Waltraut Carola Seitter

ATLAS for OBJECTIVE PRISM SPECTRA

BONNER SPECTRAL ATLAS II

DÜMMLER

VERÖFFENTLICHUNGEN DER ASTRONOMISCHEN INSTITUTE BONN

WALTRAUT CAROLA SEITTER

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Meinen Eltern

To my Parents

PREFACE

As in PART I of the atlas the author is indebted to a number of dedicated and capable collaborators.

Above all, thanks go to *Dr. Hilmar W. Duerbeck* who contributed about 20 % of the spectra used in the atlas. Without his excellent assistance the completion of the plate material could not have been achieved during the allotted time interval. His untiring attention and valuable advice during all stages of preparation of the atlas were equally indispensable.

It is a pleasure to thank *Professor Dr. Hans Schmidt*, Director of the Bonn Observatory, who extended his generous hospitality to me on numerous occasions, thus permitting me to carry out this project at Hoher List, even after I had accepted a position in the USA. It is due to his efforts that financial support for this project was secured.

Alice Lindner-Koch proved to be as dependable and efficient in performing the laborious task of labelling the atlas plates as in the first part of the atlas. Several of my American students participated in the preparatory work.

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Again, it is a pleasure to acknowledge the extreme care exercised by the printing company, *Graphische Kunstanstalten E. Schreiber, Stuttgart*, especially the competent work of *Harry Häfner, Günter Höll* and *Werner Kind*.

Thanks go to the administrations of *Smith College* and the *Five College Astronomy Department* (and my deserted students there) for granting a number of leaves during which I had the opportunity to work on the atlas.

The *Deutsche Forschungsgemeinschaft* supported the atlas with several grants which are most gratefully acknowledged.

Spring 1975 Waltraut Carola Seitter

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I. INTRODUCTION

1. Objectives and Correlation with the MK System

PART II of the *Bonner Spectral Atlas* presents side by side MK standard spectra of (reciprocal linear) dispersions 645 and 1280 Å/mm at Hγ.* The application of the MK system is thus extended to low and very low dispersions following the objectives stated in PART I (1) of the atlas:

> *To link the classification of objective prism spectra, especially those of low dispersion, to the MK system.*
>
> *To approach the classification accuracy of the MK system as closely as possible within the instrumental limits.*

All stars displayed in PART I and PART II of the atlas are taken from the catalogue of MK standard stars of 1953 (2). The 159 different types are represented by the *same* stars in all three dispersions (with the accidental exception of KO III). The arrangement of the stars is the same on all atlas plates so that intercomparison of the spectra taken with different dispersions is facilitated.**

The *combination* of PART I and PART II then gives:

> *The collateral presentation of different dispersions in order to trace the change of useful criteria in proceeding to smaller resolutions. It serves as an aid in interpolating criteria for dispersions over the total range 240 - 1280 Å/mm at Hγ.*

2. The Revised 1973 System of MK Classification

During the period in which PART II of the *Bonner Spectral Atlas* was in preparation, a revision of the MK system was published by Morgan and Keenan (3). A comparison of the 1953 and the 1973 standards is given in the *Bonner Spectral Atlas Supplement* (4).

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* Throughout the second part of the atlas we retain the unit Ångström for wavelength measures in order to be consistent with the first part. The unit *nanometer*, which will be in official use in some countries starting in 1976, is larger by one decimal place:

$$1 \text{ Ångström} = 0.1 \text{ nanometer} = 10^{-10} \text{ meter.}$$

Thus all numbers given in the text and on the atlas plates can be transformed into the new unit through division by 10.

** A small change in the scale of the atlas plates of PART II was requested by the printer. The alignment of plates from the two parts is thus not perfect.

Here it has to be explained why we did not use the revised "dagger - system" and what the resulting errors in the *Bonner Spectral Atlas* are.

Five reasons made it desirable or justified to retain the 1953 MK system:

1) PART I of the *Bonner Spectral Atlas* was already published and for PART II all observational work had been completed before the 1973 system became available.

2) Our *primary* purpose, the use of several dispersions side by side for the *same* stars, could not have been accomplished if in PART II we had changed the stars according to the new system.

3) So far, relatively few stars of early and medium types define the new system (though additional standards from various sources are suggested by Morgan). A more complete coverage of types, however, leads to a higher classification accuracy, which partly balances the defects of the older system.

4) Considerable overlap exists between the two systems. All stars common to both are marked in the LIST OF STANDARD STARS according to a key given on page 19.

5) It is shown in reference (4) that the errors introduced through the use of the older system lie largely within the accuracy expected at the low dispersions used in the *Bonner Spectral Atlas*.

3. Classification Accuracy

The classification accuracy at all three dispersions (240 Å/mm at Hγ in PART I; 645 and 1280 Å/mm at Hγ in PART II) is considerably larger than has hitherto been expected for dispersions less than about 100 Å/mm. A detailed discussion of the classification accuracy attainable on low-dispersion spectrograms is given in the *Bonner Spectral Atlas Supplement* (4). In the present introduction it may suffice to list in TABLE 1 the mean errors in spectral types and luminosity classes for the different dispersions, obtained according to a method described in (4). For comparison, estimates made by M. and C. Jaschek (5) are given.

TABLE 1

O9 - M2 V - Ia	240 Å/mm	645 Å/mm	1280 Å/mm
S	± [0.31] 0.16 (0.16)	0.16 (0.16)	0.31 (0.23)
L	± [1.2] 0.8 (1.0)	1.0 (1.5)	1.5 (1.8)

S = spectral type

The numbers are errors in spectral classes of the sequence O9 - M2. The numbers in brackets are estimates by M. and C. Jaschek (5); the values in square brackets are uncorrected earlier estimates which include larger personal errors.

L = luminosity class

The numbers refer to seven luminosity classes (V,IV,III,II,Ib,Iab,Ia). The numbers in brackets are estimates by M. and C. Jaschek (5); the values in square brackets are uncorrected as above.

II. TECHNICAL DATA

1. Instrument

As in PART I of the atlas, the instrument used for observation is the 340/500/1375 mm (diameter of correcting plate/mirror diameter/focal length) Schmidt-telescope of the Hoher List Observatory of Bonn University.

The data pertaining to the prisms used in the second part of the atlas are given in TABLE 2 and TABLE 3.

TABLE 2

Glass		Refractive Index at h		Angle of Refraction
F3		1.62464		2°67
Reciprocal Linear Dispersion in Å/mm at Different Wavelengths				
3500 Å	3700 Å	Hγ	Hα	8000 Å
260	350	645	2200	4100

TABLE 3

Glass		Refractive Index at h		Angle of Refraction
UBK 7		1.52198		3°12
Reciprocal Linear Dispersion in Å/mm at Different Wavelengths				
3500 Å	3700 Å	Hγ	Hα	8000 Å
600	755	1280	3800	7000

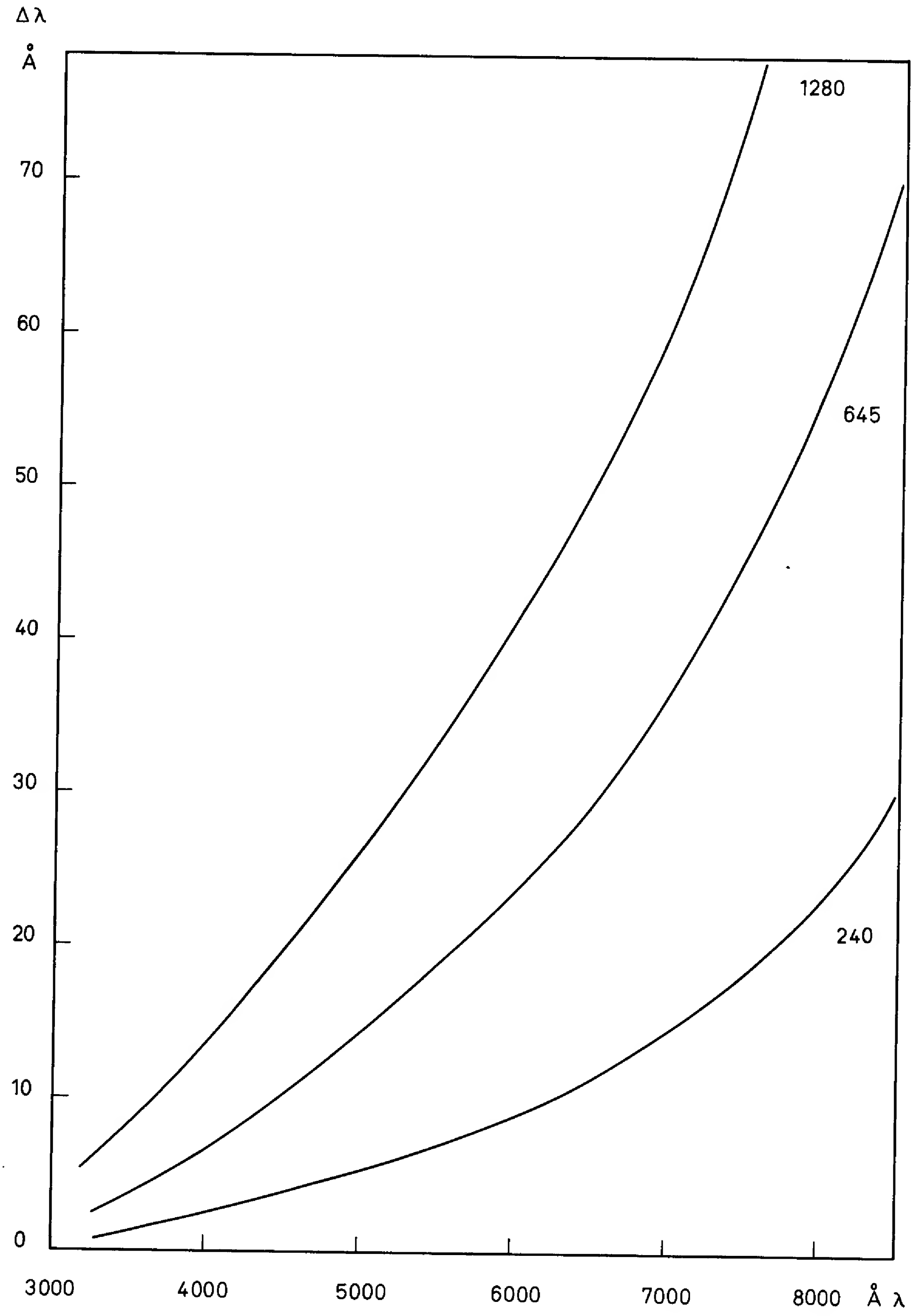


FIG. 1. Wavelength resolution Δλ in Ångström units as a function of wavelength λ for dispersions 240, 645 and 1280 Å/mm at Hγ at the Bonn Schmidt telescope with 2" seeing.

The different changes in slope with wavelength of the three curves result from the fact that the two higher dispersions are obtained with flint glass prisms (F3) and the lowest dispersion with a crown glass prism (UBK 7).

The wavelength resolution $\Delta\lambda$ (separation in Ångström units of two sharp lines which are just resolved) at 2" seeing (other effects neglected; equivalent to medium resolving power of the photographic emulsion) is determined according to Bowen (6) through the relation

$$\Delta\lambda = T \cdot \beta \cdot K$$

where

$\Delta\lambda$ = resolution in Å
T = focal length of the telescope in mm
β = seeing in radians
K = (reciprocal linear) dispersion in Å/mm.

The relations for all three dispersions used in PART I and PART II of the atlas are shown in FIG. 1.

2. Plate Material

In order to produce comparable spectra, the plates used in PART II of the atlas are the same as those in PART I, *Kodak I-N plates*. For justification of this choice we refer to Chapter 3.b in the first part of the atlas. Among the advantages cited there are the availability of the red and infrared regions which become useful for late-type stars and emission-line objects. This is most important in view of further parts of the *Bonner Spectral Atlas* which display and describe stars not included in the 1953 MK system, among them very late-type stars, Wolf-Rayet stars and novae.*

The most important quality of the I-N plate, however, is its steep gradation and good grain size. The latter is essential when the width of features looked for is of the order of magnitude of a few grains, as is the case on low-dispersion spectrograms. While the IIIa-J emulsion is somewhat superior in this respect, it lacks the quality cited in the above paragraph.

The rôle played by grain size is obvious from the enlargements. In this context we must explain the remarkable differences between plates which result from different developing times. *Rodinal* in concentration 1:20, the developer which was used in all cases, gives good grain size only up to developing times of 7 - 8 minutes. Longer times, up to 20 minutes, increase the plate density at the cost of small grain size. For faint stars developing times leading to coarser grain were necessary because the high reciprocity failure of the I-N plate gives insufficient gain with increased exposure times.

---

* Extensions of the *Bonner Spectral Atlas*, *PECULIAR STARS* and *AN ATLAS OF NOVA DELPHINI 1967* are in preparation.

The much more noticeable grain in the reproductions of PART II of the atlas as compared to PART I is, of course, explained by the fact that the enlargements of the spectra in the second part are larger by almost a factor of two.

3. Exposures

Most spectra were obtained during the years 1970 - 1972, with some exceptions from earlier and later years. Exposure times range from 1.5 minutes with reduced aperture to two hours with clear aperture.

4. Reproductions

Six steps lead from the original negatives of the spectra to the prints displayed in the atlas:

1) *Original Negatives*
   The original negatives are the photographs obtained at the telescope.
2) *Intermediate Positives*
   The original negatives are enlarged nine times on *Agfa N 33 p film* (see PART I,3.d) leading to intermediate positives. At lower dispersions focussing became extremely trying.
3) *Paper Negatives*
   The enlarged positives are copied on paper *Tura Brom 11 PEW, soft* (for PART I: *Agfa Brovira BEW 1, extra soft*) leading to paper negatives with total enlargements of 22.5 for dispersion 240 Å/mm and about 40 for the two lower dispersions. The enlarged negatives are assembled on plates S and L (see below), important features are marked and comments are written on the L-plates.
4) *Printing Photographs*
   The plates are photographed with a reduction to about 2/3 of their original sizes as the first step in photo-printing. Separate films are obtained for the half-tone spectra and the high-contrast writing. Retouches of plate defects, considered unavoidable by the printer, were carried out under close supervision by the author to insure that spectral features were not affected by the process.
5) *Printing Plates*
   The copies of spectra and texts obtained in step *4)* are combined on the gelatine of the printing plates through double exposures.
6) *Atlas Prints*
   About 500 prints are obtained from each printing plate.

In spite of the extreme care exercised by the printing company, the above process cannot preserve all information that is available on the paper negatives. *No loss* of information occurred between the original negatives and the paper negatives.

All statements made in the texts are based on the paper negatives. Because of the losses indicated above, it is not always possible to verify the written comments through inspection of the reproductions. In these cases the text should be taken as the primary source of information.

III. APPROACH TO SPECTRAL CLASSIFICATION

1. Number of Criteria

In PART I of the spectral atlas it was stated that, in order to achieve high classification accuracy at low dispersions, an approach different from that usually taken in spectral classification has to be followed. It is necessary to make *use of large numbers of criteria*, to perform a *detailed study* of the "totality of lines, blends and bands" referred to by Morgan in (3).

Extensive work with low-dispersion spectra has strengthened our conviction that classification must be based on *as many criteria as are available*. For this purpose the *Bonner Spectral Atlas Supplement* (4) supplies virtually all criteria which are useful at the three atlas dispersions.

Explanations for the above requirement are given in points a) - d) of Chapter 1 in PART I of the atlas where seeing and exposure effects and plate defects are discussed. While we should like to emphasize all that is said there, we want to expand on the statement concerning the *widening* of spectra, one of the *major* prerequisites for the recognition of criteria.

2. Widening of Spectra

It has been realized by several investigators, e.g. Morgan and Keenan (3), that ample widening of spectrograms is important for high accuracy in spectral classification. This message has not yet reached all observers and the astronomical literature shows that, especially for objective prism spectra, the optimal width is frequently underestimated.

We have often noticed that on insufficiently widened spectra spurious lines *appear* or real lines *disappear* because of smudges or even *chance configurations* of plate grain. The *Spectral Atlas Supplement* (4) gives examples illustrating the statement:

Narrow as well as faint features require length to be seen.

Since the effect is most pronounced for intrinsically weak lines at low dispersions (the decrease in contrast between features and background with decreasing resolution can be followed on the R-plates) two rules should be observed:

1) The *widening* of the spectra must be large.
2) The *width/length ratio* of the spectra must *increase* with *decreasing* dispersion.

Our own results are good at ratios:

1/14 for dispersion 240 Å/mm at H γ
1/7 for dispersion 645 Å/mm at H γ
1/5 for dispersion 1280 Å/mm at H γ

for the long I-N spectra. On blue-sensitive plates with shorter images these ratios should be increased by a factor 1.5. (See *Bonner Spectral Atlas Supplement* (4) for widening at higher and lower dispersions and corresponding diagram).

The above ratios are approximately reproduced on the atlas plates and the reader can judge for himself how far below these ratios one can go and still retain sufficient information.

The gain in limiting brightness with decreasing dispersion depends, of course, on the widening. TABLE 4 shows different gain factors under three different assumptions: I. *Equal width* at all dispersions. II. *Changing width/length ratios* according to the above values. III. *Equal width/length ratios* at all dispersions.

TABLE 4

Assumption	240 Å/mm	645 Å/mm	1280 Å/mm
I. Equal width	1	2.7	5.3
II. Changing ratios	1	5.4	14.8
III. Equal ratios	1	7.2	28.4

3. Types of Classification Criteria

Four types of classification criteria are distinguished at all three dispersions

1) *lines*
2) *blends*
3) *bands*
4) *continuum features.*

From the atlas plates it is seen that in:

EARLY- TO MEDIUM-TYPE STARS

Strong lines (e.g. H-lines) are *retained* between dispersions 240 Å/mm and 1280 Å/mm at Hγ or *replaced* by blends to which these lines are the *main* contributors.

Single weak lines *disappear* at low dispersions.
Weak lines with *weak neighbours* may combine into noticeable *blends*.

The most important *continuum* feature, the Balmer discontinuity, appears *enhanced* at lower dispersions.

MEDIUM- TO LATE-TYPE STARS

A few of the *strongest* lines (CaII, CaI) show relatively small contributions from neighbouring lines. All other lines are heavily *blended*.

Fairly uniform and broad blends extend over those regions in which *absorptions of comparable strength* occur within *wavelength intervals comparable to the wavelength resolution* (e.g.,MnI,FeI,SrII 4031-4078 at lower dispersions).

Spectral regions with only *very weak* absorptions over wavelength intervals *large* compared to the wavelength resolution appear as "emission-like" features enclosed between absorption-rich regions (e.g. around λ4500 at higher dispersions).

Molecular absorptions (CN, TiO) appear generally *strengthened* at lower dispersions due to the fact that the individual band components overlap and due to additional superpositions of line-absorptions.

Band heads are better defined (sharper) at higher dispersions.

At lower dispersions blends of metallic lines, which occur near the same wavelengths as the TiO bands and appear structurally similar, produce *mock-bands* in *earlier* spectral types.

IV. DESCRIPTION AND USE OF THE ATLAS

1. Contents

The atlas consists of 57 plates with reproductions of spectra, 4 plates with tracings of spectra and 6 plates with verbal descriptions of spectra. They are labelled P1 (Spectra in Original Sizes), C1 - C6 (Verbal Descriptions), S1 - S24 (Spectral Types), L1 - L32 (Luminosity Classes), R1 - R4 (Spectral Tracings).

Plate P1 (Spectra in Original Sizes)

Plate P1 shows the original sizes of spectra as obtained at the telescope with the three dispersions used in PART I and PART II of the *Bonner Spectral Atlas*. It is intended to illustrate with this plate the extreme difficulties encountered in reproducing the spectra with the enlargements shown in the atlas and to explain why certain features described in the texts may not be readily visible on the atlas plates (see Section II.4).

Plates C1 - C3 (645) and C4 - C6 (1280) (Verbal Description)

Plates C1 - C3 give brief summaries of the major classification criteria in different ranges of spectral types at dispersion 645 Å/mm at Hγ. Plates C4 - C6 give the same for dispersion 1280 Å/mm at Hγ. The information should suffice for rough determinations of spectral types and luminosity classes. Finer subdivisions are found according to the procedure described below.

Plates S1 - S24 (Spectral Types)

Plates S1 - S24 illustrate the sequences of spectra from the hottest to the coolest stars of the MK system within each of the luminosity classes. Spectra with dispersion 645 Å/mm at Hγ are shown on the right-hand side of each plate, spectra of the *same* stars with dispersion 1280 Å/mm at Hγ are shown on the left-hand side. Each plate gives in the upper and lower parts, adjacent to the spectrum photographs, schematic drawings of line spectra resembling the nearest photographic spectrum. They are intended to aid in line identification. Most absorption features visible in the original spectra are marked with wavelengths and spectroscopic symbols according to Moore (7); only *major* contributors to blends are listed.

The arrangements of the spectra are identical to those of the same *plate numbers* in PART I and comparisons of the spectra at the three different dispersions are possible through alignments of corresponding plates from PART I and PART II. (As mentioned above, technical reasons required a slightly smaller scale for the plates of PART II so that the alignments are not perfect).

