroscopy of several Ap's (Aller *et al.*); rotational velocities of all Ap stars brighter than 9^m (Preston). Bertaud is preparing a supplement to his Am-Ap catalogue. The peculiar star HD 101065 may be "the coolest Ap" (Przybylski, *Postepyi. Astr.*, **15**, 225).

Work on α^2 CnV includes; Cohen *et al.* (*Ap. J.*, **156**, 629) identifications in the visual (Pb II, P II, Gd III, Pr III, Cl II etc.), a theoretical discussion is in progress; variations in spectrum, radial velocity and magnetic field (Pyper, *Ap. J. Suppl.*, **18**, 347; Kodaira, Unno, *Ap. J.*, **157**, 769; Octken *et al.*, *A.N.*, **292**, 1) these support the oblique-rotator hypothesis; abundances (Chumak, *Alma-Ata*); spectral variations (Kumaigorodskya, Kozlova). Studies of similar stars are; HD 124224 spectrum and velocity changes and model (Khokhlova); 73 Dra (Bonsack, Markowitz, *P.A.S.P.*, **79**, 235, Berg, *McCormick Publ.*, **15**, 9), period constant since 1933, rapid variations in H lines; 56 Ari (Bonsack, Wallace), extensive material shows Si II, He I period constant over 8400 cycles, H, Ca II, Mg II vary but in a different period; detailed spectroscopy of Osawa's Ap star HD 221568 (Kodaira, *Ann. Tokyo Obs.*, **10**, 157; *Ap. J.*, **157**, L59); CU Vir, spectral and radial velocity changes (Aydin, *A.I.*, **39**, 721); variations of HR 234 (Guderley, *P.A.S.P.*, **79**, 589); HD 221006, a λ4200 spectrum variable with a shell (Hyland, *P.A.S.P.*, **80**, 559); γ Boo (A7 III) (Baglin *et al.*, *Budapest*, 300), possibly a spectrum variable.

Praderie (*Ann. Astr.*, **30**, 793; **31**, 15, *3rd Harvard*) studied several Am stars in detail and computed $U-V$ spectra for Am and Ap stars. Nishimura, Watanabe followed light and velocity changes in 28 And (Am) (*Ann. Tokyo Obs.*, **11**, 142; *Astrophys. Space Sci.*, **3**, 77). Osawa's group in Tokyo is also studying RR Lyn, δ Cap, δ Del, HR 4816. Provost, Veer-Menneret (*Astr. Astrophys.*, **2**, 218) analyse 22 Ser (Am) and also 9 Aur (F0V) which has an unusually high microturbulence. The Jascheks (*A.J.*, **72**, 806) studied the relation between blanketing and degree of metallicity for Am's. HD 111844-5 is the only reported case of an Am in a visual binary system with an evolved secondary. Cowley *et al.* (*P.A.S.P.*, **79**, 497) conclude that the primary is not a true Am star though related to this class. Classification of some proposed Am's has been discussed (Walker, Cowley *et al.*, *Observatory*, **87**, 80). In normal main sequence A-F and Am stars, microturbulence up to the sound speed is observed (Baschek, Reimers, *Astr. Astrophys.*, **2**, 240). A number of writers have discussed theories of the origin of the Am and Ap stars (e.g., Van den Heuvel, *B.A.N.*, **19**, 309, etc.; Renson, *Ann. Astr.*, **30**, 697; Guthrie, *Astrophys. Space Sci.*, **3**, 542.)

