Boyarchuk, A. A. 1959. *Astr. J., Moscow* **36,** 766. A quantitative analysis of the chemical composition of the atmosphere of the bright component of β Lyr.
Jugaku, J. 1959. *Publ. astr. Soc. Japan* **11,** 161. On the abundance ratio of He to H in the atmosphere of τ Sco.
Neven, L. 1959. *Commun. Obs. Belg.* **157,** 112. Effets de saturation dans les raies de fraunhofer.
Baschek, B. 1960. *Z. Ap.* **50,** 296. Abhangigkeit des Strögrenschen Index m und der farbindices *U-B*, *B-V* von der Metallhäufigkeit bei sonnenähnlichen Sternen.
Khokhlov, M. Z. 1960. *Publ. Crim. Aph. Obs.* **22,** 128. An estimate of the upper limit of the lead content of the solar atmosphere from the infra-red lead line λ7229.
Aller, L. H. 1961. Interscience Press, New York. *Abundances of the elements.*

29*b*. SOUS-COMMISSION DES ETALONS D'INTENSITE DE RAIES

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MEMBRES: Abt, Butler, Greenstein, Houtgast, Melnikov, Plaskett, Righini, Wrubel.

INTRODUCTION

The most important accomplishment in the field of line intensity standards in stellar spectra during the past three years has been the development of a high-dispersion photo-electric scanner at the coudé focus of the Mount Wilson 100-inch telescope. For many years it has been felt that there should be a direct check on measurements of line intensities obtained by the techniques of photographic spectrophotometry. Even at high dispersion there is often a very large range in density on a photographic plate over the small area covered by a sharp stellar absorption line and numerous errors can be made with little probability of detection. Calibration techniques, while fairly well standardized at several observatories, require frequent checks to make certain that conditions under which the stellar and calibration spectra are photographed are as nearly identical as possible. One of the principal aims of this Sub-Commission has been to arrange that spectra of a few selected stars should be obtained and that equivalent widths and profiles of representative lines should be measured at several observatories for inter-comparison purposes and to serve as first-approximation standards in the hope that at least the observational data, on which studies of stellar atmospheres are based, should be comparable. The 'operational' use of the Mount Wilson high-dispersion scanner is an important addition to stellar spectrophotometry and it is hoped that its success will provide new impetus toward the installation of similar instruments at other observatories.

MOUNT WILSON PHOTO-ELECTRIC SCANNER

The following brief description of the Mount Wilson photo-electric scanner has been abstracted from a report prepared by J. B. Oke and J. L. Greenstein:

'One of the purposes of this instrument is to provide accurate measurements of the equivalent widths of spectral lines. It is used in conjunction with the 114-inch camera. The light is detected by 1P21 photomultiplier tubes. One channel of the instrument monitors about 75 Å of spectrum adjacent to the spectral region being scanned. The second channel is used to scan the spectrum. The grating and photo-electric equipment do not move while the spectrum is being scanned. The ratio of the scan and monitor signals, amplified by independent D. C. amplifiers, is recorded continuously. By proper balancing, seeing effects under favorable conditions can be almost entirely eliminated. The observations were made with the grating

usually used at the coudé focus of the 100-inch telescope. The dispersion at the scanning slit is 2·8 Å/mm and the scans were made over a range of about 50 Å at a rate of 1·35 Å/minute. At present no measurements have been made of the scattered light of the spectrograph. The photo-electric scanner is well adapted to this type of measurement and such measurements will be made shortly.

'Preliminary results of observations made with the photo-electric scanner are given in Table 1; given for comparison are measurements obtained photographically by other observers. Since the equivalent widths depend strongly on the location of the continuum, it is necessary to specify how it was chosen. The wave-length interval chosen to represent the continuum is listed in column 4.'