Plates L1 - L32 (Luminosity Classes)

Plates L1 - L32 compare stars of the *same* spectral type but *different* luminosity classes. The two dispersions are shown in the same order as on the S-plates. Each spectrum is accompanied by a schematic spectrum showing the features which can be used for luminosity classification as well as features which experience no significant or no systematic variations and can thus be used for comparison. The classification features are identified in the upper part of each plate, separated according to whether they show maximum strength in *lower* or *higher* luminosity classes. The comparison features are identified in the lower parts of the plates.

The strength of each feature is estimated on an arbitrary scale based on the apparent strength of the atmospheric A-band in early-type stars where it is not drowned in the stellar continuum. In order to obtain an evaluation of the quality of the estimated line strengths comparisons were made with published equivalent widths. The results are discussed in the *Bonner Spectral Atlas Supplement* (4).

Verbal descriptions of the major luminosity criteria are given at the bottom of the plates.

Plates R1 - R2 (645), R3 (1280), R4 (645,1280) (Spectral Tracings)

Plates R1 - R3 give computed tracings of the solar spectrum based on the revision of Rowland's table by Moore, Minnaert and Houtgast (8). In order to derive the artificial tracings, the strengths of all absorption features present in a wavelength interval equal to the resolution of the spectrum are added and displayed as a function of wavelength. The intensity scales in mÅ correspond to those used in PART I, corrected by factors which take into account the larger wavelength intervals over which the line strengths are averaged. As in PART I, the continuously changing resolutions of prism spectra are approximated by 13 steps. Their widths range from 3 Å in the ultraviolet to 60 Å in the infrared for dispersion 645 Å/mm at Hγ , and 7.5 Å to 100 Å for 1280 Å/mm at Hγ . The resolutions obtained with the three different objective prisms for 2" seeing are also shown in FIG. 1.

The intervals in which a given step width is used are indicated at the bottom of the R1 - R3 plates. Also listed are the factors by which the units along the abscissa and along the ordinate have to be multiplied in order to go from the listed numbers, which apply to the interval of shortest wavelengths, to the values valid for the other intervals.

For comparison with the computed *intensity* tracings, portions of *density* tracings of the G2 V star HR 483 as obtained with dispersions 645 and 1280 Å/mm at Hγ are given on plate R4.

The wavelengths and spectroscopic symbols of the most important contributors to a given absorption feature are listed in the upper parts of the R-plates. Their strengths are indicated on R1 - R3 through the lengths of the corresponding arrow tails up to the zero absorption level; on R4 the lines simply connect the features with their respective identifications.

The R-plates show the following:

With low resolution and large numbers of absorption lines per resolution interval, most lines contribute to the *overall depression of the continuum* rather than to individual absorption features, which tend to occur only around the *strongest* lines. The former leads to a loss in limiting magnitude, especially in the ultraviolet, which partially counteracts the gain obtained through the use of lower dispersions.

At lower dispersions even strong lines and blends appear increasingly washed out and their separation from the continuum becomes more difficult. These disadvantages, however, may be used to derive new classification criteria (e.g., the presence of an absorption feature in a *more limited* range of types helps to segregate this group from others).

The blend patterns on the computed tracings facilitate the identification of absorption features in late-type stars. The major contributors to blends can be obtained from the listings.

2. Classification Procedure

The classification procedure is as follows:

I. With the aid of the C-plates the unknown spectrum is fitted into the sequences S1 - S24, a process which yields simultaneously a preliminary range of both spectral types and luminosity classes.

II. The first step sets aside a small number of plates from the L1 - L32 group from which the most similar standard spectrum can be found or interpolated, i.e., that spectrum is chosen from the preselected ones, for which a majority of line intensities, ratios and other criteria agree with those of the unknown spectrum.
For the choice of criteria the complete catalogue of criteria in the *Bonner Spectral Atlas Supplement* (4) should be consulted.

The interpolation process mentioned in II. refers to *types* which are not represented in the sequence of standard stars as well as to *dispersions* which lie in the range 240 - 1280 Å/mm at Hγ.

Intercomparison of *several* unknown spectra which are arranged according to progressing spectral types facilitates the classification process.

EXPLANATION TO THE LIST OF STANDARD STARS

The column headings of the following list are self-explanatory.

The objects marked by crosses and asterisks are common to the 1953 and the 1973 MK systems:

† stars having the *same* types assigned in both systems

*† stars having *finer subdivisions* in the new system, but the same basic types

* stars having *revised* types in the new system

(mean revision: 0.07 spectral classes
0.6 luminosity classes).

NO.	HD	HR	NAME	RA			DEC 1900.0		Δα	Δδ	VISUAL MAG	TYPE
				h	m	s	°	′	s	′		
1	21 46 80	8622	10 Lac	22	34	46	+ 38	32	+ 2.69	+ 0.31	4.88	† O9 V
2	3 74 68	1931	σ Ori	5	33	44	− 2	39	+ 3.01	+ 0.03	3.75	† O9.5 V
3	3 65 12	1855	υ Ori	5	27	6	− 7	23	+ 2.90	+ 0.04	4.63	† B0 V
4	2 47 60	1220	ε Per	3	51	8	+ 39	43	+ 4.03	+ 0.17	2.88	* B0.5 V
5	2 41 31	1191	–	3	45	30	+ 34	3	+ 3.84	+ 0.18	5.76	B1 V
6	33 60	153	ζ Cas	0	31	24	+ 53	21	+ 3.34	+ 0.33	3.61	* B2 V
7	12 03 15	5191	η UMa	13	43	36	+ 49	49	+ 2.36	− 0.30	1.86	† B3 V
8	19 81 83	7963	λ Cyg	20	43	31	+ 36	7	+ 2.34	+ 0.22	4.47	B5 V
9	2 33 38	1145	19 Tau	3	39	15	+ 24	9	+ 3.57	+ 0.19	4.29	* B6 V
10	8 79 01	3982	α Leo	10	3	3	+ 12	27	+ 3.19	− 0.29	1.36	B7 V
11	21 49 23	8634	ζ Peg	22	36	28	+ 10	19	+ 2.99	+ 0.31	3.47	B8 V
12	19 68 67	7906	α Del	20	35	0	+ 15	34	+ 2.79	+ 0.21	3.77	* B9 V
13	22 26 61	8988	ω^2 Aqr	23	37	32	− 15	6	+ 3.11	+ 0.33	4.48	B9.5 V
14	17 21 67	7001	α Lyr	18	33	33	+ 38	41	+ 2.03	+ 0.06	0.04	† A0 V
15	17 00 73	6923	39 Dra	18	22	27	+ 58	45	+ 0.88	+ 0.03	4.85	A1 V
16	12 80	63	θ And	0	11	52	+ 38	8	+ 3.14	+ 0.33	4.61	A2 V
17	5 65 37	2763	λ Gem	7	12	21	+ 16	43	+ 3.45	− 0.11	3.58	A3 V
18	9 76 03	4357	δ Leo	11	8	47	+ 21	4	+ 3.19	− 0.33	2.55	A4 V
19	1 16 36	553	β Ari	1	49	7	+ 20	19	+ 3.32	+ 0.29	2.65	A5 V
20	69 61	343	θ Cas	1	5	1	+ 54	37	+ 3.66	+ 0.32	4.33	A7 V
21	5 89 46	2852	ρ Gem	7	22	41	+ 31	59	+ 3.86	− 0.12	4.16	F0 V
22	11 31 39	4931	78 UMa	12	56	26	+ 56	54	+ 2.57	− 0.32	4.93	† F2 V
23	2 66 90	1309	46 Tau	4	8	10	+ 7	28	+ 3.23	+ 0.15	5.32	F3 V
24	21 00 27	8430	ι Peg	22	2	21	+ 24	51	+ 2.79	+ 0.29	3.76	F5 V
25	17 36 67	7061	110 Her	18	41	21	+ 20	27	+ 2.58	+ 0.06	4.20	F6 V
26	1 68 95	799	θ Per	2	37	22	+ 48	48	+ 4.10	+ 0.25	4.12	F7 V
27	98 26	458	υ And	1	30	56	+ 40	54	+ 3.52	+ 0.30	4.08	F8 V
28	46 14	219	η Cas	0	43	3	+ 57	17	+ 3.63	+ 0.32	3.45	G0 V
29	11 50 43	–	–	13	9	32	+ 57	14	+ 2.44	− 0.32	6.74	G1 V
30	1 03 07	483	–	1	35	42	+ 42	7	+ 3.66	+ 0.30	4.94	G2 V
31	2 06 30	996	κ Cet	3	14	7	+ 3	0	+ 3.15	+ 0.22	4.82	G5 V
32	10 15 01	4496	61 UMa	11	35	47	+ 34	46	+ 3.16	− 0.34	5.35	G8 V
33	18 51 44	7462	σ Dra	19	32	33	+ 69	29	− 0.12	+ 0.10	4.68	K0 V
34	2 20 49	1084	ε Eri	3	28	13	− 9	48	+ 2.83	+ 0.20	3.73	K2 V
35	21 91 34	8832	–	23	8	28	+ 56	37	+ 2.89	+ 0.33	5.57	K3 V
36	20 10 91	8085	61 Cyg A	21	2	25	+ 38	15	+ 2.69	+ 0.29	5.19	† K5 V
37	BD+56°1458	–	–	10	24	2	+ 56	31	+ 3.86	− 0.31	(8.9)	K7 V
38	14 73 79	–	–	16	16	29	+ 67	29	+ 0.19	− 0.15	8.9	M0 V
39	9 57 35	–	–	10	57	52	+ 36	36	+ 3.32	− 0.32	7.60	M2 V

NO.	HD	HR	NAME	RA	DEC	Δα	Δδ	VISUAL MAG	TYPE
				1900.0					
				h m s	° ′	s	′		
40	8 86	39	γ Peg	0 8 5	+ 14 38	+ 3.09	+ 0.33	2.83	† B2 IV
41	14 73 94	6092	τ Her	16 16 44	+ 46 33	+ 1.80	– 0.14	3.89	† B5 IV
42	1 49 51	702	ξ Ari	2 19 27	+ 10 9	+ 3.22	+ 0.27	5.49	B7 IV
43	4 71 05	2421	γ Gem	6 31 56	+ 16 29	+ 3.47	– 0.05	1.93	A0 IV
44	21 13 36	8494	ε Cep	22 11 21	+ 56 33	+ 2.21	+ 0.30	4.19	F0 IV
45	4 32	21	β Cas	0 3 50	+ 58 36	+ 3.20	+ 0.33	2.25	* F2 IV
46	1 14 43	544	α Tri	1 47 23	+ 29 6	+ 3.42	+ 0.29	3.53	† F6 IV
47	21 63 85	8697	σ Peg	22 47 20	+ 9 18	+ 3.04	+ 0.32	5.22	F7 IV
48	22 06 57	8905	υ Peg	23 20 23	+ 22 51	+ 2.99	+ 0.33	4.51	F8 IV
49	15 06 80	6212	ζ Her	16 37 31	+ 31 47	+ 2.26	– 0.11	2.82	* G0 IV
50	16 17 97	6623	μ Her	17 42 33	+ 27 47	+ 2.35	– 0.03	3.35	G5 IV
51	18 85 12	7602	β Aql	19 50 24	+ 6 9	+ 2.95	+ 0.15	3.71	† G8 IV
52	19 81 49	7957	η Cep	20 43 15	+ 61 27	+ 1.22	+ 0.23	3.43	K0 IV
53	22 24 04	8974	γ Cep	23 35 14	+ 77 4	+ 2.46	+ 0.33	3.22	K1 IV
54	3 70 43	1899	ι Ori	5 30 32	– 5 59	+ 2.94	+ 0.04	2.77	† O9 III
55	4 84 34	2479	–	6 38 22	+ 4 2	+ 3.17	– 0.06	5.74	B0 III
56	18 49 15	7446	κ Aql	19 31 31	– 7 15	+ 3.23	+ 0.13	4.96	B0.5III
57	2 31 80	1131	ο Per	3 38 3	+ 31 58	+ 3.76	+ 0.19	3.82	† B1 III
58	21 49 93	8640	12 Lac	22 37 0	+ 39 42	+ 2.69	+ 0.31	5.22	B2 III
59	2 14 83	–	–	3 22 38	+ 30 2	+ 3.68	+ 0.21	7.06	B3 III
60	2 29 28	1122	δ Per	3 35 48	+ 47 28	+ 4.27	+ 0.19	2.99	B5 III
61	19 58 10	7852	ε Del	20 28 26	+ 10 58	+ 2.87	+ 0.20	3.98	B6 III
62	2 36 30	1165	η Tau	3 41 32	+ 23 48	+ 3.57	+ 0.19	2.86	† B7 III
63	2 38 50	1178	27 Tau	3 43 13	+ 23 45	+ 3.57	+ 0.18	3.62	† B8 III
64	17 64 37	7178	γ Lyr	18 55 12	+ 32 33	+ 2.24	+ 0.08	3.25	B9 III
65	18 68 82	7528	δ Cyg	19 41 51	+ 44 53	+ 1.87	+ 0.15	2.92	B9.5III
66	12 32 99	5291	α Dra	14 1 41	+ 64 51	+ 1.63	– 0.29	3.64	A0 III
67	5 00 19	2540	θ Gem	6 46 12	+ 34 5	+ 3.95	– 0.07	3.59	A3 III
68	15 95 61	6556	α Oph	17 30 18	+ 12 38	+ 2.78	– 0.04	2.08	A5 III
69	12 77 62	5435	γ Boo	14 28 3	+ 38 45	+ 2.42	– 0.26	3.03	A7 III
70	14 75 47	6095	γ Her	16 17 31	+ 19 23	+ 2.65	– 0.14	3.74	A9 III
71	8 90 25	4031	ζ Leo	10 11 8	+ 23 55	+ 3.34	– 0.30	3.43	† F0 III
72	1 31 74	623	14 Ari	2 3 44	+ 25 28	+ 3.42	+ 0.28	5.01	F2 III
73	2 17 70	1069	36 Per	3 25 30	+ 45 43	+ 4.16	+ 0.20	5.30	F4 III
74	11 18 12	4883	31 Com	12 46 50	+ 28 5	+ 2.92	– 0.33	4.95	† G0 III
75	2 70 22	1327	–	4 11 16	+ 64 54	+ 5.65	+ 0.15	5.27	* G5 III
76	14 88 56	6148	β Her	16 25 55	+ 21 42	+ 2.58	– 0.13	2.83	G8 III
77	19 79 89	7949	ε Cyg	20 42 10	+ 33 36	+ 2.43	+ 0.22	2.45	*† K0 III
78	13 77 59	5744	ι Dra	15 22 42	+ 59 19	+ 1.34	– 0.21	3.26	K2 III
79	36 27	165	δ And	0 33 59	+ 30 19	+ 3.21	+ 0.33	3.21	K3 III
80	13 18 73	5563	β UMi	14 51 0	+ 74 34	– 0.17	– 0.25	2.08	K4 III

NO.	HD	HR	NAME	RA 1900.0	DEC	Δα	Δδ	VISUAL MAG	TYPE
				h m s	° ′	s	′		
81	29139	1457	α Tau	4 30 11	+ 16 18	+ 3.44	+ 0.12	0.86	† K5 III
82	6860	337	β And	1 4 8	+ 35 5	+ 3.36	+ 0.32	2.03	*† M0 III
83	119228	5154	83 UMa	13 36 57	+ 55 11	+ 2.28	− 0.30	4.73	*† M2 III
84	207198	8327	–	21 42 8	+ 62 0	+ 1.65	+ 0.28	5.96	O9 II
85	36486	1852	δ Ori	5 26 54	− 0 22	+ 3.07	+ 0.04	2.20	O9.5 II
86	43818	–	–	6 13 14	+ 23 31	+ 3.65	− 0.02	7.03	B0 II
87	199216	–	–	20 50 38	+ 49 9	+ 1.94	+ 0.23	7.13	B1 II
88	52089	2618	ε CMa	6 54 42	− 28 50	+ 2.36	− 0.08	1.50	B2 II
89	51309	2596	ι CMa	6 51 41	− 16 55	+ 2.68	− 0.08	4.38	B3 II
90	53244	2657	γ CMa	6 59 14	− 15 29	+ 2.71	− 0.09	4.10	B8 II
91	43836	–	–	6 13 18	+ 23 19	+ 3.65	− 0.02	7.03	B9 II
92	34578	1740	19 Aur	5 13 25	+ 33 51	+ 3.96	+ 0.06	5.03	A5 II
93	25291	1242	–	3 56 7	+ 58 53	+ 5.00	+ 0.17	5.03	F0 II
94	164136	6707	ν Her	17 54 41	+ 30 12	+ 2.30	+ 0.00	4.48	F2 II
95	195295	7834	41 Cyg	20 25 19	+ 30 2	+ 2.45	+ 0.20	4.02	F5 II
96	84441	3873	ε Leo	9 40 11	+ 24 14	+ 3.40	− 0.28	2.96	* G0 II
97	159181	6536	β Dra	17 28 10	+ 52 23	+ 1.36	− 0.04	2.87	*† G2 II
98	173764	7063	β Sct	18 41 52	− 4 51	+ 3.18	+ 0.06	4.22	* G5 II
99	202109	8115	ζ Cyg	21 8 41	+ 29 49	+ 2.55	+ 0.25	3.20	*† G8 II
100	180809	7314	θ Lyr	19 12 54	+ 37 57	+ 2.08	+ 0.11	4.35	*† K0 II
101	163770	6695	θ Her	17 52 49	+ 37 16	+ 2.06	− 0.01	3.84	*† K1 II
102	39400	2037	56 Ori	5 47 15	+ 1 50	+ 3.12	+ 0.01	4.78	* K2 II
103	186791	7525	γ Aql	19 41 30	+ 10 22	+ 2.85	+ 0.15	2.62	† K3 II
104	210809	–	–	22 7 50	+ 51 56	+ 2.28	+ 0.30	7.7	O9 Ib
105	209975	8428	19 Cep	22 2 4	+ 61 48	+ 1.85	+ 0.29	5.10	O9.5 Ib
106	204172	8209	69 Cyg	21 21 42	+ 36 14	+ 2.45	+ 0.26	5.95	B0 Ib
107	213087	8561	26 Cep	22 23 52	+ 64 37	+ 1.93	+ 0.31	5.46	B0.5 Ib
108	24398	1203	ζ Per	3 47 51	+ 31 35	+ 3.77	+ 0.18	2.83	† B1 Ib
109	193183	–	–	20 13 42	+ 37 55	+ 2.20	+ 0.19	7.12	B1.5 Ib
110	206165	8279	9 Cep	21 35 14	+ 61 38	+ 1.61	+ 0.27	4.72	B2 Ib
111	42087	2173	3 Gem	6 3 40	+ 23 8	+ 3.64	− 0.01	5.76	B2.5 Ib
112	164353	6714	67 Oph	17 55 38	+ 2 56	+ 3.00	+ 0.00	3.97	B5 Ib
113	208501	8371	13 Cep	21 51 31	+ 56 8	+ 2.02	+ 0.28	5.79	B8 Ib
114	35600	1804	–	5 20 44	+ 30 7	+ 3.84	+ 0.05	5.65	B9 Ib
115	46300	2385	13 Mon	6 27 30	+ 7 24	+ 3.24	− 0.04	4.48	A0 Ib
116	207673	8345	–	21 45 36	+ 40 41	+ 2.44	+ 0.28	6.42	A2 Ib
117	210221	8443	–	22 3 44	+ 52 49	+ 2.22	+ 0.29	6.14	A3 Ib
118	59612	2874	–	7 25 37	− 22 49	+ 2.55	− 0.12	4.85	A5 Ib
119	36673	1865	α Lep	5 28 19	− 17 54	+ 2.65	+ 0.04	2.59	† F0 Ib