Intensive and continuing work on stellar magnetic fields has been carried out at Lick and later Palomar by Preston, partly in collaboration with Stepiens and others (*Ap. J.*, **147**, 804; **150**, 547, 871; **151**, 577, 583; **154**, 971; **156**, 653, 967; **157**, 247). He has been particularly concerned with the periodicity of magnetic variations and their correlation with light variations. Periodic changes in light, spectrum and magnetic field are established for 17 Com and of light and field for κ Cnc. In HD 10783 light and magnetic maxima coincide, a small velocity variation lags $\sim\frac{1}{4}$ cycle; the star is probably a long period spectroscopic binary. In HD 32633, for which the period and range in light and field have remained constant over 8 years, light maximum coincides with magnetic minimum. In 53 Cam the relative phase of light and field is a function of wavelength. Also in 53 Cam partially resolved Zeeman patterns were detected and it may be a spectroscopic binary (Faraggiana IB 388). 73 Dra is an unusual spectrum variable, a spectroscopic binary and a periodic magnetic variable. The field in HD 215441 is periodic and not dipolar. If most magnetic stars *are* oblique dipolar rotators the magnetic inclination must generally be large. Other stars studied by Preston are 78 Vir, 21 Per, β CrB, HD 126515. In HD 188041 (Wolff, *Ap. J.*, **157**, 253) elements showing the largest spectral changes show the smallest field changes, non-uniform abundances over the star are deduced. In HD 125248 (Hockey, *M.N.R.A.S.*, **142**, 543) the field is periodic (9 days) and the star is a spectroscopic binary (4·4 years). The cross-over effect was investigated. Conti (*Ap. J.*, **156**, 661) finds no evidence of magnetic fields in 16 Ori or 15 Vul (Am's). This throws doubt on previous reports of magnetic fields in Am's. The possibility that some phenomena of magnetic stars are not periodic is discussed by Jarzebowski (*Budapest*, 227). Zirin (*Ap. J.*, **152**, L177) finds evidence of He^3 (from $\lambda 10830$) in several magnetic stars including γ^1 Vir, a star with high chromospheric activity and lithium content. The primary of the double-lined binary HD 98088 is an Ap magnetic variable. The periods of the binary, of the field and of stellar rotation are the same. The primary mass is 2·2 $M_\odot$ suggesting that the Ap star is on the main sequence for the first time (Abt *et al.*, *Ap. J.*, **153**, 177).

F, G AND K TYPE STARS

General

Pagel (*Liège*, 1968, 189) reviews forbidden absorption lines in late type stars. Scanner observations include: Whiteoak (*Ap. J.*, **150**, 521), G5-K7 dwarfs and subdwarfs in the red; Hagen, v.d. Bergh (*Toronto Publ.*, **2**, 479), F-K stars; Komarov, Pozigoon, *Astr. Zu.*, **45**, 133) α Ari, β Ari, α Cet. Other continuum investigations are: Ardeberg (*Astr. Astrophys.*, **3**, 257), O5-G0, energy distribution as function of type and luminosity; Glebocki (*Acta Astr.* **17**, 381) A-K stars for population differences; Rodriguez (*Kiev*) blanketing effects on colours, F-M stars; Smolinski (*Acta Astr.*, **19**, 103) microturbulence from low dispersion spectra.

F and G types

Cayrel is working on F dwarfs (*Ann. Astr.*, **31**, 43 also 15 Peg) to calibrate Strömgren's m_1, against Fe/H. 16 Psc is a double lined binary (*Astr. Letters*, **1**, 173); this, rather than metal deficiency, accounts for the star's m_1. Spite continues work on G stars, with increasing Fe/H, Ca/Fe and Ti/Fe decrease, Mn/Fe increases (*Ann. Astr.*, **30**, 211, 685; **31**, 269; *Astr. Astrophys.*, **1**, 52). The absolute magnitude dispersion of G giants is being studied spectroscopically. μ Cet (F0 IV) and 36 Per (F4 III) are being studied (Wellmann). The Griffins are making an extensive study of Procyon. Seven F stars studied by Islik (*Trieste Publ.*, 366) and the single-lined binary HR 5317 (F6 IV) (Kondo, McCluskey, *Ap. J.*, **156**, 1007) are probably metallic line stars. Profiles of strong lines in two Hyades F stars give metal abundances 1·5 times solar (as do curve of growth analyses) (Krishna Swamy, *Ap. J.*, **146**, 731). Cayrel also measured line profiles (3rd Harvard) and used spectroscopy and photometry for temperatures and absolute magnitudes of G-K stars. Kipper (*Tartu*, **36**, 241) studied 41 Cyg, ν Her (F stars).

Spectroscopic work (Kraft, Kuhi, *A.J.*, **73**, 221) shows that differences in Strömgren's m_1 are caused primarily by abundance effects though one case of turbulent induced m_1 variations was found (see also Barry, *Ap. J.*, **148**, L87, McNamara, *Ap. J.*, **149**, L133). Kraft (*Ap. J.*, **150**, 551) measured the rotation of many F-G stars; chromospheric activity and rotation decay on the same time scale (rotation halved in $\sim 4 \times 10^8$ years). Powell who has a curve of growth programme on F stars shows that Hβ photometry can give temperatures for F dwarfs (*Astr. Letters*, **2**, 11). Alexander (*M.N.R.A.S.*, **137**, 41) redetermined Fe/H for 18 G dwarfs. Samson (*Edin. Publ.*, **6**, 225) used objective prism plates for F-G abundances and luminosities (v.d. Bergh system).