Table 1. Equivalent widths

Star	Tracings	Entr. exit slits	Location of continuum	Equivalent width 4471 Å			4481 Å		
				Scanner	Other obs.		Scanner	Other obs.	
		μ	Å	Å	Å		Å	Å	
τ Sco	3	100	4457·0—4462·3	1·212	1·24	*a*	0·110	0·105	*a*
		100	4483·2—4487·0		0·98	*b*		0·105	*b*
					1·00	*c*		0·090	*g*
					1·06	*g*			
10 Lac	4	160	4460·0—4464·0	0·995	1·38	*d*	0·095	0·087	*g*
		150	4475·0—4479·7		0·93	*e*			
			4482·0—4487·5		0·92	*g*			
9 Sge	3	160	4459·0—4468·0	0·656	0·72	*f*			
		150	4474·8—4478·0		1·30	*d*			
					0·95	*e*			

References: *a*. Aller and Jugaku *b*. Unsöld *c*. Mount Wilson *d*. Petrie *e*. Underhill *f*. Oke *g*. Traving

The results given in Table 1 are preliminary. A revised version is given by Oke and Greenstein (11).

REPORTS

Reports from other observatories in reply to a circular requesting information concerning programs relating to the work of the Sub-Commission were received as follows:

Crimea. I. M. Kopylov (1, 2) has studied spectra of numerous O5 – B7 stars with moderate dispersion (20 – 70 Å/mm) and has measured equivalent widths in the region λλ3734 – 4922 of the recommended 'standard' stars, α Cam (O9·5 Ia), ρ Leo (B1 Ib), χ^2 Ori (B2 Ia), ζ Cas (B2 V), γ Peg (B2·5 IV) and ι Her (B3 V).

Edinburgh. The work on early-type stars has been completed with papers by H. E. Butler and H. Seddon (3) and H. E. Butler and G. I. Thompson (4). Butler is also studying a number of Mount Wilson spectra of B-, A- and F-type stars.

Heidelberg. Kienle and his associates have made new measures of the step-ratios at several wave-lengths for Minnaert's platinum-on-quartz step filter and also for the Heidelberg 10-step Zeiss platinum-on-quartz step filter. Both of these step filters have been placed at the disposal of the Sub-Commission.

Kiel. Unsöld and his associates have studied Mount Wilson coudé spectra of B- to G-type stars, measuring numerous equivalent widths and giving theoretical interpretations as far as possible: HD 142283 (G-type sub-dwarf), λλ 3430 – 8700, B. Baschek (5); α Lyr (A0 V),

λλ4800 – 8750, S. Matsushima and H. G. Groth (**6**), and K. Hunger (**7**); α Cyg (A2 I), λλ3300–8700, H. G. Groth (**8**), which includes a suitable enlargement of the infra-red spectrum to identify telluric lines; γ Ser (F6 V), λλ4200 – 8700, W. Kegel (**9**), G. Traving has also taken spectra of τ Sco (Bo V) and α CMa (A1 V) in the regions, λλ4000 – 6700 and λλ3100 – 6700 with dispersions of 1·3 and 0·8 Å/mm respectively, and these will be used 'as standards along the stellar temperature sequence'. Unsöld recommends the study of the infra-red region of stellar spectra since there is almost no blending and interesting lines of lighter elements and high-excitation lines of the heavier elements are observed.

Kitt Peak. Abt plans to make equivalent-width measurements of some standard stars, and is interested in problems concerning the relative efficiency and accuracy of photo-electric and photographic methods of stellar spectrophotometry.

Michigan. Aller and Jugaku have measured equivalent widths of numerous lines in Mount Wilson spectra of HD 36959 and 36960, 22 Ori, 114 Tau, φ Ori, λ Ori, and α Scl. Profiles of the hydrogen and helium lines have also been measured on these plates.

Mount Stromlo. Aller and Faulkner are working on standards for spectrophotometry in the southern skies. They plan to make scans with their relatively low-dispersion spectrophotometer of α Car and several southern B-type stars, but their main effort is to establish the energy distribution in the continuous spectrum for comparison with northern standards.

Mount Wilson and Palomar. In addition to the work on the photo-electric scanner described above, Greenstein has obtained additional plates of θ Leo (A2 V), σ Boo (F2 V) and α CMi (F5 IV-V) for purposes of inter-comparison and of standards for line intensities.

Padova. Taffara has obtained several plates of θ Leo (A2 V) with cameras III and IV (dispersions 40 Å/mm and 13 Å/mm at H_γ) of the Asiago spectrograph, and is comparing the Asiago intensity calibration with the Keinle step filter.