NO.	HD	HR	NAME	RA 1900.0	DEC	Δα	Δδ	VISUAL MAG	TYPE
				h m s	° ′	s	′		
120	18 28 35	7387	ν Aql	19 21 24	+ 0 8	+ 3.07	+ 0.12	4.64	F2 Ib
121	2 09 02	1017	α Per	3 17 11	+ 49 30	+ 4.29	+ 0.21	1.79	† F5 Ib
122	19 40 93	7793	γ Cyg	20 18 38	+ 39 56	+ 2.15	+ 0.19	2.24	F8 Ib
123	2 66 30	1303	μ Per	4 7 33	+ 48 9	+ 4.41	+ 0.15	4.13	† G0 Ib
124	20 97 50	8414	α Aqr	22 0 39	− 0 48	+ 3.08	+ 0.29	2.93	† G2 Ib
125	20 68 59	8313	9 Peg	21 39 47	+ 16 53	+ 2.84	+ 0.28	4.35	† G5 Ib
126	4 83 29	2473	ε Gem	3 37 47	+ 25 14	+ 3.69	− 0.06	3.08	† G8 Ib
127	21 07 45	8465	ζ Cep	22 7 23	+ 57 42	+ 2.08	+ 0.30	3.36	* K1 Ib
128	20 67 78	8308	ε Peg	21 39 16	+ 9 25	+ 2.95	+ 0.28	2.42	† K2 Ib
129	1 75 06	834	η Per	2 43 24	+ 55 29	+ 4.38	+ 0.25	3.76	*† K3 Ib
130	20 09 05	8079	ξ Cyg	21 1 18	+ 43 32	+ 2.18	+ 0.24	3.72	* K5 Ib
131	3 63 89	1845	119 Tau	5 26 21	+ 18 31	+ 3.52	+ 0.04	4.73	* M2 Ib
132	3 63 71	1843	χ Aur	5 26 13	+ 32 7	+ 3.91	+ 0.04	4.89	B5 Iab
133	20 28 50	8143	σ Cyg	21 13 29	+ 38 59	+ 2.36	+ 0.25	4.24	B9 Iab
134	19 55 93	7847	44 Cyg	20 27 11	+ 36 36	+ 2.28	+ 0.20	6.17	F5 Iab
135	5 08 77	2580	o^1 CMa	6 49 59	− 24 4	+ 2.49	− 0.08	3.78	* K3 Iab
136	4 45 37	2289	ψ^1 Aur	6 17 12	+ 49 20	+ 4.62	− 0.03	4.95	* M0 Iab
137	3 98 01	2061	α Ori	5 49 45	+ 7 23	+ 3.25	+ 0.01	0.80	* M2 Iab
138	3 06 14	1542	α Cam	4 44 6	+ 66 10	+ 5.97	+ 0.10	4.29	O9.5 Ia
139	3 71 28	1903	ε Ori	5 31 8	− 1 16	+ 3.04	+ 0.04	1.70	† B0 Ia
140	3 87 71	2004	κ Ori	5 43 1	− 9 42	+ 2.85	+ 0.02	2.04	B0.5 Ia
141	29 05	130	κ Cas	0 27 19	+ 62 23	+ 3.41	+ 0.33	4.15	B1 Ia
142	19 06 03	7678	–	20 0 41	+ 31 56	+ 2.35	+ 0.17	5.60	B1.5 Ia
143	4 11 17	2135	χ^2 Ori	5 57 59	+ 20 8	+ 3.56	+ 0.00	4.63	† B2 Ia
144	19 84 78	7977	55 Cyg	20 45 32	+ 45 45	+ 2.04	+ 0.22	4.83	B3 Ia
145	1 32 67	627	5 Per	2 4 31	+ 57 10	+ 4.18	+ 0.28	6.39	B5 Ia
146	1 54 97	–	–	2 24 38	+ 57 15	+ 4.34	+ 0.27	7.20	B6 Ia
147	3 40 85	1713	β Ori	5 9 44	− 8 19	+ 2.88	+ 0.07	0.08	† B8 Ia
148	2 12 91	1035	–	3 20 58	+ 59 36	+ 4.86	+ 0.21	4.23	B9 Ia
149	2 13 89	1040	–	3 21 55	+ 58 32	+ 4.79	+ 0.21	4.58	A0 Ia
150	1 29 53	618	–	2 1 41	+ 57 57	+ 4.19	+ 0.29	5.68	A1 Ia
151	19 73 45	7924	α Cyg	20 38 1	+ 44 55	+ 2.05	+ 0.21	1.26	† A2 Ia
152	1 73 78	825	–	2 42 8	+ 56 40	+ 4.43	+ 0.25	6.26	A5 Ia
153	79 27	382	φ Cas	1 13 47	+ 57 42	+ 3.78	+ 0.32	4.95	F0 Ia
154	16 35 06	6685	89 Her	17 51 23	+ 26 4	+ 2.42	− 0.01	5.47	F2 Ia
155	1 04 94	–	—	1 37 17	+ 61 21	+ 4.12	+ 0.30	7.46	F5 Ia
156	5 46 05	2693	δ CMa	7 4 20	− 26 14	+ 2.44	− 0.10	1.84	F8 Ia
157	21 74 76	8752	–	22 55 52	+ 56 26	+ 2.53	+ 0.32	4.99	* G0 Ia
158	4 25 43	2197	6 Gem	6 6 15	+ 22 56	+ 3.64	− 0.01	6.11	* M1 Ia
159	20 69 36	8316	μ Cep	21 40 27	+ 58 19	+ 1.84	+ 0.28	3.99	† M2 Ia

REFERENCES

1. Seitter, W.C. 1970, *Atlas for Objective Prism Spectra, Bonner Spektral Atlas I*,
   Bonn: Ferd. Dümmlers Verlag.

2. Johnson, H.L., Morgan, W.W. 1953, *Fundamental Stellar Photometry for Standards of Spectral Type on the Revised System of the Yerkes Spectral Atlas*,
   Astrophys. J. 117, 313.

3. Morgan, W.W., Keenan, P.C. 1973, *Spectral Classification*,
   A. Rev. Astr. Astrophys. 11, 29.

4. Seitter, W.C. 1975, *Atlas for Objective Prism Spectra, Bonner Spectral Atlas Supplement*,
   Bonn: Ferd. Dümmlers Verlag.

5. Jaschek, C. and M. 1974, private communication.

6. Bowen, I.S. 1962, *Spectrographs* in *Stars and Stellar Systems*,
   Vol. 2, Ed. W.A. Hiltner
   Chicago: Univ. Chicago Press.

7. Moore, Ch.E. 1972, *A Multiplet Table of Astrophysical Interest*,
   Revised Edition, Nat.Stand.Ref.Data Ser., Nat.Bur.Stand. 40,
   Washington: US Government Printing Office.

8. Moore, Ch.E., Minnaert, M.G.H., Houtgast, J. 1966, *The Solar Spectrum 2035 Å to 8770 Å*,
   National Bureau of Standards Monograph 61,
   Washington: US Government Printing Office.

7016

FERD. DÜMMLERS VERLAG · BONN

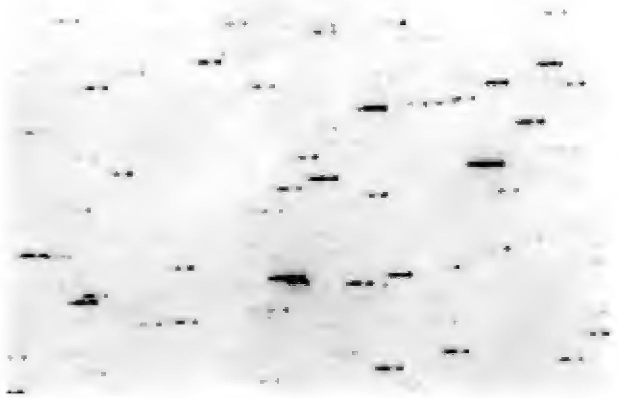
Dispersion: Field: $10^{h}\ 26^{m}.1$; $56^{\circ}\ 31'$ (1900)

E

N

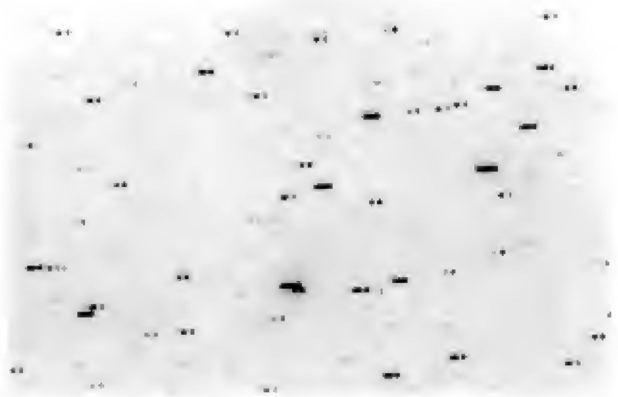
240 Å/mm at H_{γ}

Part I



645 Å/mm at H_{γ}

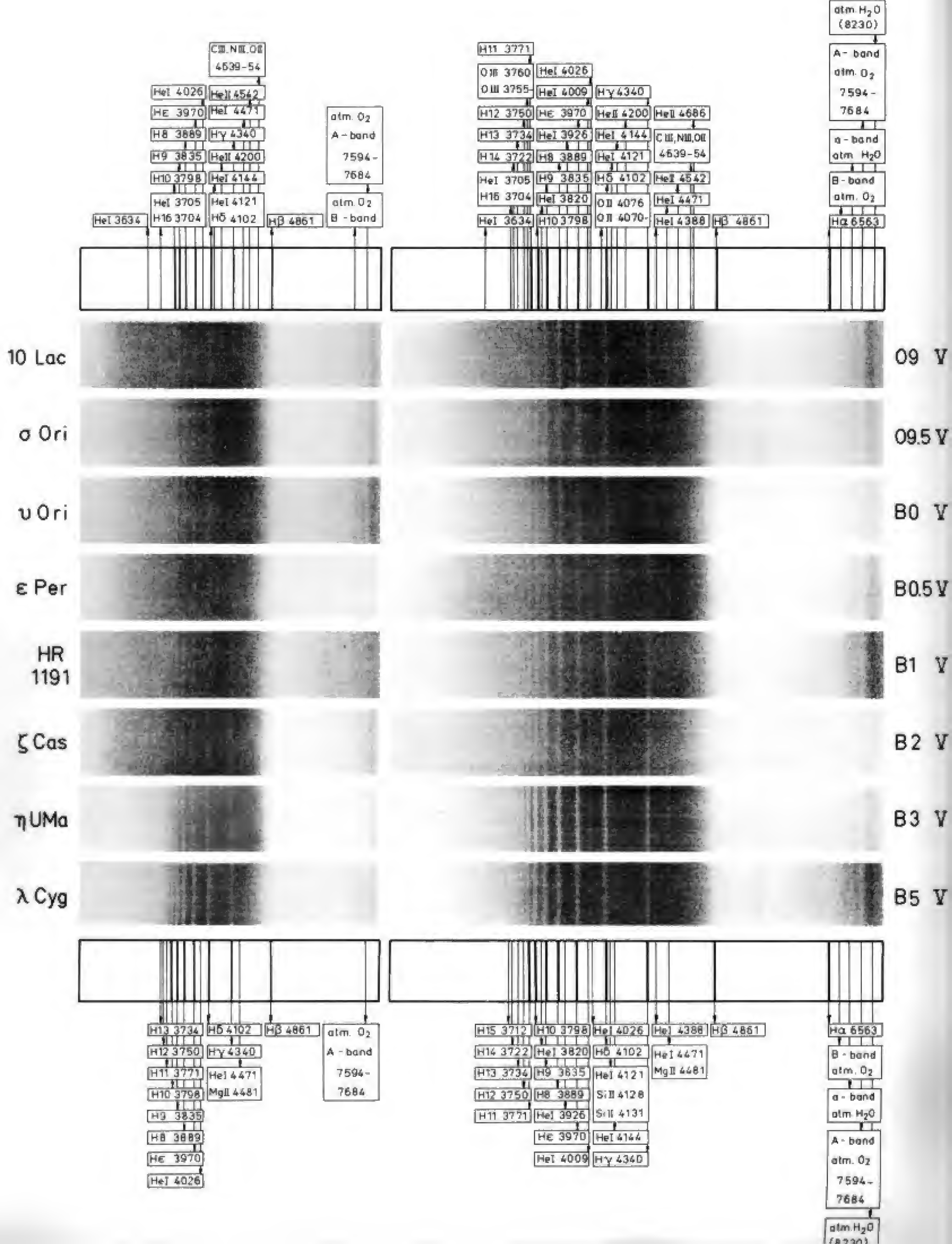
Part II



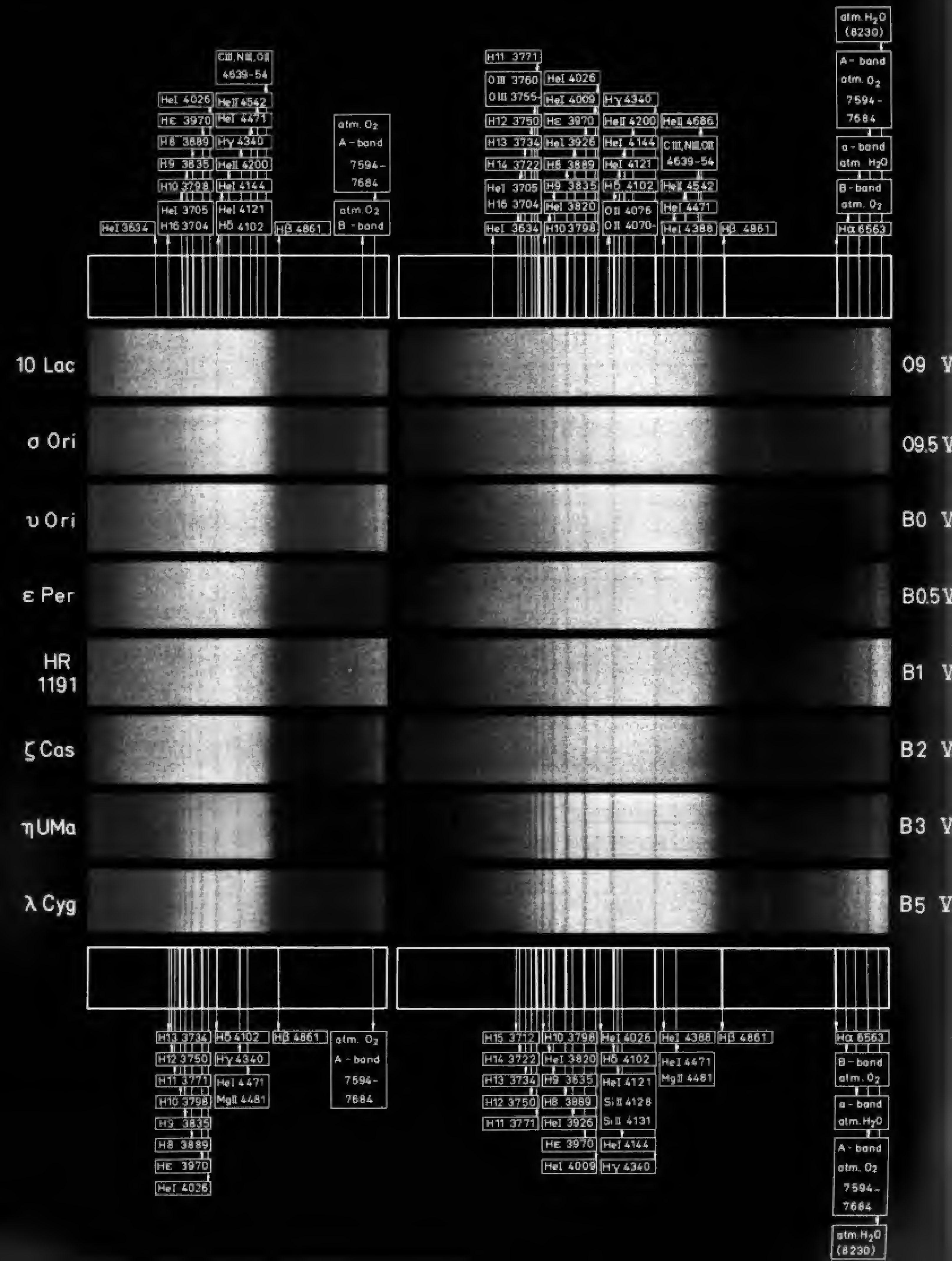
1280 Å/mm at H_{γ}

Part II

Original sizes of spectra in the Bonner Spektral Atlas I and II



HeI 3634
HeI 3705
H16 3704
H10 3798
H9 3835
H8 3889
Hε 3970
HeI 4026
HeI 4121
Hδ 4102
HeI 4144
HeII 4200
Hγ 4340
HeI 4471
HeII 4542
CIII, NIII, OII 4639-54
Hβ 4861
atm. O2 A-band 7594-7684
atm. O2 B-band
H11 3771
OIII 3760
OIII 3755
H12 3750
H13 3734
H14 3722
HeI 4009
HeI 3926
HeI 3820
OII 4076
OII 4070
HeII 4686
HeI 4388
Hα 6563
a-band atm. H2O
atm. H2O (8230)
10 Lac
O9 V
σ Ori
O9.5 V
υ Ori
B0 V
ε Per
B0.5 V
HR 1191
B1 V
ζ Cas
B2 V
η UMa
B3 V
λ Cyg
B5 V
MgII 4481
H15 3712
SiII 4128
SiII 4131


10 Lac
O9 V
σ Ori
O9.5 V
υ Ori
B0 V
ε Per
B0.5 V
HR 1191
B1 V
ζ Cas
B2 V
η UMa
B3 V
λ Cyg
B5 V
CIII, NIII, OII 4639-54
HeI 4026
HeII 4542
Hε 3970
HeI 4471
H8 3889
Hγ 4340
H9 3835
HeII 4200
H10 3798
HeI 4144
HeI 3705
H16 3704
HeI 4121
Hδ 4102
HeI 3634
Hβ 4861
atm. O2 A-band 7594-7684
atm. O2 B-band
H11 3771
OIII 3760
OIII 3755
HeI 4009
H12 3750
HeII 4686
H13 3734
HeI 3926
HeI 4144
H14 3722
HeI 4121
HeI 4388
H15 3712
HeI 3820
atm. H2O (8230)
a-band atm. H2O
B-band atm. O2
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OII 4070
HeI 4471
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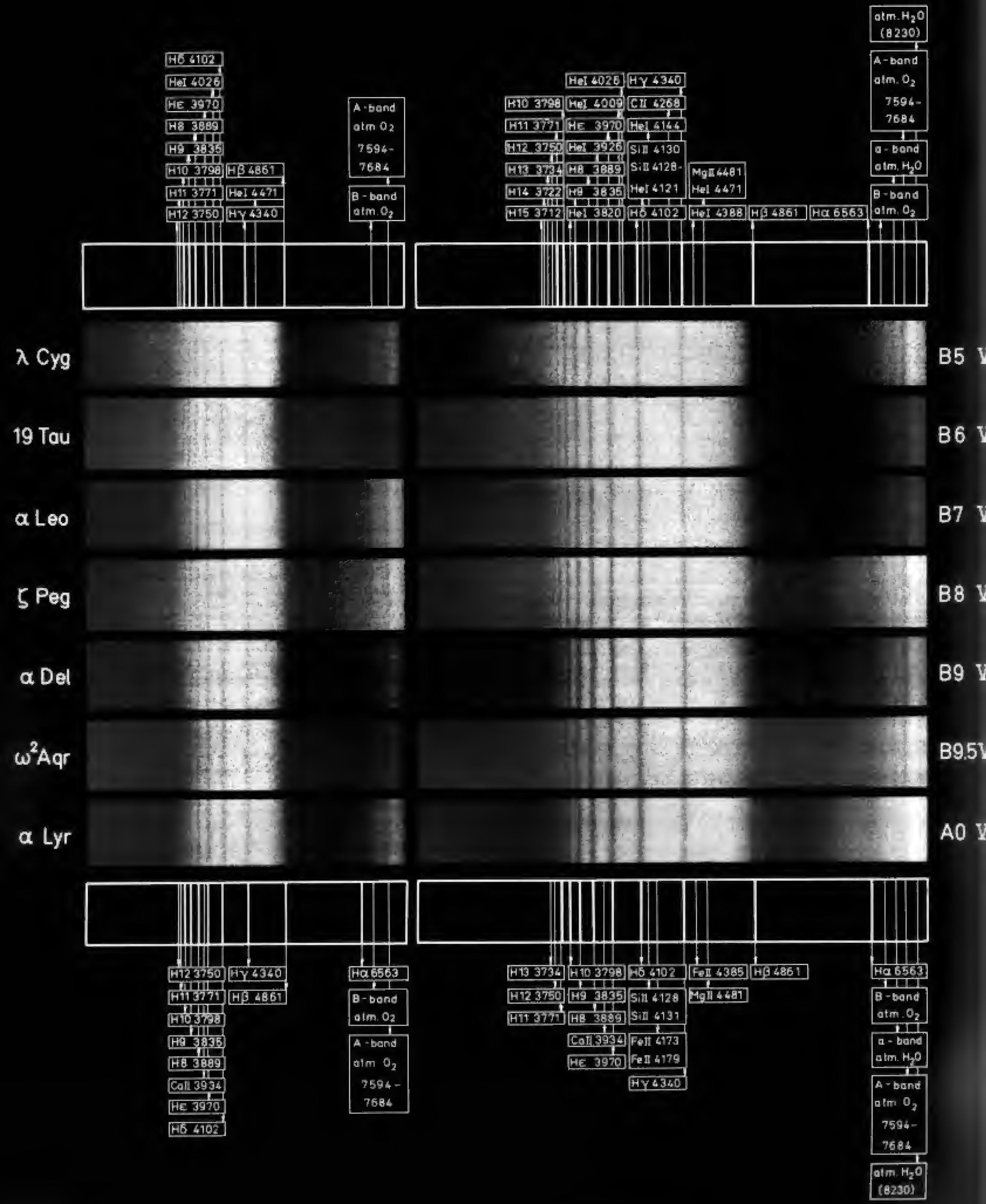