Parsons made a detailed study of α Per (F5 Ib) and β Aqr (G0 Ib), both stars have large N/C ratios. Further work will use improved model atmospheres (*Ap. J.*, **150**, 263; *Suppl.*, **18**, 127). Line blanketing in supergiants was determined by Rodgers, Bell (*M.N.R.A.S.*, **142**, 161). Hack is obtaining high dispersion spectra of supergiants to study stratification effects.

The lithium-beryllium problem has been reviewed in detail by Wallerstein and Conti (*Ann. Rev.*, **7**, 99). Only recent work, not dealt with by them, is mentioned here. Danziger (*Astr. Letters*, **3**, 115) studied abundances in the Coma cluster and finds that solar mass, main sequence, stars deplete lithium by a factor *e* in 7×10^8 years. He also gives data for some field G-M stars. Feast (submitted to *M.N.R.A.S.*) finds Li^7 the predominant isotope in 12 F-G stars. ζ Dor (F8, slightly above the main sequence), a star with a very active chromosphere, probably has a significant amount of Li^6. Both ω Sgr (a highly evolved subgiant) and γ Pav (a metal deficient subdwarf) have high lithium abundances.

Subdwarfs, subgiants, metal poor stars

The mild subdwarf μ Cas belongs to the α-rich group (also $Y \sim 0{\cdot}26$) (Catchpole *et al.*, *M.N.R.A.S.*, **36**, 403; *R.O.B.*, 154; Cohen, *Ap. J.*, **154**, 179). The cool subdwarf HD 25329 has metals ~1/20 ☉ with Mn lower (Pagel, Powell, *R.O.B.*, 124, curve of growth, Krishna Swamy, *Ap. J.*, **154**, 983, line profiles). In the subdwarfs HD 140283, HD 19445 carbon shares the large metal deficiency (Cohen, Strom, *Ap. J.*, **151**, 623, model atmosphere work). In σ Boo Fe/H ~ ¼ ☉ (Kipper, *Astrophys.*, **4**, 303). The oldest stars seem to contain substantial amounts of helium (Strom, *Ap. J.*, **150**, 501). Microturbulence is *not* a function of metal abundance (*P.A.S.P.*, **80**, 269). C^{13} has not been found in metal deficient stars (Cohen, Grasdalen, *Ap. J.*, **151**, L41) which places restrictions on theories of element production. Jones (*R.O.B.*, 126) includes metal content in a spectral classification scheme. Further work on the very metal deficient giant HD 122563 shows even-odd elements deficient with respect to even-even elements (Wolff, Wallerstein, *Ap. J.*, **150**, 257 from ultraviolet work). The similar star HD 6268 is being studied by Lloyd Evans. Koelbloed (*Ap. J.*, **149**, 299) analysed the metal deficient red giants HD 6755, HD 2665. An over-deficiency of C in HD 6755 was questioned by Cohen (*Astrophys. Letters*, **2**, 163) who used a more refined analysis. Harmer, Pagel (MS) find N is more deficient than metals in the metal deficient star ν Ind using CN 3883. They suggest that various earlier analyses for N using 4215 CN are in error because of blending problems. The C abundance in HD 122563 (cf. Pagel, Ball, *Observatory*, **87**, 19) is now being re-examined (Pagel).

K types

Griffins fine atlas of Arcturus has been published and several studies made of it (*M.N.R.A.S.*, **137**, 253; *Observatory*, **87**, 253; **89**, 9, 62); atmospheric parameters and metal abundances (~⅓ ☉) were determined: [O I], [Fe II], [Ca II], Rb I absorptions were found and hyperfine line structure discussed. Wavelengths, identifications and equivalent widths for 1036 stellar lines 11 407–25 129 Å are given by Montgomery *et al.* for Arcturus (*Ap. J. Suppl.*, **19**, 1, high resolution Fourier transform spectra by Connes). Helfer and Wallerstein (*Ap. J. Suppl.*, **16**, 1) completed a curve of growth analysis of 27 early K giants, some have over-abundances of V, Mn, Co, some have subsolar masses. They find Na anomalies as does Cayrel (*Ann. Astr.*, **29**, 413 details of 7K stars). Griffin analyses two Hyades giants and β Her and α Ser (CN strong K2 III, metals ~2 ☉) (*M.N.R.A.S.*, **143**, 223, 381). Work on 61 Cyg B is in progress (Kandal, *Trieste*, 1966, 148; Catchpole). 70 Oph (K0 V), ε Peg (K2 Ib), 61 Cyg A (K5 V), ξ Cyg (K5 Ib) have about solar abundances (Boyarchuk, Voihanskaja).