Stockholm. Sinnerstad has measured equivalent widths in 179 early-type stars from spectrograms with a dispersion of 75 Å/mm. Comparisons show good agreement with the Mount Wilson, Victoria and Edinburgh systems. For 35 stars, measurements of Hβ and Hγ give the ratio, Mean W (Stockholm) / Mean W (Edinburgh) = 0·97 ± 0·05, which is very satisfactory.

Utrecht. Houtgast is now preparing apparatus to scan the solar spectrum photo-electrically with different resolutions, and will compare tracings so obtained with the Utrecht Solar Atlas. Thus the solar spectrum may be used as a standard for comparison with similar spectra obtained with other instruments of lower resolution. Minnaert has also provided a step-weakener for checking calibration procedures at different observatories.

Victoria. Wright and Lee have made intensity tracings of several plates of each of the following stars recommended by the Sub-Commission: ρ Leo (B1 Ib), γ Peg (B2 IV), ι Her (B3 V), γ Gem (A0 IV), θ Leo (A2 V), 68 Tau (A2 V), 15 Vul (A5 m), σ Boo (F2 V), α CMi (F5 IV-V), 110 Her (F6 V), λ Ser (G0 V) and μ Her (G5 IV). The tracings have been studied over the region λλ3900 – 4080 and λλ4170 – 4500, and equivalent widths of several hundred lines have been measured. Analysis of the measures is well under way and the results should soon be ready for publication.

GENERAL COMMENT

It seems probable that, in spite of the necessity for accurate calibration and the uncertainties due to grain of the emulsion, photographic methods of deriving equivalent widths of absorption lines in stellar spectra will continue to be used for some time since large stretches of spectrum can be photographed simultaneously in a reasonable time, and can be analyzed later.

Photo-electric scanning instruments will undoubtedly be developed rapidly and, with the use of multi-channel slits, may eventually rival photographic methods in speed as well as in accuracy. Certainly for the study of line profiles, or other purposes where only short stretches of the spectrum are to be investigated, high-dispersion photo-electric spectrophotometry will be used more and more. The relative advantages of photographic and photo-electric methods were discussed by T. Dunham, Jr. (10).

Several members of the Sub-Commission have recommended that calibration devices used for photographic spectrophotometry should be checked by photo-electric means since the response of photomultiplier tubes is linear over a large range of intensity. This should certainly be done where possible, although at the very low light levels that are often used in calibrating spectrographs, the sensitivity of some commercial photometers is not adequate.

The calibration devices at several observatories have already been checked by means of the step filters made available to the Sub-Commission by Minnaert and Kienle and re-calibrated at Heidelberg by Kienle. The thanks of the Sub-Commission are extended to Professor Kienle and Professor Minnaert for their co-operation in thus encouraging the use of standardized procedures in spectrophotometry.

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President of the Sub-Commission

REFERENCES

1. Kopylov, I. M. *Publ. Crim. Aph. Obs.* **20**, 123, 1958.
2. Kopylov, I. M. *Publ. Crim. Aph. Obs.* **20**, 156, 1958.
3. Butler, H. E. and Seddon, H. *Publ. R. Obs. Edinb.* **2**, 187, 1960.
4. Butler, H. E. and Thompson, G. I. *Publ. R. Obs. Edinb.* **2**, 225, 1961.
5. Baschek, B. *Z. Ap.* **48**, 95, 1959.
6. Matsushima, S. and Groth, H. G. *Z. Ap.* **49**, 126, 1960.
7. Hunger, K. *Z. Ap.* **49**, 129, 1960.
8. Groth, H. G. *Z. Ap.* **51**, 206, 1961.
9. Kegel, W. In preparation.
10. Dunham, T., Jr. *Vistas in Astronomy*, **2**, 1223, 1956.
11. Oke, J. B. and Greenstein, J. L. *Ap. J.* **133**, 349, 1961.

29*c*. SOUS-COMMISSION DES CLASSIFICATIONS STELLAIRES

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INTRODUCTION

The isolation of groups of stars having similar properties—and the subsequent study of relations between these groups—has proved essential to our understanding of the stellar universe. Naturally this categorization of stars has been accomplished in a variety of ways. Sub-Commission 29*c* is primarily concerned with the classification of stars on the basis of their spectra, whether the requisite spectral information is acquired by conventional photographic techniques or by more sophisticated photo-electric instrumentation.*

*Thus a classification of variable stars based on their light variations alone is not considered a concern of this Sub-Commission.