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HeI 4026
Hε 3970
H8 3889
H9 3835
H10 3798
H11 3771
H12 3750
Hβ 4861
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Hγ 4340
A-band atm. O_2 7594-7684
B-band atm. O_2
HeI 4026
Hγ 4340
H10 3798
HeI 4009
CII 4268
H11 3771
Hε 3970
HeI 4144
H12 3750
HeI 3926
SiII 4130
H13 3734
H8 3889
SiII 4128-
H14 3722
H9 3835
HeI 4121
MgII 4481
HeI 4471
H15 3712
HeI 3820
Hδ 4102
HeI 4388
Hβ 4861
Hα 6563
atm. H_2O (8230)
A-band atm. O_2 7594-7684
a-band atm. H_2O
B-band atm. O_2
λ Cyg
B5
19 Tau
B6
α Leo
B7
ζ Peg
B8
α Del
B9
ω²Aqr
B9.5
α Lyr
A0
H12 3750
Hγ 4340
H11 3771
Hβ 4861
H10 3798
H9 3835
H8 3889
CaII 3934
Hε 3970
Hδ 4102
Hα 6563
B-band atm. O_2
A-band atm. O_2 7594-7684
H13 3734
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Hδ 4102
FeII 4385
Hβ 4861
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H9 3835
SiII 4128
MgII 4481
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H8 3889
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CaII 3934
FeII 4173
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FeII 4179
Hγ 4340
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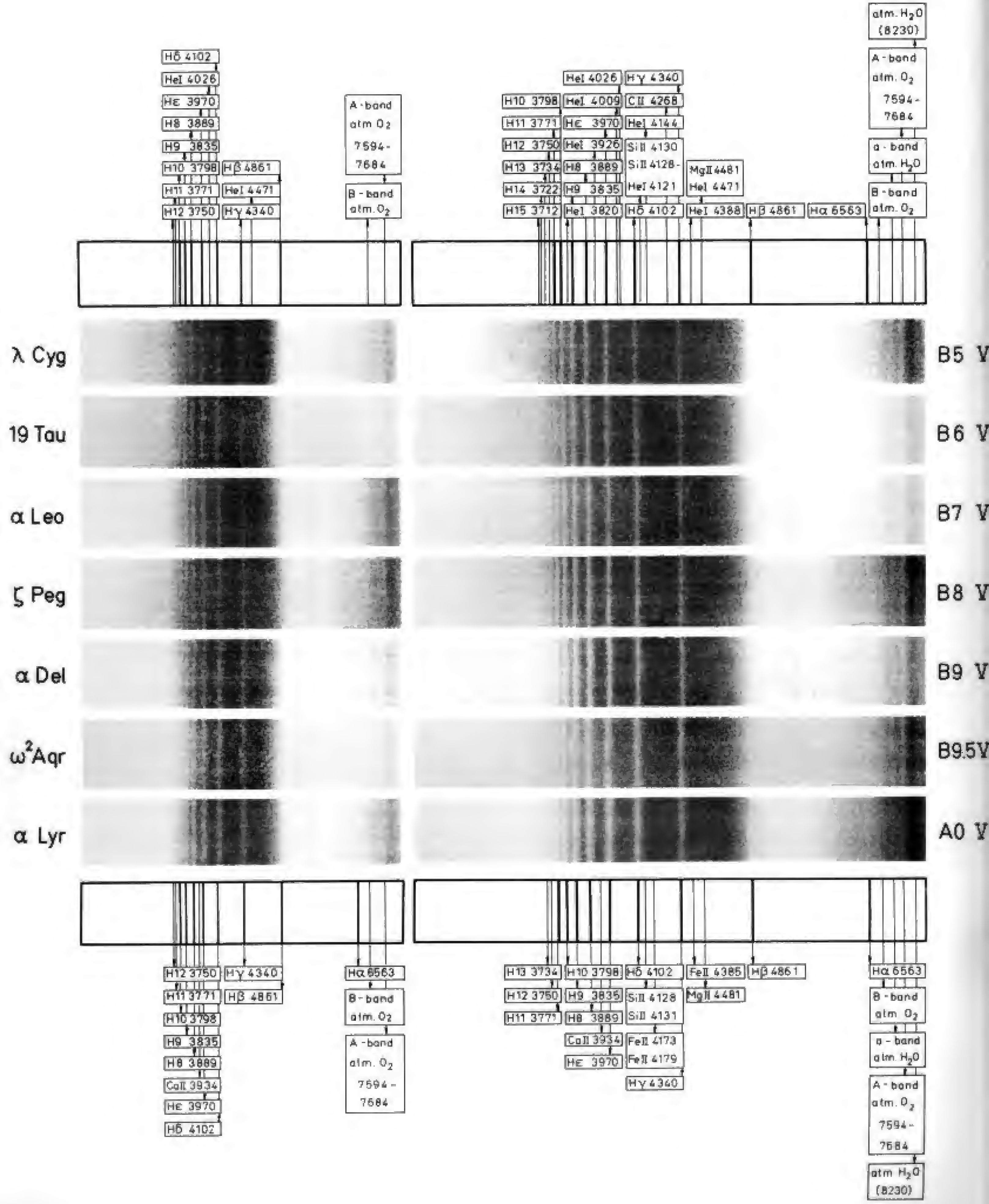
B-band atm. O_2
a-band atm. H_2O
A-band atm. O_2 7594-7684
atm. H_2O (8230)



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HeI 4026
Hε 3970
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H9 3835
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H11 3771
H12 3750
Hβ 4861
HeI 4471
Hγ 4340
A-band atm O2 7594-7684
B-band atm. O2
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Hγ 4340
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CII 4268
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Hε 3970
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H12 3750
HeI 3926
SiII 4130
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H8 3889
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H9 3835
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MgII 4481
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HeI 3820
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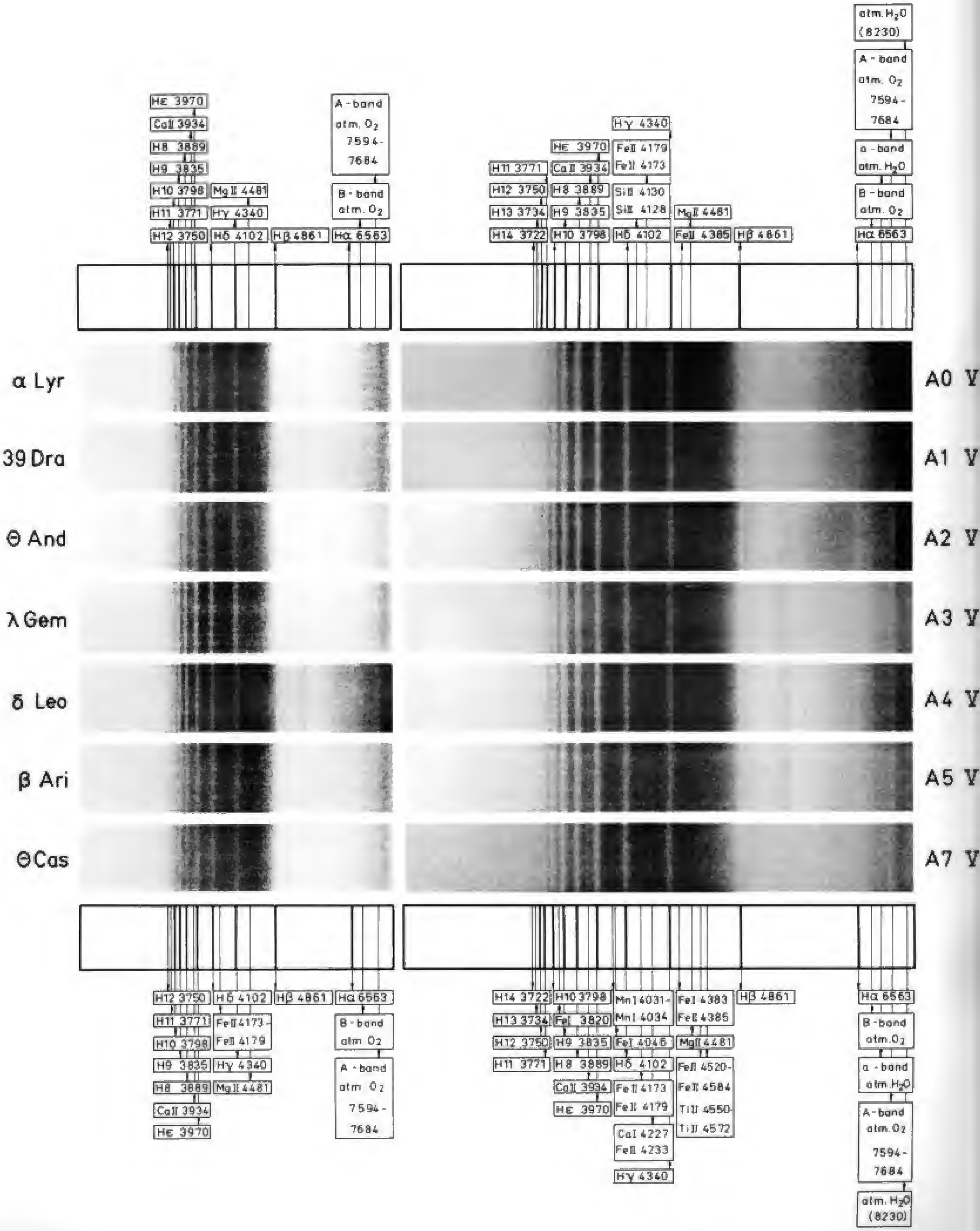
HeI 4388
Hβ 4861
Hα 6563
atm. H2O (8230)
A-band atm. O2 7594-7684
a-band atm. H2O
B-band atm. O2
λ Cyg
B5 V
19 Tau
B6 V
α Leo
B7 V
ζ Peg
B8 V
α Del
B9 V
ω2Aqr
B9.5V
α Lyr
A0 V
H12 3750
Hγ 4340
H11 3771
Hβ 4861
H10 3798
H9 3835
H8 3889
CaII 3934
Hε 3970
Hδ 4102
Hα 6563
B-band atm. O2
A-band atm. O2 7594-7684
H13 3734
H10 3798
Hδ 4102
FeII 4385
Hβ 4861
H12 3750
H9 3835
SiII 4128
MgII 4481
H11 3771
H8 3889
SiII 4131
CaII 3934
FeII 4173
Hε 3970
FeII 4179
Hγ 4340
Hα 6563
B-band atm. O2
a-band atm. H2O
A-band atm. O2 7594-7684
atm H2O (8230)