Spinrad, Taylor (*Ap. J.*, **157**, 1279) use a scanner to measure line and band strengths and also visual and infrared continua (for temperatures). They find evidence for supermetallicity amongst substantial numbers of evolved K stars including stars in M 67 and NGC 188. Lack of agreement with curve of growth analyses of the cooler K stars is attributed to unsuspected opacities affecting the latter. Further work is clearly required, see for instance Cayrel (*Paris*, 1967, 239) and Rodgers (*M.N.R.A.S.*, **145**, 151) who suggests that the old disk star δ Pav (G8 V) would qualify as a Spinrad-Taylor supermetal star but has in fact solar abundances and high microturbulence. Pagel is studying spectra of M 67 stars for signs of super-metallicity.

Schadee (*Ap. J.*, **151**, 239) computes band intensities in G-K stars for different C, N, O abundances. Enhancement of CN, C_2, CH in two metal strong K giants suggests $C/O \sim 1$ (Greenstein, Oinas, *Ap. J.*, **153**, L91). C, N, O abundances were determined in 4K giants (Greene, *Ap. J.*, **157**, 737); N is enhanced for $M \geqslant 2M_{\odot}$. There are discrepancies between the observed and predicted red CN band strengths. There has been further work on the auto-ionization lines of Ca I (*B.A.N.*, **18**, 259; *Ap. J.*, **146**, 719; *P.A.S.P.*, **79**, 33). Rousseau discusses line blanketing (*Trieste*, 1966, 174). The Cambridge narrow band photometry has continued (*M.N.R.A.S.*, **131**, 467; **133**, 99, 449; **134**, 135,

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171; **140**, 21; *Observatory*, **87**, 18). Lines measured include Fe I, Hα, Na. Analysis (Peat, Pemberton, Price, Scarfe) indicates Ca, Na but not Mg are deficient in high velocity stars. Mg is more abundant in the Hyades than in Coma. Weistrop (*P.A.S.P.*, **79**, 546) studied Hα as a luminosity criterion and found variations in Hα in 22 Vul (G0 Ib) over a 3-year period.

M, N AND S TYPE STARS

There are no systematic differences between high dispersion spectra of low and high (intermediate Population II) velocity K2-M6 giants though some high velocity M stars have strong lines slightly weakened (Deutsch *et al.*, *Ap. J.*, **156**, 107). Spectral classification is discussed by Yamashita, Treanor, McCarthy (*Trieste*, 1966, 94, 109). Boesgaard reports: from MgH (5211 Å) in K-M stars, Mg^{25}, Mg^{26} are present in at least their terrestrial proportions (*Ap. J.*, **154**, 185): Little trace of S characteristics was found in a group of 26 M giants, if M stars evolve into S stars they do so very rapidly (*P.A.S.P.*, **81**, 365); Ti/Zr is 5–10 times greater in K, M stars than in MS, S or Ba II stars: She is working with Deutsch on the circumstellar envelopes of M giants (from profiles of Ca II, Na I, Hα). Abundance work on M stars includes: Orlov, Rodriguez, Shavrina (*Kiev*), Kipper (*Tartu*); Yokoo (*Tokyo*) who is analysing 3 high velocity giants. Boyarchuk (*Astrophys.*, **4**, 289, *Izv. Kzym.*, **39**, 114) studied TiO absorption in M stars. A great deal of infrared work on cool stars has been carried out recently. This is adequately covered by the review of Spinrad and Wing (*Ann. Rev.*, **7**, 249).

In the S star HR 1105 the ZrO bands show that the Zr isotope ratios are different from the terrestrial values and neither O^{17} nor O^{18} are found: there is little evidence for Tc (Schadee, Davis, *Ap. J.*, **152**, 169, L13). Tsuji studied atmospheric structure, composition and mass ejection effects in R And and R Cyg (S types). Locanthi (Davis) is preparing a wavelength list for S stars and V Cnc (intermediate S-Ba II). She and Keenan find NbO in R Cyg.

A major attack on the problems of C stars has continued in Japan (*Proc. Japan Acad.*, **43**, 472. 966; **44**, 495; **45**, 272, 484; *P.A.S.J.*, **19**, 342; **20**, 731; **21**, 41; *Trieste*, 1966, 49, 75; *B.A.C.*, **19**, 274). Results and work in progress include: analysis of high dispersion R star spectra using non-grey model atmospheres (Tsuji); identifications and curve of growth analyses of 22 C stars in the visible (Utsumi); isotope work on Merrill-Sanford bands and analysis of early C stars (including CH stars) (Utsumi, Yamashita); analysis of WZ Cas (Hirai); spectral scanning of CN red bands for spectral classification (Fujita); C^{12}/C^{13} ratios (Fujita *et al*). Fujita's monograph *Interpretation of Spectra and Atmospheric Structure in Cool Stars* (Univ. of Tokyo Press) will be published soon. Other C star work is: C^{12}/C^{13} ratios Climenhaga (*Trieste*, 1966, 54); rotational temperatures (CN red bands) Querci *Ann. Ast.*, **30**, 557); detailed computations of CN rotational profiles and band analysis (Fay); low dispersion spectra of C stars (Catchpole, *P.A.S.P.*, **80**, 744); population differences (Krempec (Torun)); calculations of molecular dissociative equilibrium (Morris, Wyller, *Ap. J.*, **150**, 877). Boesgaard has determined lithium abundances in 20 MS, S and Ba II stars. Some S stars have lithium abundances 2–3 orders of magnitude more than the Sun. Catchpole and Feast have so far found one very lithium rich S star in their spectroscopic survey of southern S and C stars. A very lithium rich S-C star was found earlier (Feast, *Highlights in Astronomy*, 232). Boesgaard finds Li^6 is 12 % (±6 % p.e.) of the total Li in δ Sgr (M2 Ib-II) (*Ap. J.*). This is less than the normally expected spallation ratio. Lloyd Evans has made a survey of a large number of southern M stars for lithium.

HYDROGEN POOR AND OTHER PECULIAR STARS INCLUDING SYMBIOTIC STARS

Work on helium stars includes: revised abundances in HD 168476, HD 124448, oxygen abundance $\sim \frac{1}{4} \odot$ from O I 7774 (Hill, *Mon. Notes astr. Soc. Sth. Afr.*, **28**, 56, *Observatory*); model atmosphere analysis of BD + 10° 2179, both it and HD 124448 have a high carbon abundance (Hunger, Klinglesmith, *Ap. J.*, **157**, 721); HD 264111 which may be a subdwarf has He/H ~ 1·0 (by number), it resembles HD 96446 (Stephenson, *Ap. J.*, **149**, 35). For υ Sge: Nariai discusses the mechanism of mass loss (*P.A.S.J.*, **19**, 564); Lee, Nariai find a large infrared excess (probably from a shell) (*Ap. J.*, **149**, L93); Sahade, Albano detect dilution effects. For the hydrogen poor star HD30353 Nariai (*P.A.S.J.*, **19**, 63) finds a general metal deficiency, Wallerstein *et al.* (*Ap. J.*, **150**, 239, 245) do not, N_C/N_N is 10^{-3}. Warner (*M.N.R.A.S.*, **137**, 119) determined abundances for 5 cool hydrogen deficient, carbon rich stars.

For Ba II stars: Griffin (*M.N.R.A.S.*, **143**, 381) finds Ti, V deficient and *s*-process elements enhanced in HD101013; Nishimura (*Trieste*, 1966, 124) and Cowley (*Ap. J.*, **153**, 169) obtained abundances in HR774 which may be slightly Fe/H deficient. Ba II stars may be a high temperature extension of the N stars (Gordon, *Ap. J.*, **153**, 915). Hiltner *et al.* (*Astrophys. Letters*, **2**, 153) describe three peculiar emission objects. The Swings (*Liège*, 1968, 99) discuss possibilities of observing forbidden iron lines ([Fe I] to [Fe VII]).