α Lyr
39 Dra
Θ And
λ Gem
δ Leo
β Ari
Θ Cas
A0 V
A1 V
A2 V
A3 V
A4 V
A5 V
A7 V
Hε 3970
CaII 3934
H8 3889
H9 3835
H10 3798
H11 3771
H12 3750
H13 3734
H14 3722
MgII 4481
Hγ 4340
Hδ 4102
Hβ 4861
Hα 6563
A-band atm. O2 7594-7684
B-band atm. O2
a-band atm. H2O
atm. H2O (8230)
FeII 4179
FeII 4173
SiII 4130
SiII 4128
FeII 4385
FeI 3820
MnI 4031-
MnI 4034
FeI 4046
FeI 4383
FeII 4520-
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TiII 4550-
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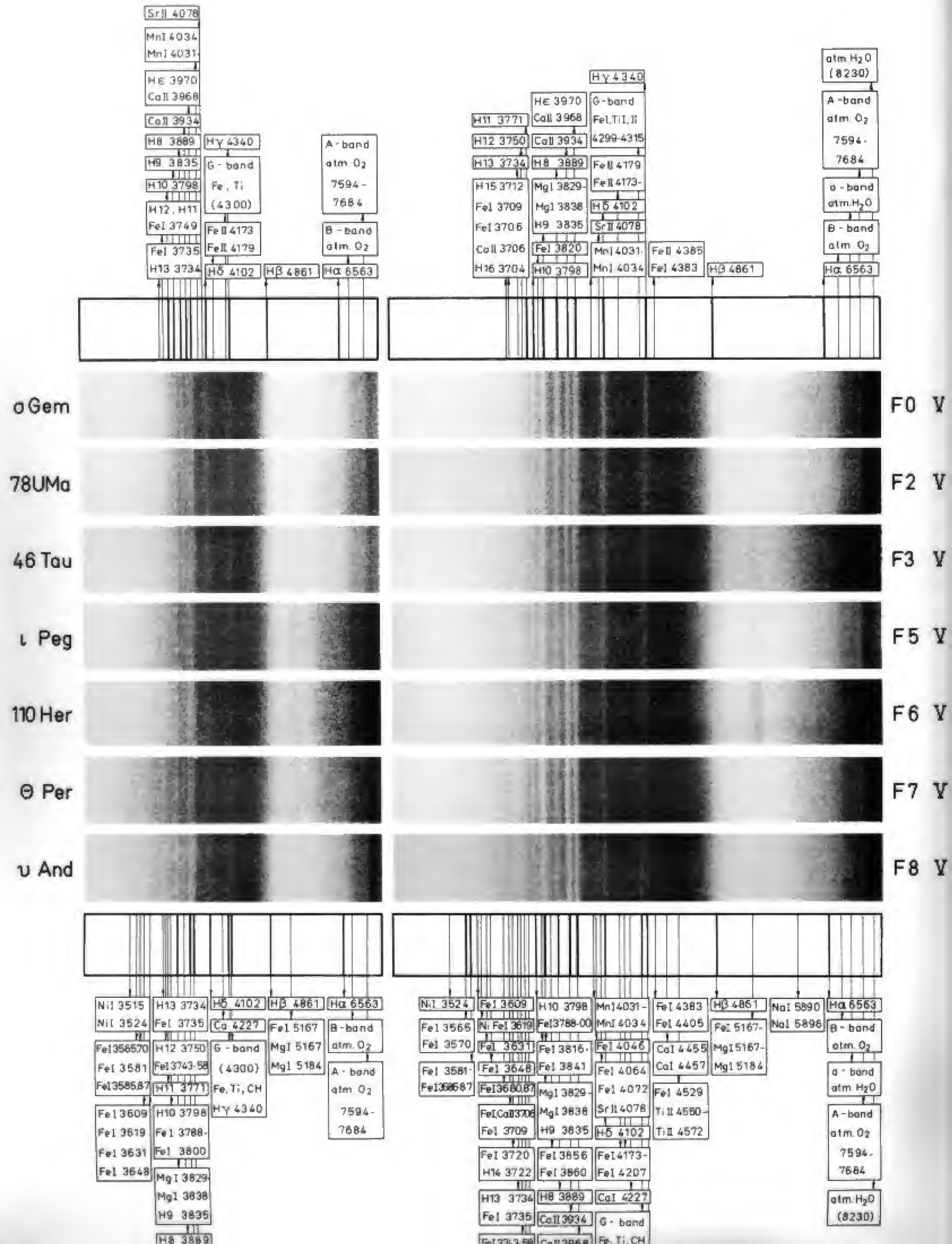
CaI 4227
FeII 4233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Mn I 4034
Mn I 4031
Hε 3970
Ca II 3968
Ca II 3934
H8 3889
Hγ 4340
H9 3835
G - band
Fe, Ti
(4300)
H10 3798
H12, H11
Fe I 3749
Fe II 4173
Fe II 4179
Fe I 3735
H13 3734
Hδ 4102
Hβ 4861
A - band
atm. O2
7594 - 7684
B - band
atm. O2
Hα 6563
H11 3771
H12 3750
H13 3734
H15 3712
Fe I 3709
Fe I 3706
Ca II 3706
H16 3704
Mg I 3829
Mg I 3838
H9 3835
Fe I 3820
H10 3798
G - band
Fe I, Ti I, II
4299 - 4315
Fe II 4179
Fe II 4173
Hδ 4102
Sr II 4078
Mn I 4031
Mn I 4034
Fe II 4385
Fe I 4383
Hβ 4861
atm. H2O
(8230)
a - band
atm. H2O
o Gem
78 UMa
46 Tau
ι Peg
110 Her
θ Per
υ And
F0 V
F2 V
F3 V
F5 V
F6 V
F7 V
F8 V
Ni I 3515
Ni I 3524
Fe I 3565 70
Fe I 3581
Fe I 3585 87
Fe I 3609
Fe I 3619
Fe I 3631
Fe I 3648
H13 3734
Fe I 3735
H12 3750
Fe I 3743 - 58
H11 3771
H10 3798
Fe I 3788
Fe I 3800
Mg I 3829
Mg I 3838
H9 3835
H8 3889
Ca 4227
G - band
(4300)
Fe, Ti, CH
Hγ 4340
Fe I 5167
Mg I 5167
Mg I 5184
Ni I 3524
Fe I 3566
Fe I 3570
Fe I 3581
Fe I 3586 87
Ni Fe I 3619
Fe I 3631
Fe I 3648
Fe I 3680 87
Fe I, Ca II 3706
Fe I 3709
Fe I 3720
H14 3722
H13 3734
Fe I 3735
Fe I 3743 - 58
H10 3798
Fe I 3788 - 00
Fe I 3816
Fe I 3841
Fe I 3856
Fe I 3860
H8 3889
Ca II 3934
Ca II 3968
Mn I 4031
Mn I 4034
Fe I 4046
Fe I 4064
Fe I 4072
Sr II 4078
Hδ 4102
Fe I 4173
Fe I 4207
Ca I 4227
G - band
Fe, Ti, CH
Fe I 4383
Fe I 4405
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Ti II 4550
Ti II 4572
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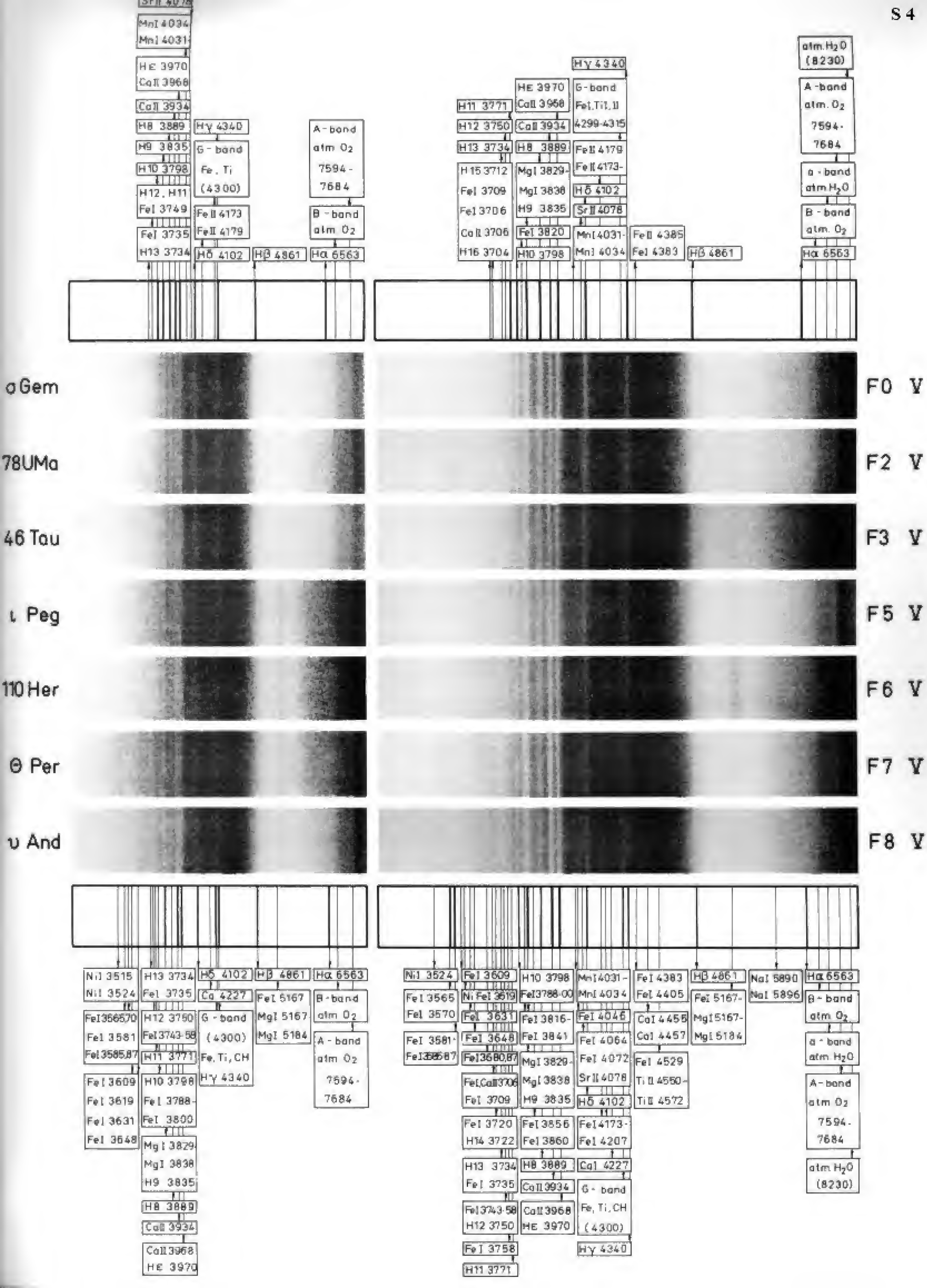
Na I 5896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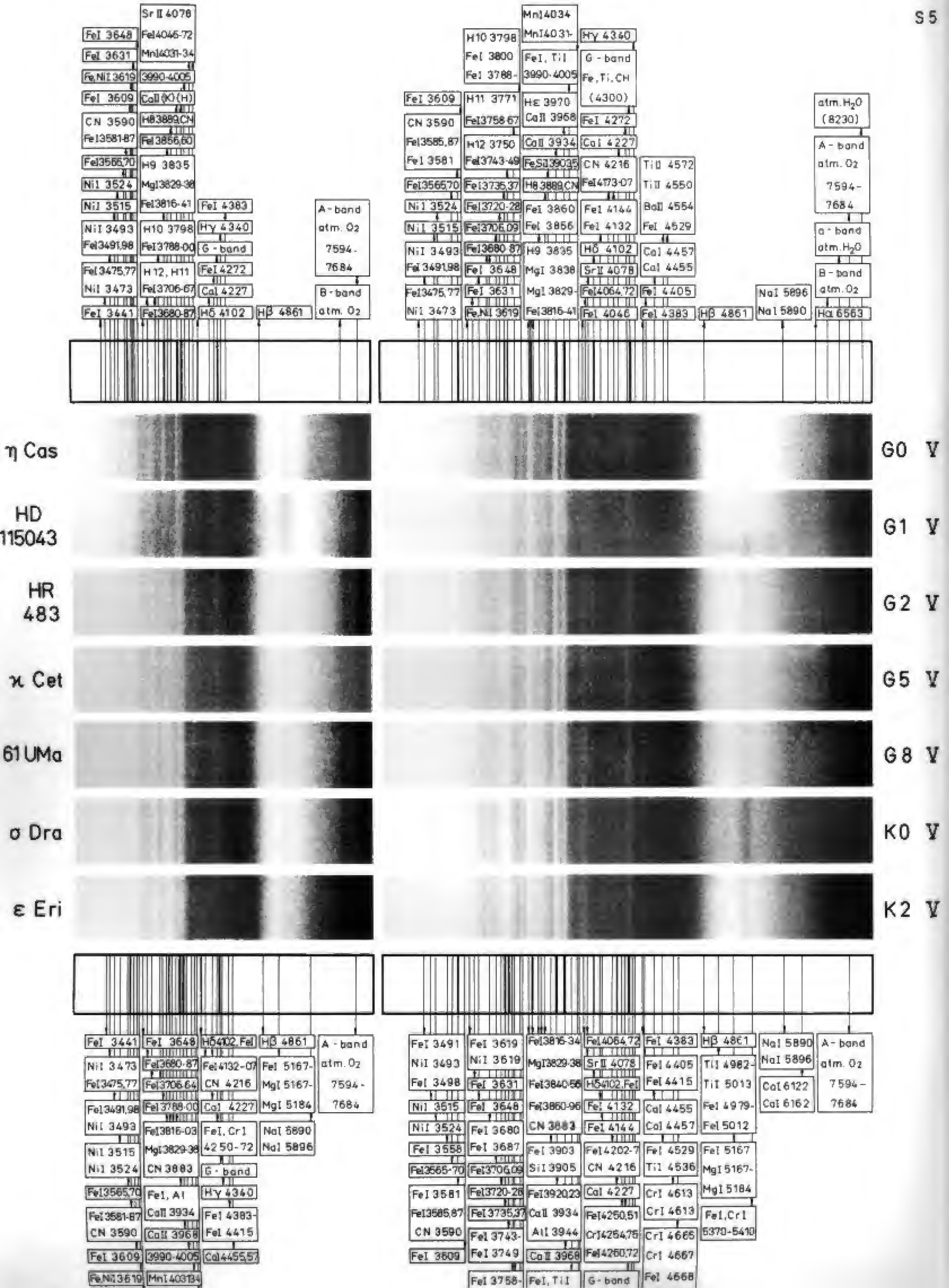
MnI 4031
Hε 3970
CaII 3968
CaII 3934
H8 3889
H9 3835
H10 3798
H12, H11
FeI 3749
FeI 3735
H13 3734
Hγ 4340
G - band
Fe, Ti
(4300)
FeII 4173
FeII 4179
Hδ 4102
Hβ 4861
A - band
atm O₂
7594 -
7684
B - band
atm O₂
Hα 6563
H11 3771
H12 3750
H13 3734
H15 3712
FeI 3709
FeI 3706
CaII 3706
H16 3704
Hε 3970
CaII 3968
CaII 3934
H8 3889
MgI 3829
MgI 3838
H9 3835
FeI 3820
H10 3798
Hγ 4340
G - band
Fe, TiI, II
4299-4315
FeII 4179
FeII 4173
Hδ 4102
SrII 4078
MnI 4031
MnI 4034
FeII 4385
FeI 4383
Hβ 4861
atm. H₂O
(8230)
A - band
atm. O₂
7594 -
7684
a - band
atm. H₂O
B - band
atm. O₂
Hα 6563
α Gem
F0 V
78 UMa
F2 V
46 Tau
F3 V
ι Peg
F5 V
110 Her
F6 V
θ Per
F7 V
υ And
F8 V
NiI 3515
NiI 3524
FeI 3565,70
FeI 3581
FeI 3585,87
FeI 3609
FeI 3619
FeI 3631
FeI 3648
H13 3734
FeI 3735
H12 3750
FeI 3743-58
H11 3771
H10 3798
FeI 3788
FeI 3800
MgI 3829
MgI 3838
H9 3835
H8 3889
CaII 3934
CaII 3968
Hε 3970
Hδ 4102
Ca 4227
G - band
(4300)
Fe, Ti, CH
Hγ 4340
Hβ 4861
FeI 5167
MgI 5167
MgI 5184
Hα 6563
B - band
atm O₂
A - band
atm O₂
7594 -
7684
NiI 3524
FeI 3565
FeI 3570
FeI 3581
FeI 3585,87
FeI 3609
Ni FeI 3619
FeI 3631
FeI 3648
FeI 3680,87
FeI, CaII 3706
FeI 3709
FeI 3720
H14 3722
H13 3734
FeI 3735
FeI 3743-58
H12 3750
FeI 3758
H11 3771
H10 3798
FeI 3788-00
FeI 3816
FeI 3841
MgI 3829
MgI 3838
H9 3835
FeI 3856
FeI 3860
H8 3889
CaII 3934
CaII 3968
Hε 3970
MnI 4031
MnI 4034
FeI 4046
FeI 4064
FeI 4072
SrII 4078
Hδ 4102
FeI 4173
FeI 4207
CaI 4227
G - band
Fe, Ti, CH
(4300)
Hγ 4340
FeI 4383
FeI 4405
CaI 4455
CaI 4457
FeI 4529
TiII 4550
TiII 4572
Hβ 4861
FeI 5167
MgI 5167
MgI 5184
NaI 5890
NaI 5896
Hα 6563
B - band
atm. O₂
a - band
atm. H₂O
A - band
atm O₂
7594 -
7684
atm H₂O
(8230)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G0 V
HD 115043
G1 V
HR 483
G2 V
ϰ Cet
G5 V
61 UMa
G8 V
σ Dra
K0 V
ε Eri
K2 V
FeI 3648
FeI 3631
Fe,NiI 3619
FeI 3609
CN 3590
FeI 3581-87
FeI 3565,70
NiI 3524
NiI 3515
NiI 3493
FeI 3491,98
FeI 3475,77
NiI 3473
FeI 3441
Sr II 4078
FeI 4046-72
MnI 4031-34
3990-4005
CaII (K) (H)
H8 3889,CN
FeI 3856,60
H9 3835
MgI 3829-38
FeI 3816-41
H10 3798
FeI 3788-00
H12, H11
FeI 3706-67
FeI 3680-87
FeI 4383
Hγ 4340
G-band
FeI 4272
CaI 4227
Hδ 4102
Hβ 4861
A-band
atm. O2
7594-7684
B-band
atm. O2
MnI 4034
MnI 4031-
H10 3798
FeI 3800
FeI 3788-
FeI, TiI
3990-4005
Hγ 4340
G-band
Fe, Ti, CH
(4300)
Hε 3970
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CaII 3934
Fe,SiI 3903,05
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FeI 3860
FeI 3856
H9 3835
MgI 3838
MgI 3829-
FeI 3816-41
H11 3771
FeI 3758,67
H12 3750
FeI 3743-49
FeI 3735,37
FeI 3720-28
FeI 3706,09
FeI 3680,87
FeI 3648
FeI 3631
Fe,NiI 3619
FeI 3609
CN 3590
FeI 3585,87
FeI 3581
FeI 3565,70
NiI 3524
NiI 3515
NiI 3493
FeI 3491,98
FeI 3475,77
NiI 3473
FeI 4272
CaI 4227
CN 4216
FeI 4173-07
FeI 4144
FeI 4132
Hδ 4102
SrII 4078
FeI 4064,72
FeI 4046
TiII 4572
TiII 4550
BaII 4554
FeI 4529
CaI 4457
CaI 4455
FeI 4405
FeI 4383
Hβ 4861
NaI 5896
NaI 5890
atm. H2O
(8230)
A-band
atm. O2
7594-7684
a-band
atm. H2O
B-band
atm. O2
Hα 6563
FeI 3441
NiI 3473
FeI 3475,77
FeI 3491,98
NiI 3493
NiI 3515
NiI 3524
FeI 3565,70
FeI 3581-87
CN 3590
FeI 3609
Fe,NiI 3619
FeI 3648
FeI 3680-87
FeI 3706,64
FeI 3788-00
FeI 3816-03
MgI 3829-38
CN 3883
FeI, AI
CaII 3934
CaII 3968
3990-4005
MnI 4031-34
Hδ 4102, FeI
FeI 4132-07
CN 4216
CaI 4227
FeI, CrI
4250-72
G-band
Hγ 4340
FeI 4383-
FeI 4415
CaI 4455,57
Hβ 4861
FeI 5167-
MgI 5167-
MgI 5184
NaI 5890
NaI 5896
A-band
atm. O2
7594-7684
FeI 3491
NiI 3493
FeI 3498
NiI 3515
NiI 3524
FeI 3558
FeI 3565-70
FeI 3581
FeI 3585,87
CN 3590
FeI 3609
FeI 3619
NiI 3619
FeI 3631
FeI 3648
FeI 3680
FeI 3687
FeI 3706,09
FeI 3720-28
FeI 3735,37
FeI 3743-
FeI 3749
FeI 3758-
FeI 3816-34
MgI 3829-38
FeI 3840-56
FeI 3860-96
CN 3883
FeI 3903
SiI 3905
FeI 3920,23
CaII 3934
AlI 3944
CaII 3968
FeI, TiI
FeI 4064,72
SrII 4078
Hδ 4102, FeI
FeI 4132
FeI 4144
FeI 4202-7
CN 4216
CaI 4227
FeI 4250,51
CrI 4254,75
FeI 4260,72
G-band
FeI 4383
FeI 4405
FeI 4415
CaI 4455
CaI 4457
FeI 4529
TiI 4536
CrI 4613
CrI 4613
CrI 4665
CrI 4667
FeI 4668
Hβ 4861
TiI 4982-
TiI 5013
FeI 4979-
FeI 5012
FeI 5167
MgI 5167-
MgI 5184
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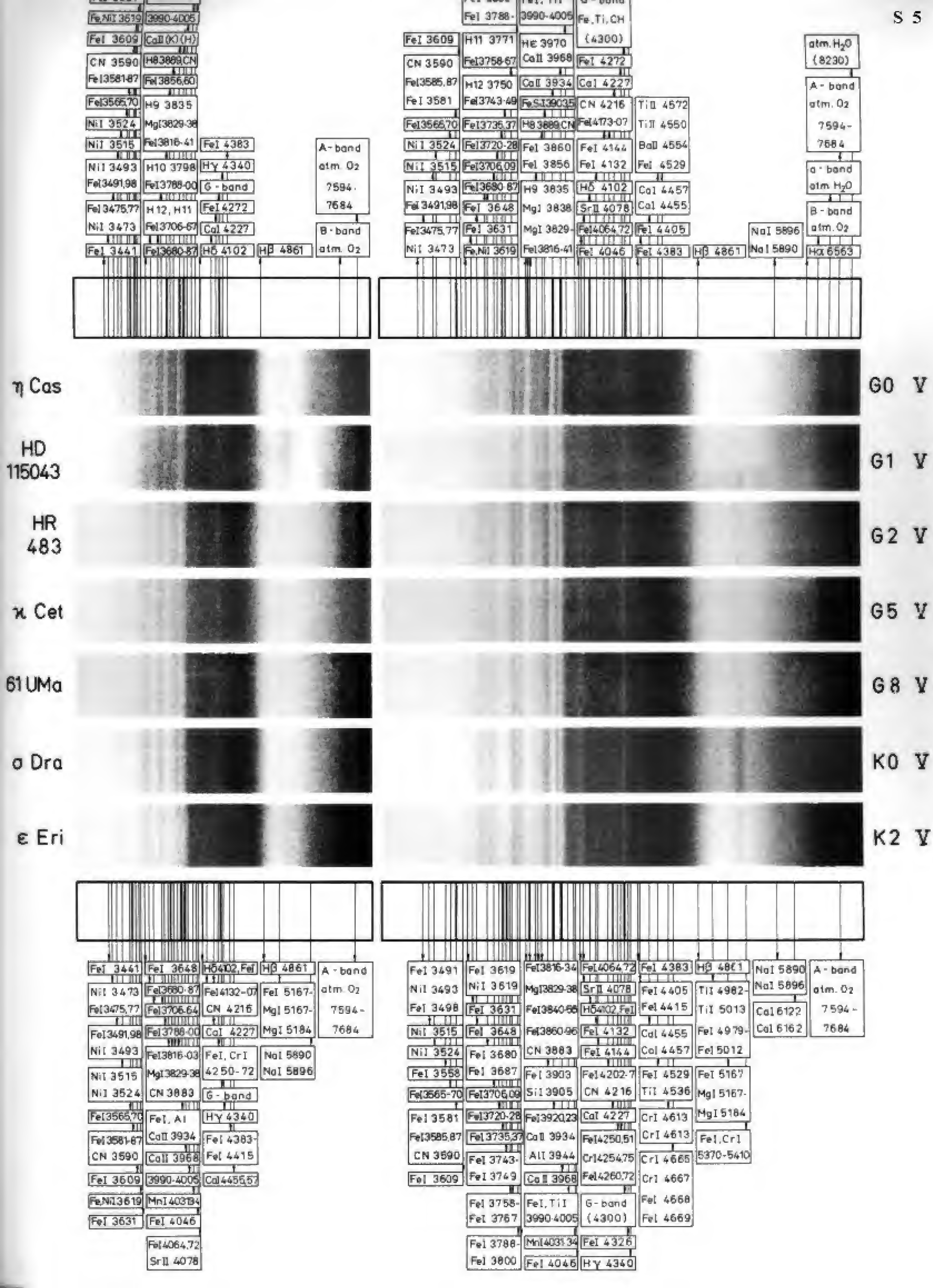
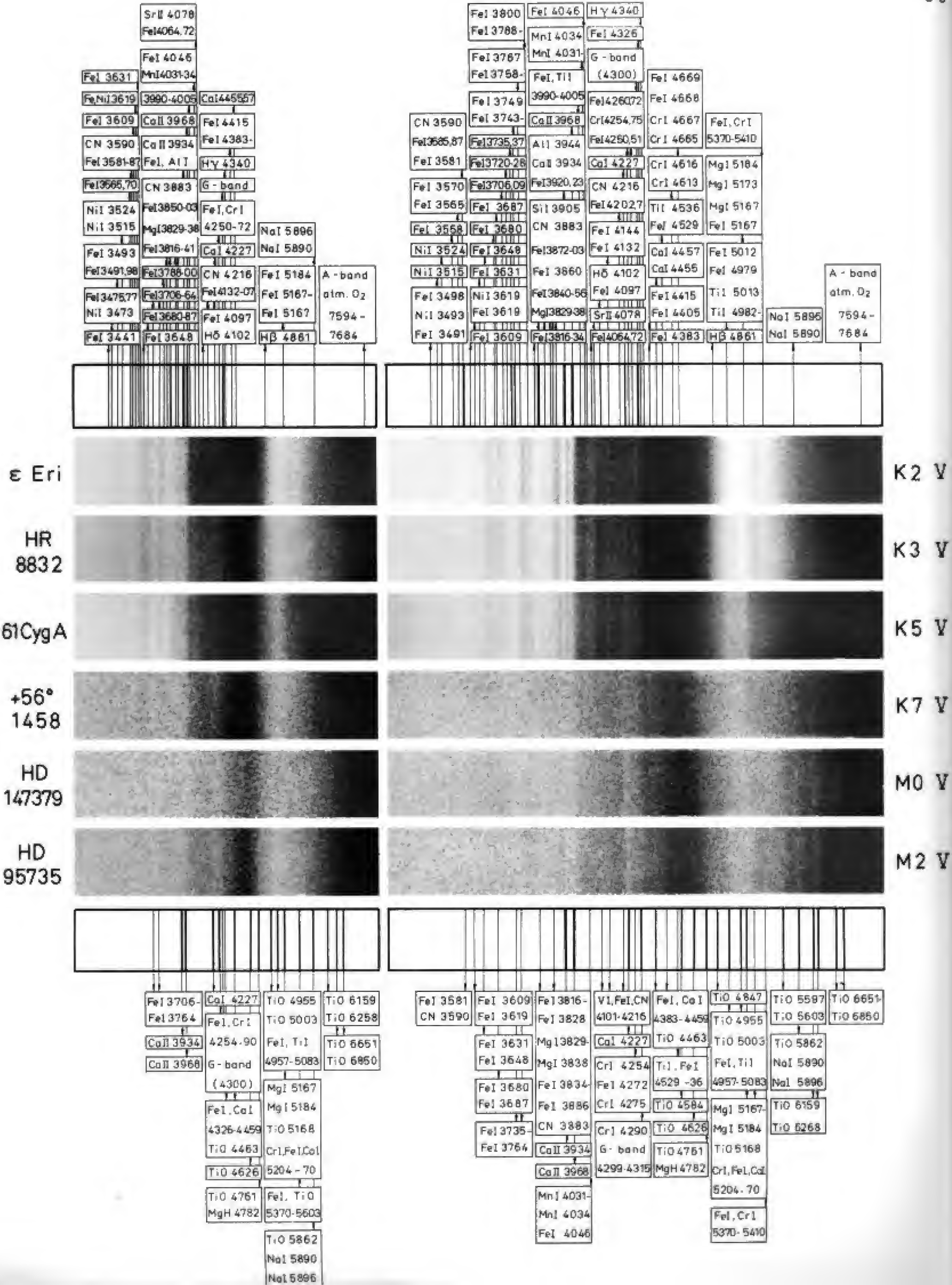
CaI 6162
A-band
atm. O2
7594-7684


η Cas
G0 V
HD 115043
G1 V
HR 483
G2 V
κ Cet
G5 V
61 UMa
G8 V
σ Dra
K0 V
ε Eri
K2 V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FeI 4383-
CN 3590
FeI 3581-87
CaII 3934
FeI, AlI
Hγ 4340
FeI 3565,70
CN 3883
G - band
NiI 3524
NiI 3515
FeI 3850-03
MgI 3829-38
FeI, CrI
4250-72
NaI 5896
NaI 5890
FeI 3493
FeI 3491,98
FeI 3816-41
CaI 4227
FeI 3788-00
CN 4216
FeI 4132-07
FeI 5184
FeI 5167-
FeI 5167
A - band
atm. O_2
7594 -
7684
FeI 3475,77
NiI 3473
FeI 3706-64
FeI 3680-87
FeI 4097
Hδ 4102
FeI 3441
FeI 3648
Hβ 4861
FeI 3800
FeI 3788-
FeI 4046
Hγ 4340
MnI 4034
MnI 4031-
FeI 4326
FeI 3767
FeI 3758-
G - band
(4300)
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3990-4005
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FeI 4668
FeI 3749
FeI 3743-
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CrI 4254,75
FeI 4250,51
CrI 4667
CrI 4665
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FeI 3581
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FeI, CrI
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AlI 3944
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CaI 4227
CrI 4616
CrI 4613
MgI 5184
MgI 5173
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FeI 3565
FeI 3706,09
FeI 3920,23
CN 4216
FeI 4202,7
MgI 5167
FeI 3687
SiI 3905
CN 3883
TiI 4536
TiI 4529
FeI 5167
FeI 3558
FeI 3680
FeI 4144
FeI 4132
NiI 3524
FeI 3648
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CaI 4455
FeI 5012
FeI 4979
NiI 3515
FeI 3631
FeI 3860
Hδ 4102
FeI 4097
TiI 5013
TiI 4982-
FeI 3498
NiI 3493
FeI 3491
NiI 3619
FeI 3619
FeI 3840-56
MgI 3829-38
FeI 4415
FeI 4405
SrII 4078
NaI 5896
NaI 5890
FeI 3609
FeI 3816-34
FeI 4064,72
FeI 4383
Hβ 4861
A - band
atm. O_2
7594 -
7684
ε Eri
K2 V
HR
8832
K3 V
61Cyg A
K5 V
+56°
1458
K7 V
HD
147379
M0 V
HD
95735
M2 V
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FeI 3764
CaII 3934
CaII 3968
CaI 4227
FeI, CrI
4254-90
G - band
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4326-4459
TiO 4463
TiO 4626
TiO 4761
MgH 4782
TiO 4955
TiO 5003
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MgI 5167
MgI 5184
TiO 5168
CrI,FeI,CaI
5204 - 70
FeI, TiO
5370-5603
TiO 5862
NaI 5890
NaI 5896
TiO 6159
TiO 6258
TiO 6651
TiO 6850
FeI 3581
CN 3590
FeI 3609
FeI 3619
FeI 3631
FeI 3648
FeI 3680
FeI 3687
FeI 3735-
FeI 3764
FeI 3816-
FeI 3828
MgI 3829-
MgI 3838
FeI 3834-
FeI 3886
CN 3883
CaII 3934
CaII 3968
MnI 4031-
MnI 4034
FeI 4046
VI,FeI,CN
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CrI 4254
FeI 4272
CrI 4275
CrI 4290
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4299-4315
FeI, CaI
4383-4459
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TiI, FeI
4529 -36
TiO 4584
TiO 4626
TiO 4761
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TiO 4955
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FeI, TiI
4957-5083
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MgI 5184
TiO 5168
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5204 - 70
FeI, CrI
5370- 5410
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TiO 5862
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NaI 5896
TiO 6159
TiO 6258
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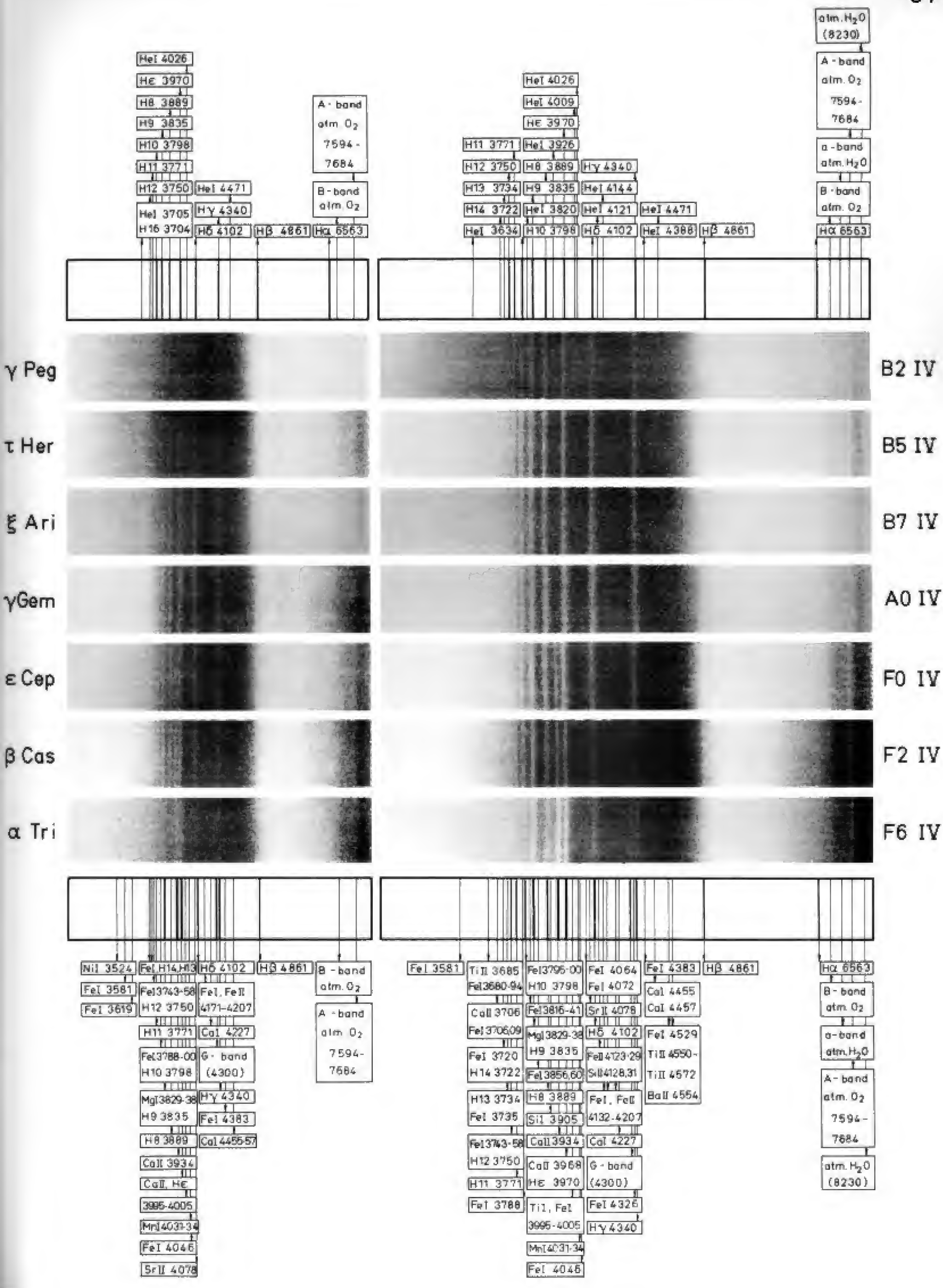
γ Peg
τ Her
ξ Ari
γ Gem
ε Cep
β Cas
α Tri
B2 IV
B5 IV
B7 IV
A0 IV
F0 IV
F2 IV
F6 IV
HeI 4026
Hε 3970
H8 3889
H9 3835
H10 3798
H11 3771
H12 3750
HeI 3705
H16 3704
HeI 4471
Hγ 4340
Hδ 4102
Hβ 4861
A - band
atm. O2
7594 - 7684
B - band
atm. O2
Hα 6563
HeI 4009
HeI 3926
H13 3734
H14 3722
HeI 3634
HeI 3820
HeI 4144
HeI 4121
HeI 4388
atm. H2O
(8230)
a - band
atm. H2O
NiI 3524
FeI 3581
FeI 3619
FeI, H14, H13
FeI 3743-58
FeI, FeII
4171-4207
CaI 4227
FeI 3788-00
G - band
(4300)
MgI 3829-38
FeI 4383
CaI 4455-57
CaII 3934
CaII, Hε
3995-4005
MnI 4031-34
FeI 4046
SrII 4078
TiII 3685
FeI 3680-94
CaII 3706
FeI 3706,09
FeI 3720
FeI 3735
FeI 3795-00
FeI 3816-41
FeI 3856,60
SiI 3905
CaII 3968
TiI, FeI
FeI 4064
FeI 4072
SrII 4078
FeII 4123-29
SiII 4128,31
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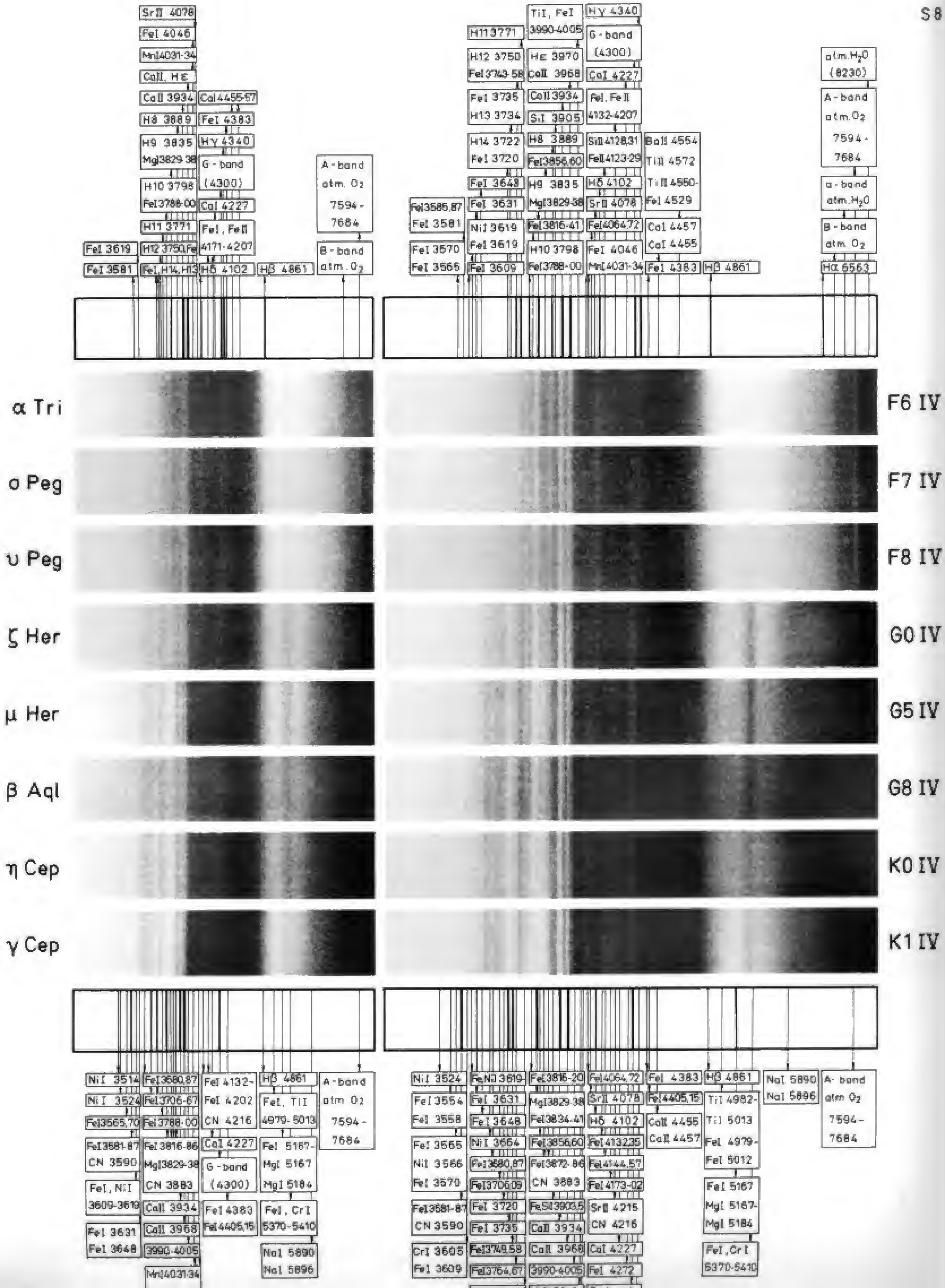
4132-4207
FeI 4326
CaI 4455
CaI 4457
FeI 4529
TiII 4550 -
TiII 4572
BaII 4554



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CaII 3934
H8 3889
H9 3835
MgI 3829-38
H10 3798
FeI 3788-00
H11 3771
H12 3750, Fe
FeI, H14, H13
FeI 3619
FeI 3581
CaI 4455-57
FeI 4383
Hγ 4340
G-band
(4300)
CaI 4227
FeI, FeII
4171-4207
Hδ 4102
Hβ 4861
A-band
atm. O2
7594-
7684
B-band
atm. O2
TiI, FeI
3990-4005
Hγ 4340
G-band
(4300)
H11 3771
H12 3750
FeI 3743-58
Hε 3970
CaII 3968
CaI 4227
FeI 3735
H13 3734
CaII 3934
SiI 3905
FeI, FeII
4132-4207
H14 3722
FeI 3720
H8 3889
FeI 3856,60
SiII 4128,31
FeII 4123-29
BaII 4554
TiII 4572
TiII 4550-
FeI 4529
FeI 3648
FeI 3631
H9 3835
MgI 3829-38
Hδ 4102
SrII 4078
FeI 3585,87
FeI 3581
NiI 3619
FeI 3619
FeI 3816-41
FeI 4064,72
CaI 4457
CaI 4455
FeI 3570
FeI 3565
FeI 3609
H10 3798
FeI 3788-00
FeI 4046
MnI 4031-34
FeI 4383
Hβ 4861
atm. H2O
(8230)
A-band
atm. O2
7594-
7684
a-band
atm. H2O
B-band
atm. O2
Hα 6563
α Tri
F6 IV
σ Peg
F7 IV
υ Peg
F8 IV
ζ Her
G0 IV
μ Her
G5 IV
β Aql
G8 IV
η Cep
K0 IV
γ Cep
K1 IV
NiI 3514
NiI 3524
FeI 3565,70
FeI 3581-87
CN 3590
FeI, NiI
3609-3619
FeI 3631
FeI 3648
FeI 3680,87
FeI 3706-67
FeI 3788-00
FeI 3816-86
MgI 3829-38
CN 3883
CaII 3934
CaII 3968
3990-4005
MnI 4031-34
FeI 4132-
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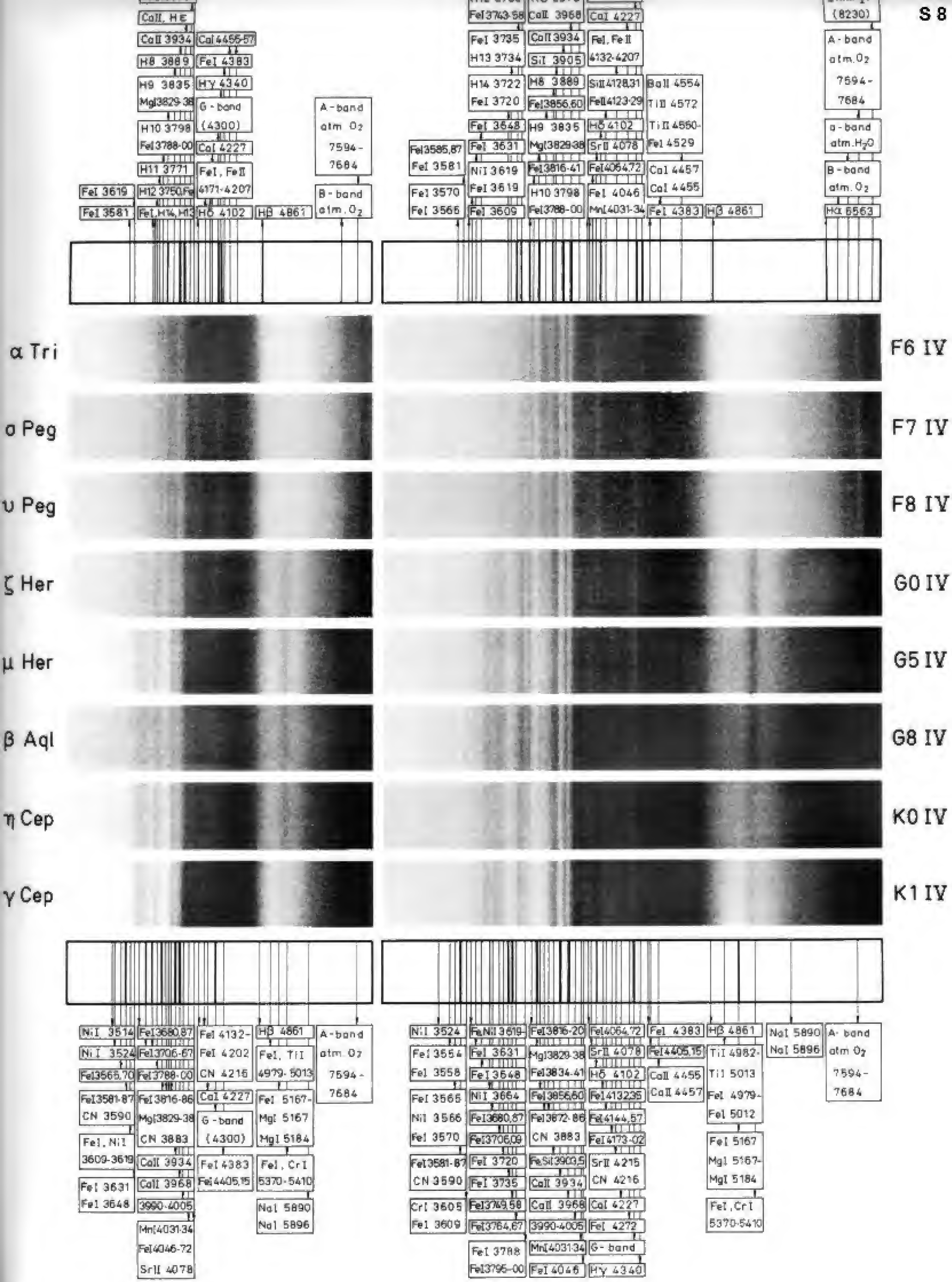
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ο Peg
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υ Peg
F8 IV
ζ Her
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μ Her
G5 IV
β Aql
G8 IV
η Cep
K0 IV
γ Cep
K1 IV
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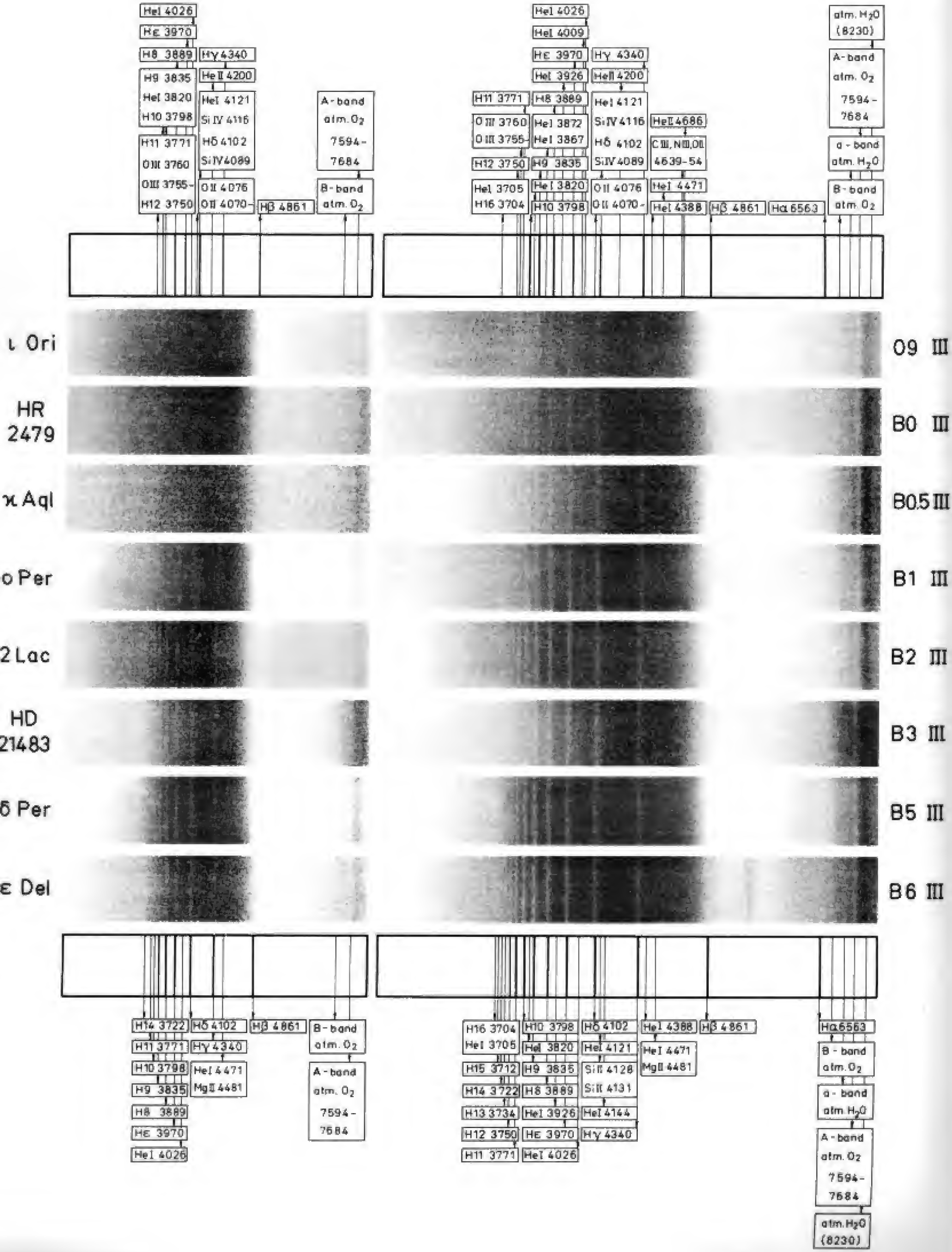
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atm. H2O
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HR
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κ Aql
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o Per
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ε Del
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H14 3722
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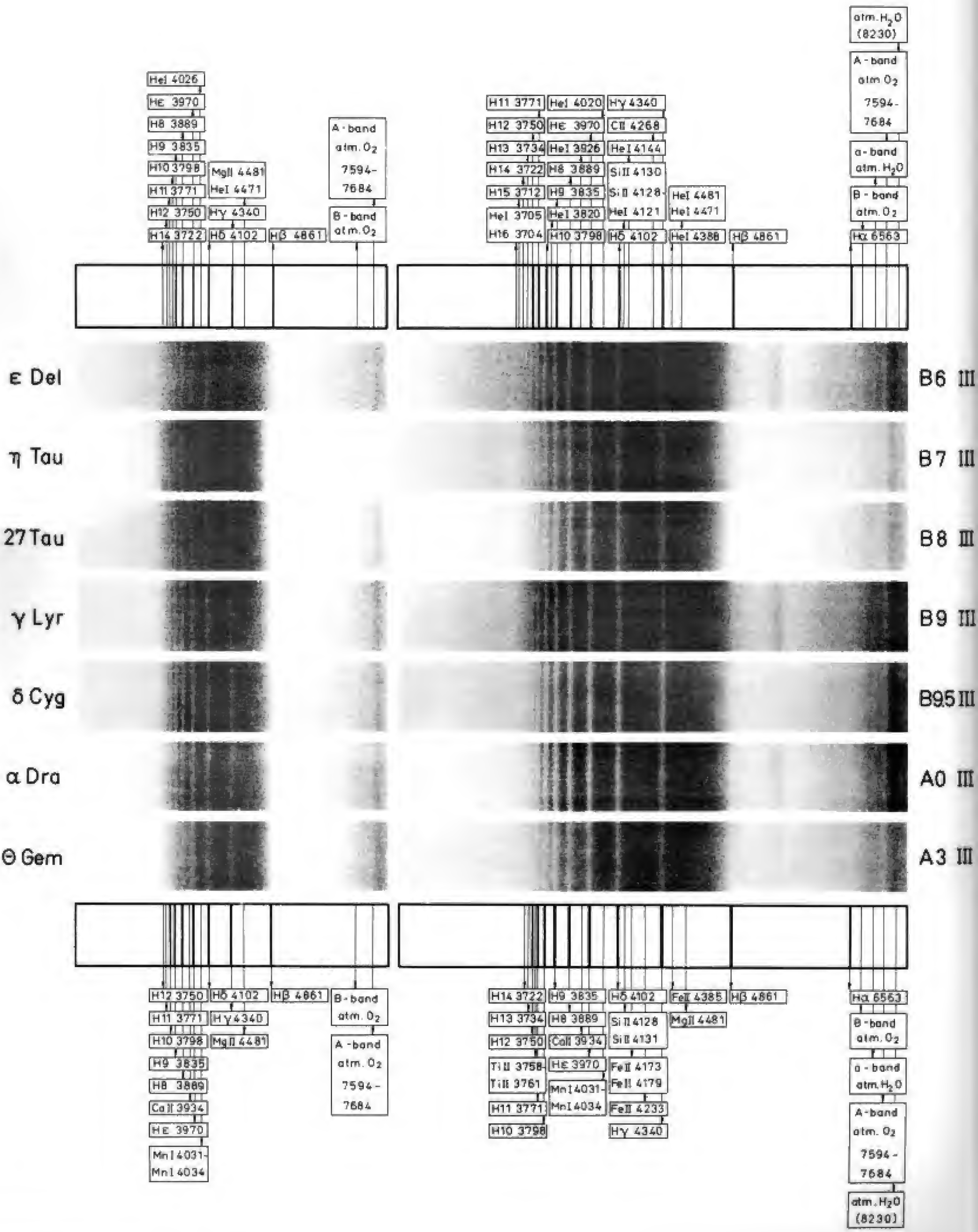