Further support has been found for the binary theory of symbiotic objects. Boyarchuk (*Sov. A.J.*, **44**, 1016; *Izv. Krym.*, **39**, 124) explains ZAnd as an M2III + a hot subdwarf and AXPer, CICyg and BFCyg as M5III stars with hot subluminous companions. Faraggiana, Hack (Liège, 1968, 317) suggest that CHCyg is M6III + a blue unstable subdwarf. WYVel (M3 Ib) now shows evidence of a B3 star (Cowley). Other work is: spectrophotometry of AGDra and AGPeg (Chkhikvadze); emission line intensities and abundances (~ solar) for AXPer, CICyg, BFCyg, V1016Cyg (Boyarchuk); scanner observations (3300–11000Å) of CHCyg, AGPeg, ZAnd, AXPer, BXMon, TCrB, V1016Cyg (Lambert); studies of SYMus, Henize1213, and CPD −36° 8436 (Carlson, Northwestern Thesis); ultraviolet emission in Boss 1985 (Swings *et al.*, *Ap. J.*, **155**, 515); the existence of two distinct envelopes in AGPeg (Lopez, Sahade, *Bol. Arg. Astr.*, **14**, 68). In V1016Cyg (MHα 328-116) which may be the early stage of a planetary nebula (FitzGerald, Houk, *Ap. J.*) the continuum may be collisional excited in a nebulosity (Gerola, Caputo, Panagia).

BINARY STARS

VVCep has multiple Hα absorptions, probably arising in a gaseous stream (Wright, Larson, *Trieste*, 1968, 106). Faraggiana, Hack who plan to study this star spectroscopically over its 20 year cycle, suggest it is a contracting star. Glebocki, Keenan (*Ap. J.*, **150**, 529) find evidence for an oxygen cloud around the companion. Cowley (*P.A.S.P.*, **81**, 297) reviews problems of the VVCep stars. CD −61° 3575 may belong to this class (Calson). The peculiar binary GG Car was described by Calson and is being studied by Sahade. Wellman finds εAur fits Huang's model but Hα emission variations are unexplained. Wright *et al.* (*Publ. Dom. Astrophys. Obs.*, **13**, No. 11, *J.R. astr. Soc. Can.*) find the "clouds" producing the multiple K-lines have lifetimes of days or weeks. Work is also in progress on this star by Hack, Kitamura. 1961/62 eclipse spectra of 31Cyg show the superexcitation is probably chromospheric (Wellman). Kitamura studied the chromospheric K line at the 1963/64 eclipse of ζAur. Spectrophotometry of βLyr supports Sahade's work on emission line structure (Svolopoulos, *A.N.*, **290**, 155). Structure and variations of He I 10830Å in this star are reported (Knappenberger, Fredrick, *P.A.S.P.*, **80**, 96; Alduseva, Esipov, *Astr. Zu.*, **46**, 113).

Other spectroscopic work on binaries includes: HZ 22 is a hot subdwarf binary ($P < 1^d$) (Smak); In UCep, satellite H lines appear at quadratures (Batten, Andrews); Kumsishvili did spectrophotometry of V448 Gem and RYGem; Kitamura, Sato (*Astrophys. Space Sci.*, **3**, 163; *P.A.S.J.*, **19**, 575) studied RCMa, RZScu, Andrews (*Ap. J.*, **147**, 1183) discusses Hα emission in Algol. Mass loss from binaries has been extensively discussed (*Trieste*, 1968). Olson (*Ap. J.*, **153**, 187) compares surface gravities for eclipsing systems from orbital parameters and from line profiles interpreted with broadening theory. 57Peg is a spectroscopic binary (M4 IIIa + A3 V) (Hackos, Perry, *A.J.*, **73**, 504). HD118216 is a semi-detached system viewed at low inclination (Conti, *Ap. J.*, **149**, 629). 17Lep is an M + B binary (Cowley, *Ap. J.*, **147**, 609). Supression of Hε in AXMon may be due to flare activity in the K star (Cowley *et al.*, *P.A.S.P.*, **79**, 21).

Meisel (*A.J.*, **73**, 350) determined types and rotational velocities in 50 visual binary systems. Murphy (*A.J.*) studied binaries with B type primaries. Several secondaries are probably pre-main sequence stars. In composite systems (typically G giant + A Dwarf) the rotational velocities of the early type components are on the average less than in the general field (Markowitz, (Perkins)).