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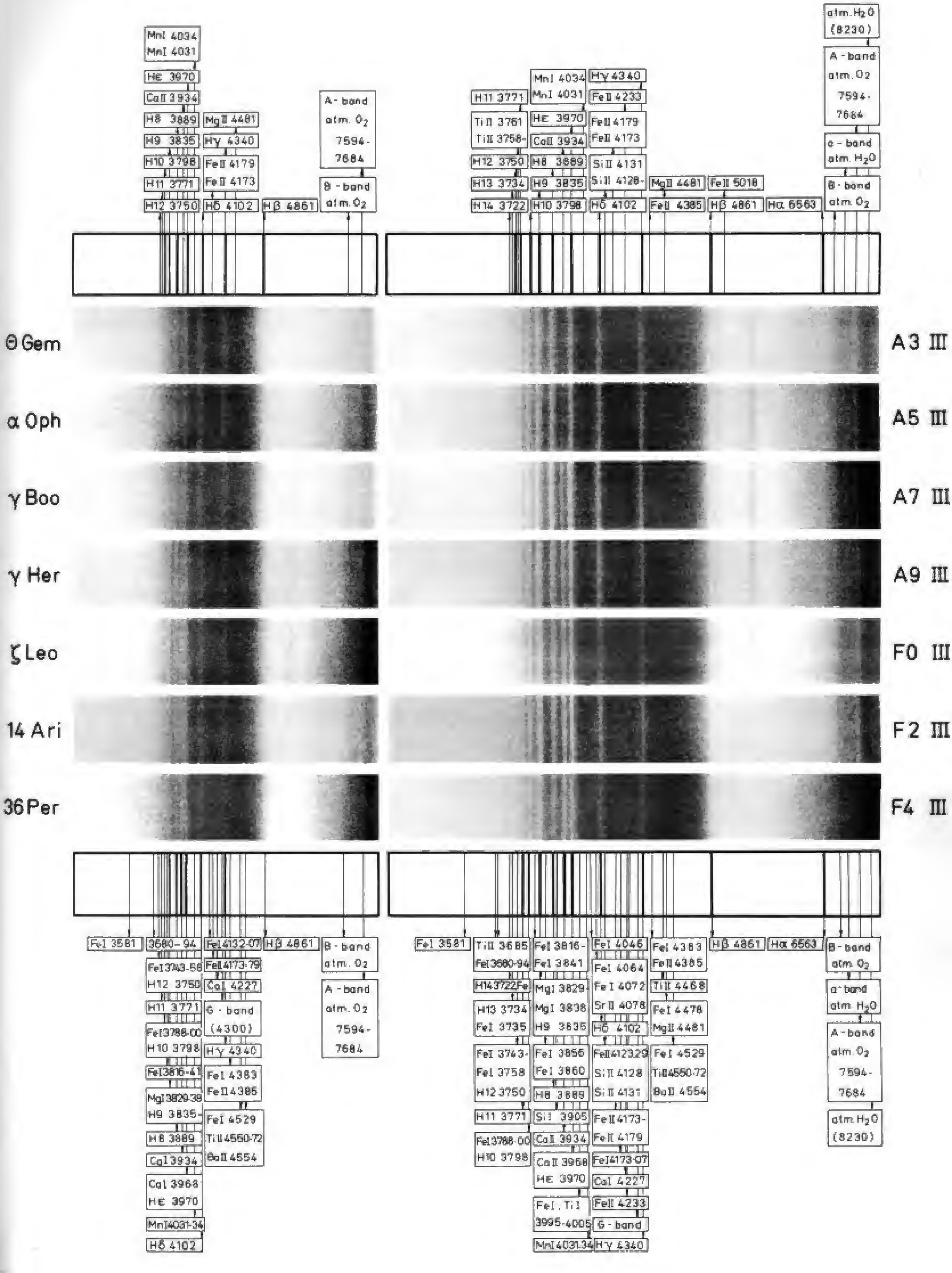
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atm. O2
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α Oph
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ζ Leo
14 Ari
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Hα 6563
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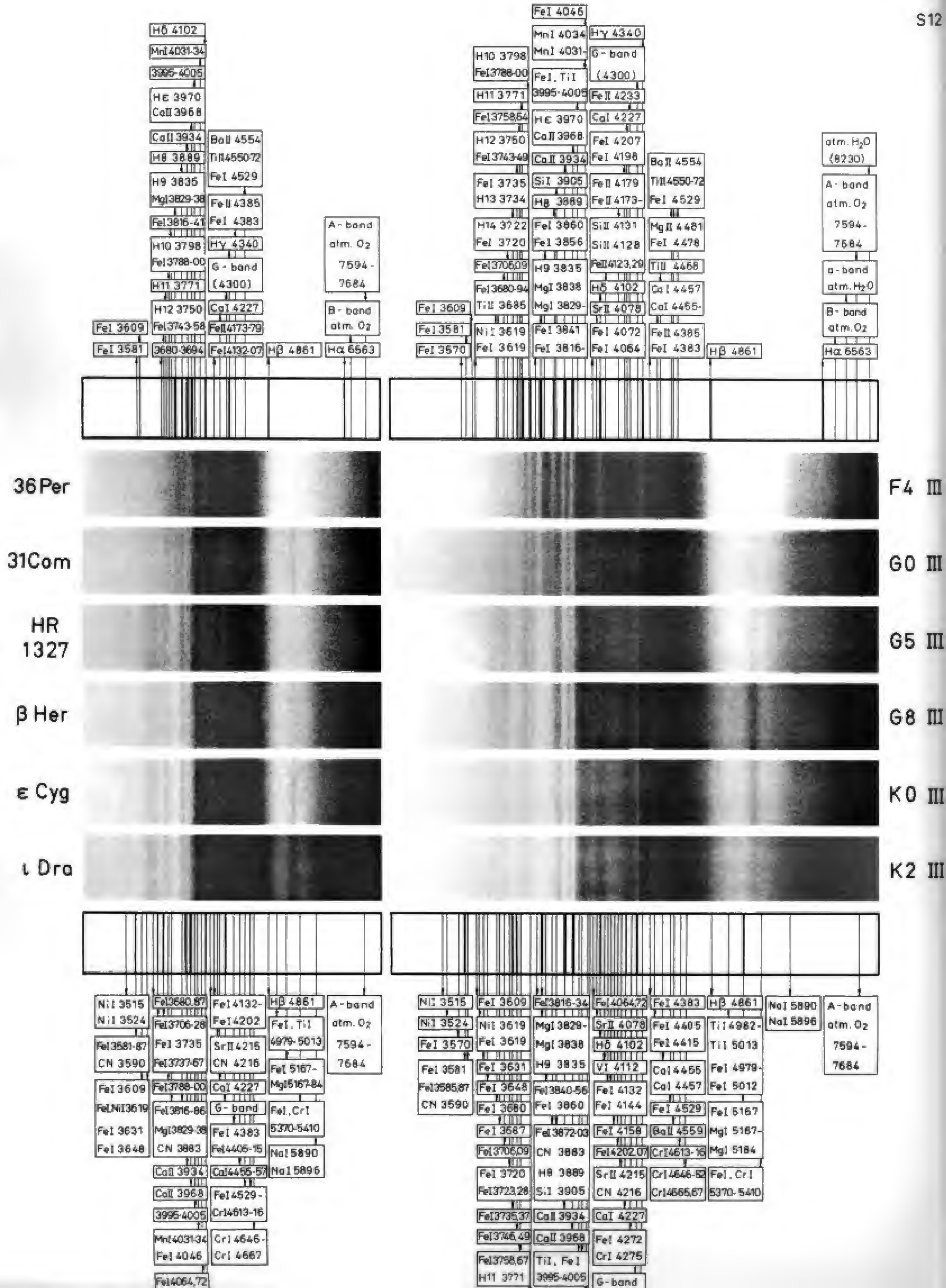