WHITE DWARFS, NUCLEI OF PLANETARY NEBULAE

Greenstein continues his work on white dwarfs. DB star frequency increases with decreasing space velocities. λ4670 stars seem confined to the high velocity group or binary systems. Work with Trimble on the Einstein effect has been published (*Ap. J.*, **149**, 283). Spectroscopy has been extended to the infrared. Other work is: spectral scans (Oke); Sirius B at 10 Å mm^{-1} (Kodaira, *P.A.S.J.*, **19**, 172); a new white dwarf (Hiltner *et al.*, *Astr. Letters*, **2**, 153). Emission nuclei of planetary nebulae are classified by Smith and Aller (*Ap. J.*, **157**, 1245).

STELLAR CHROMOSPHERES

Recent reviews are Praderie (IAU Colloquium No. 42; Feast, *Lunteren*). Work on Ca II emission in late type stars includes; variations in giants (sometimes flare-like). Liller (*Ap. J.*, **151**, 589 Deutsch, *P.A.S.P.*, **79**, 431; *Lunteren*); use of a spectrum scanner, chromospheric activity and age, variations in main sequence stars (e.g. 61 Cyg A period ~ 6½ months, 61 Cyg B period ~ 1 year) (Wilson, *Ap. J.*, **153**, 221, etc.); variations in o' Ori (MS type); (Boesgaard, *P.A.S.P.*, **81**, 283); use of Ca II emission to define lower main sequence of Hyades and Pleiades (Kraft, Greenstein, *Low Luminosity Stars*, 1969; also Haro, Chavira, *Ton. Bol.*, **31**); widths and intensities in 200 southern stars, emission in γ Vir N (F0 V) (Warner, *M.N.R.A.S.*, **144**, 333; *Observatory*, **88**, 217); Ca II in γ Boo (Praderie); intensification of emission in binaries (Abt *et al.*, *Ap. J.*, **157**, 717); inverse correlation of emission and intrinsic polarization (Dyck, Johnson, *Ap. J.*, **156**, 389). Wilson finds H and K widths are similar in normal and very metal deficient giants. However Pagel, Tomkin (*Q.J.R.A.S.*, **10**, 194) find that K widths underestimate (~ 1^m) the luminosities of metal deficient giants.

Vaughan, Zirin studied chromospheric He I 10830 Å absorption (and sometimes emission) in late type stars (*Ap. J.*, **152**, 123). The line originates in clouds or streams, not a homogeneous layer. Work continues and time variations are found. ε Gem (G8 Ia), θ Her (K1 II) have strong chromospheric activity and strong CN absorption which may thus be a general indicator of such activity (Zirin). Chromospheric He I 5876 absorption is present in ζ Dor (F8), other work is in progress (Feast). Deutsch has studied chromospheric Balmer absorption and Hε emission which are strongly time dependent in some red giants (cf. also Deutsch *et al.*, *Ap. J.*, **156**, 107).

M. W. FEAST
President of the Commission

29a. WORKING GROUP ON ABSOLUTE SPECTROPHOTOMETRY

Two new and independent determinations of the absolute spectral energy distribution in α Lyr have been completed during the last three years. The first of these by Hayes has been published in part (Wolff, Kuhi and Hayes, 1968). It was done at the Lick Observatory using the Crossley reflector and two ribbon-filament standard lamps. His published results are based on the old practical temperature scale which is based on a melting point for gold of 1336·16K. The new scale has been adjusted to agree as well as possible with the thermodynamic temperature scale and is based on 1337·59K for the melting point of gold. Hayes' results have been adjusted to this new scale and are shown in Table 1. The numbers listed are $-2{\cdot}5 \log f_\nu + \text{const.}$ when f_ν is the flux from α Lyr in ergs s^{-1} cm^{-2} Hz^{-1}. The results are normalized to 0·000 at λ5556.

The new calibration by Oke and Schild was carried out on Palomar Mountain. A four inch reflecting telescope was built and mounted with the prime focus scanner which was built for the 200-inch telescope. Three light sources were used (1) a ribbon-filament standard lamp calibrated with an accuracy of 2% by the National Bureau of Standards was used from λ3300 to λ8000. (2) Radiation from a sight tube immersed in pure copper in the process of melting or freezing was

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