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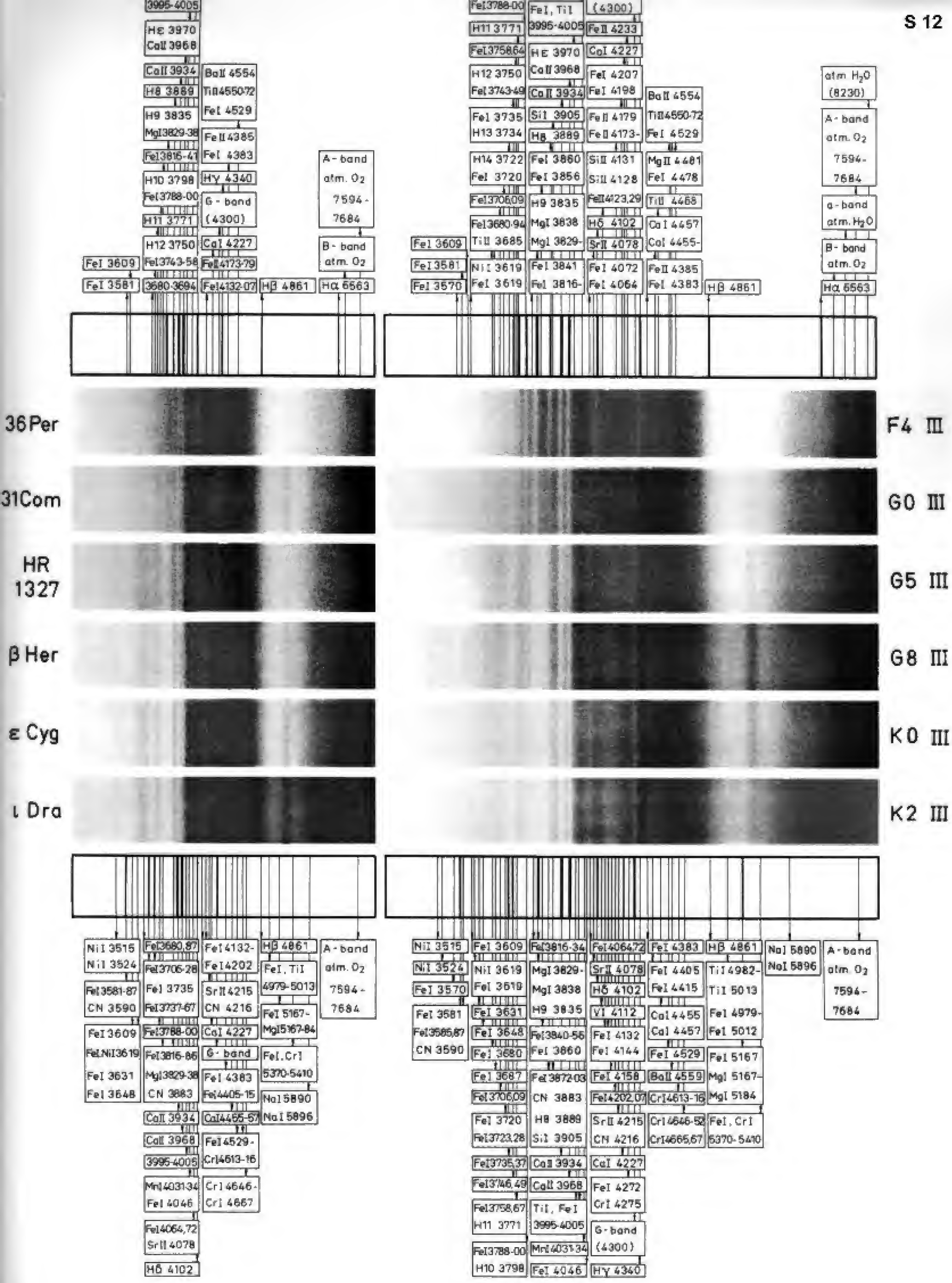
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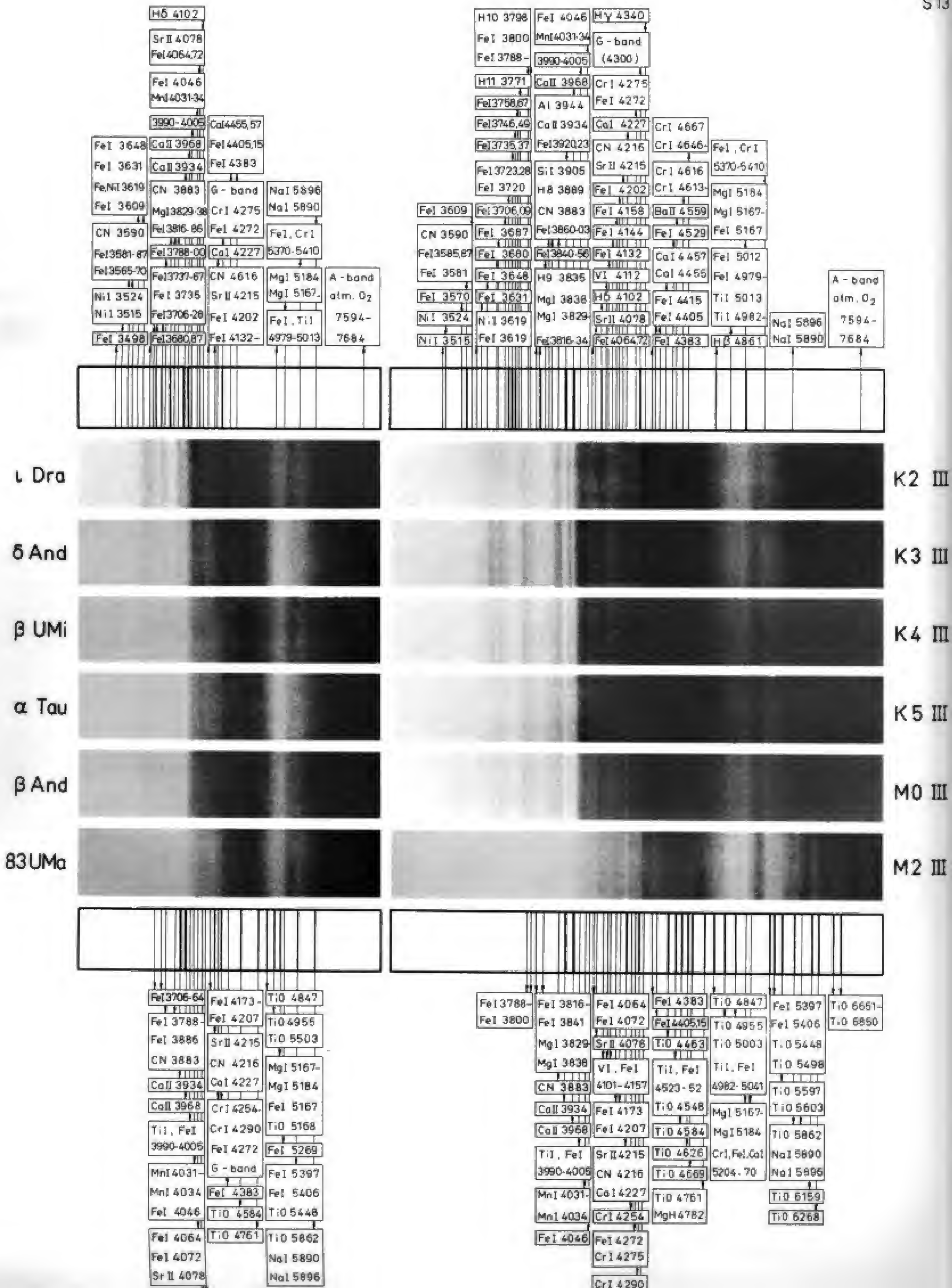
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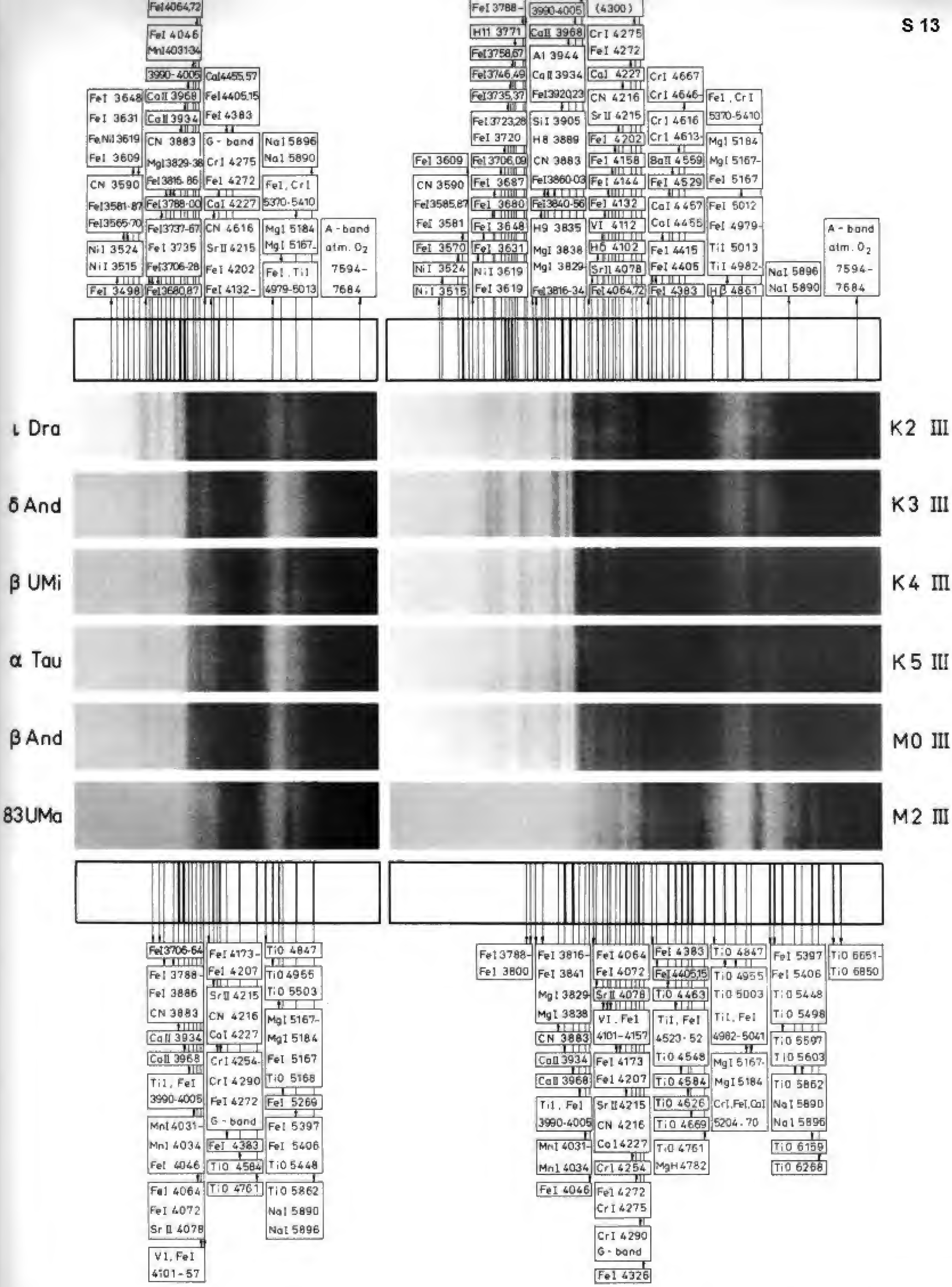
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CN 3590
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SrII 4215
FeI 4202
FeI 4132-
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NaI 5890
FeI, CrI
5370-5410
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FeI, TiI
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A - band
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FeI 4383
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δ And
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α Tau
K5 III
β And
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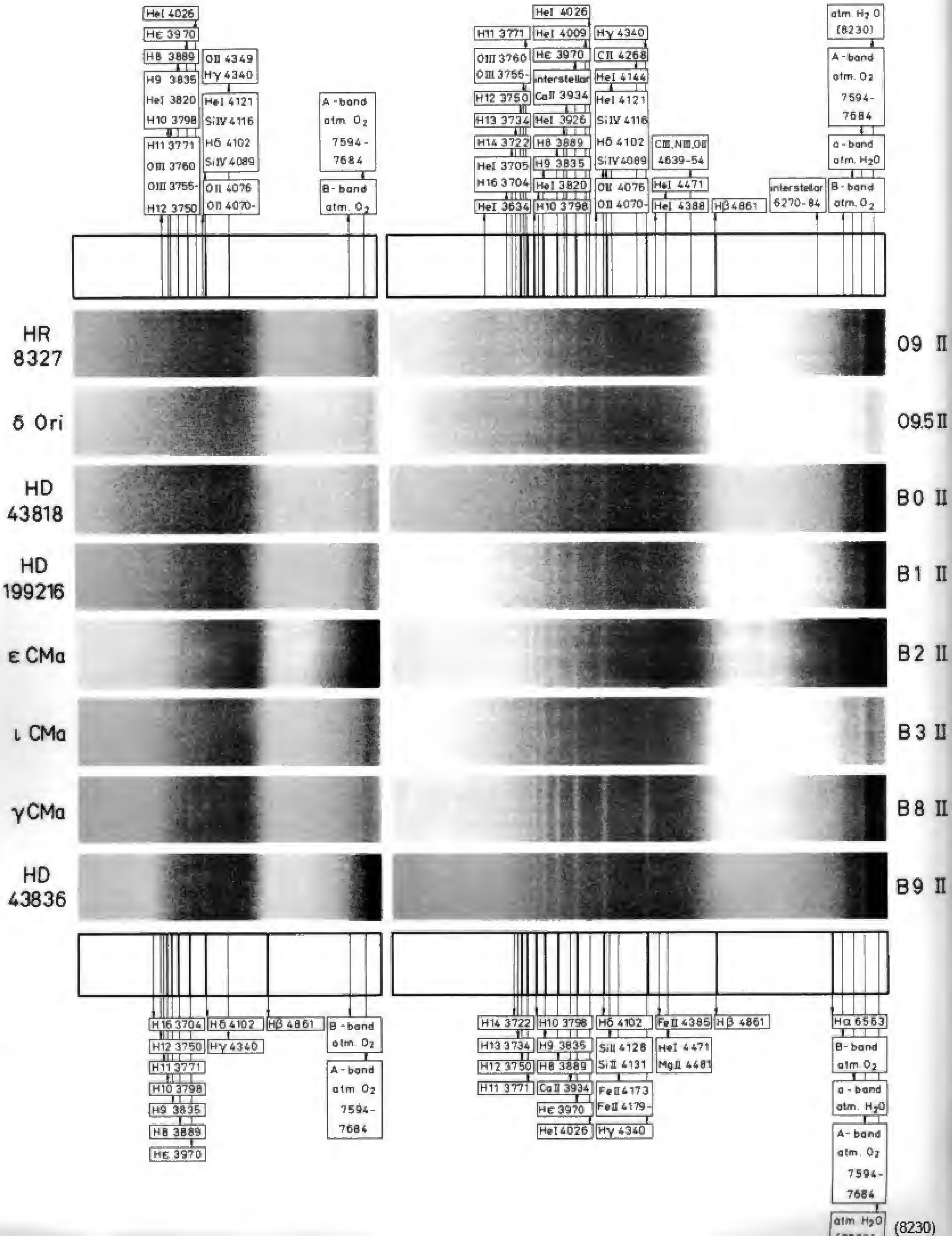
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SiIV 4116
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H11 3771
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interstellar CaII 3934
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CII 4268
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SiIV 4116
Hδ 4102
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OII 4076
OII 4070-
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Hβ 4861
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B-band atm. O2
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A-band atm. O2 7594-7684
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SiII 4128
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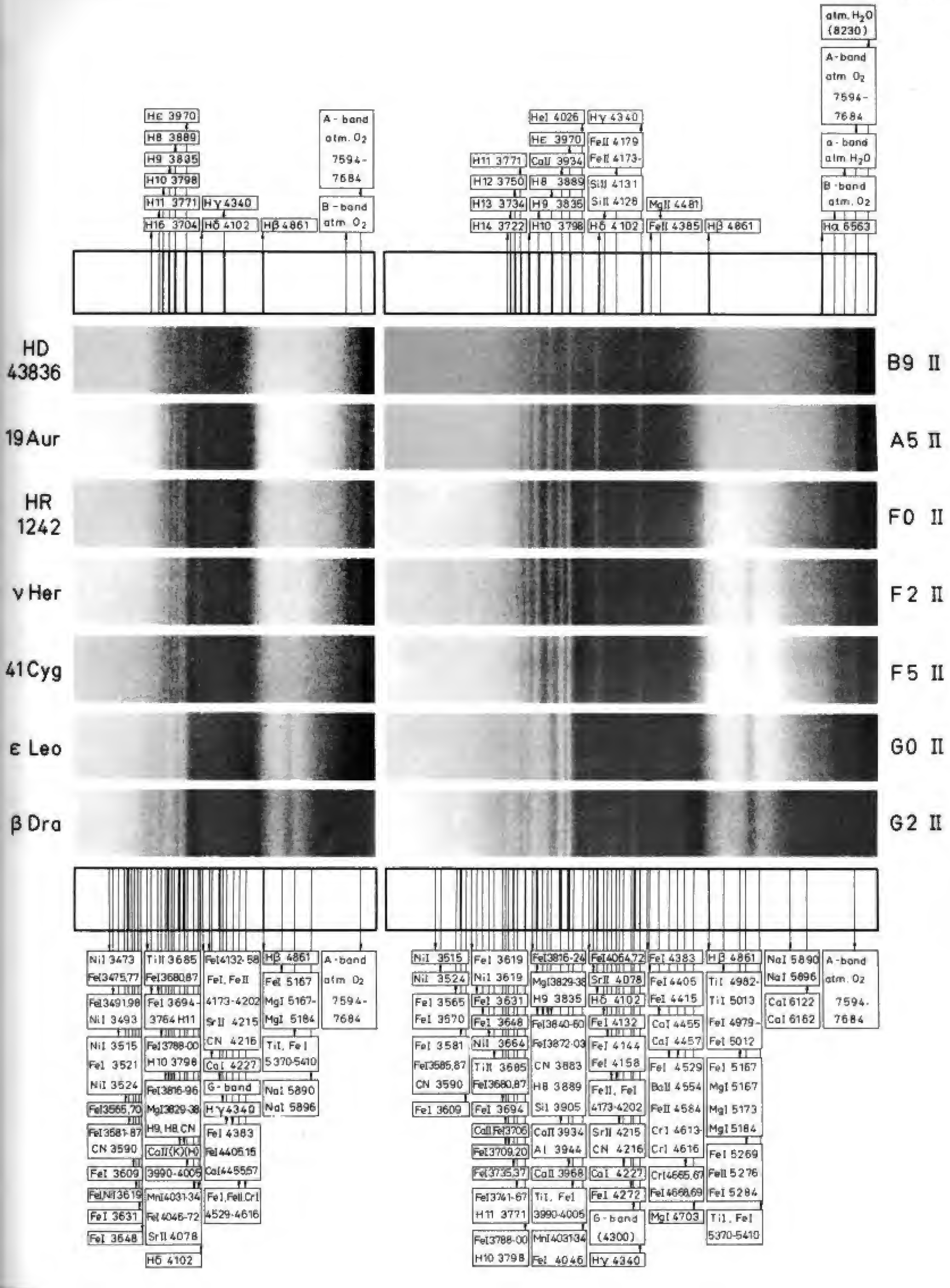
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Hβ 4861
A-band atm. O_2 7594-7684
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Hγ 4340
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ε Leo
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FeI 3788-00
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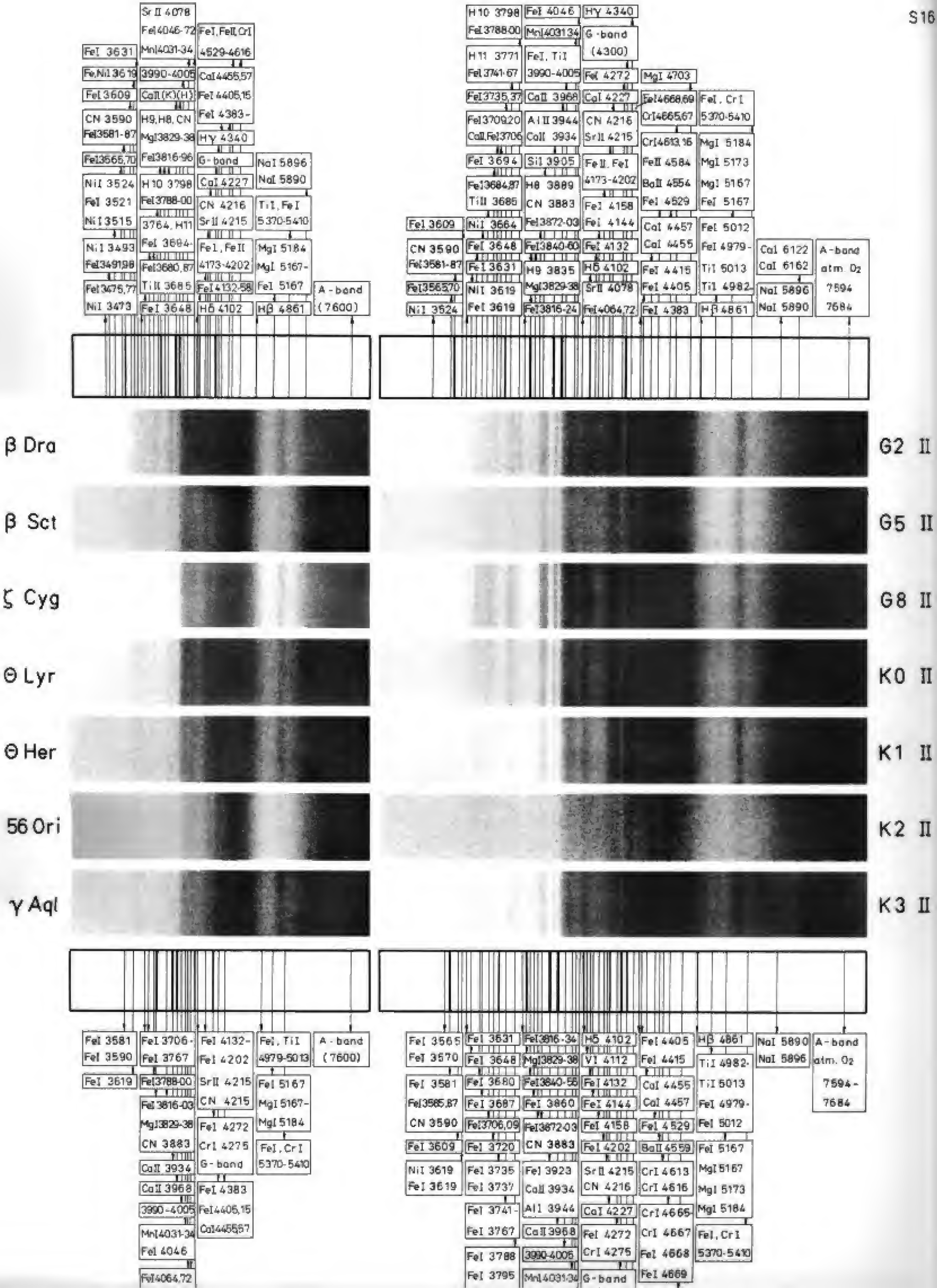
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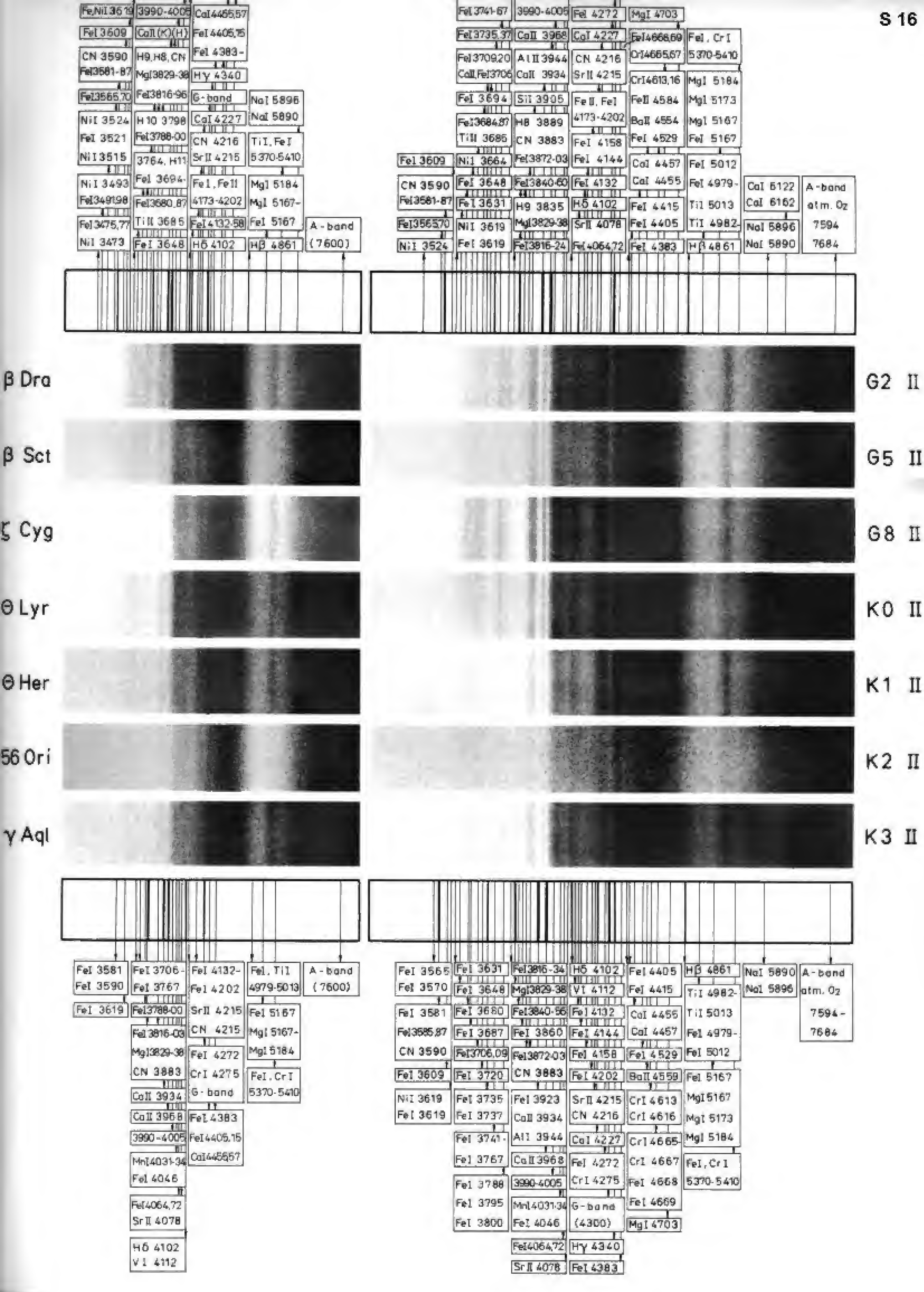
K3 II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A-band
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β Sct
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K2 II
γ Aql
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G-band
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FeI, CrI
5370-5410
A-band
(7600)
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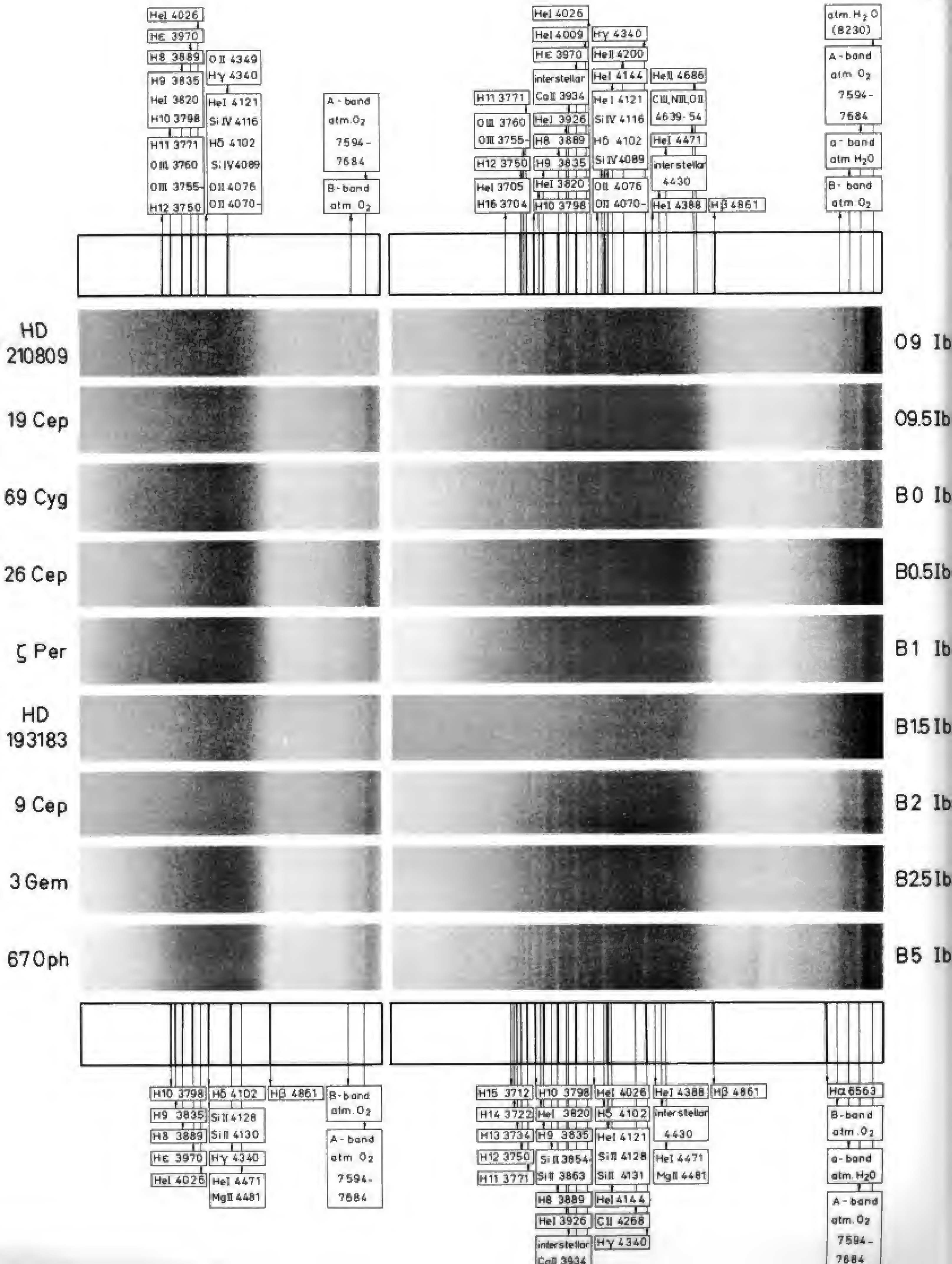
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B-band atm O_2
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69 Cyg
26 Cep
ζ Per
HD 193183
9 Cep
3 Gem
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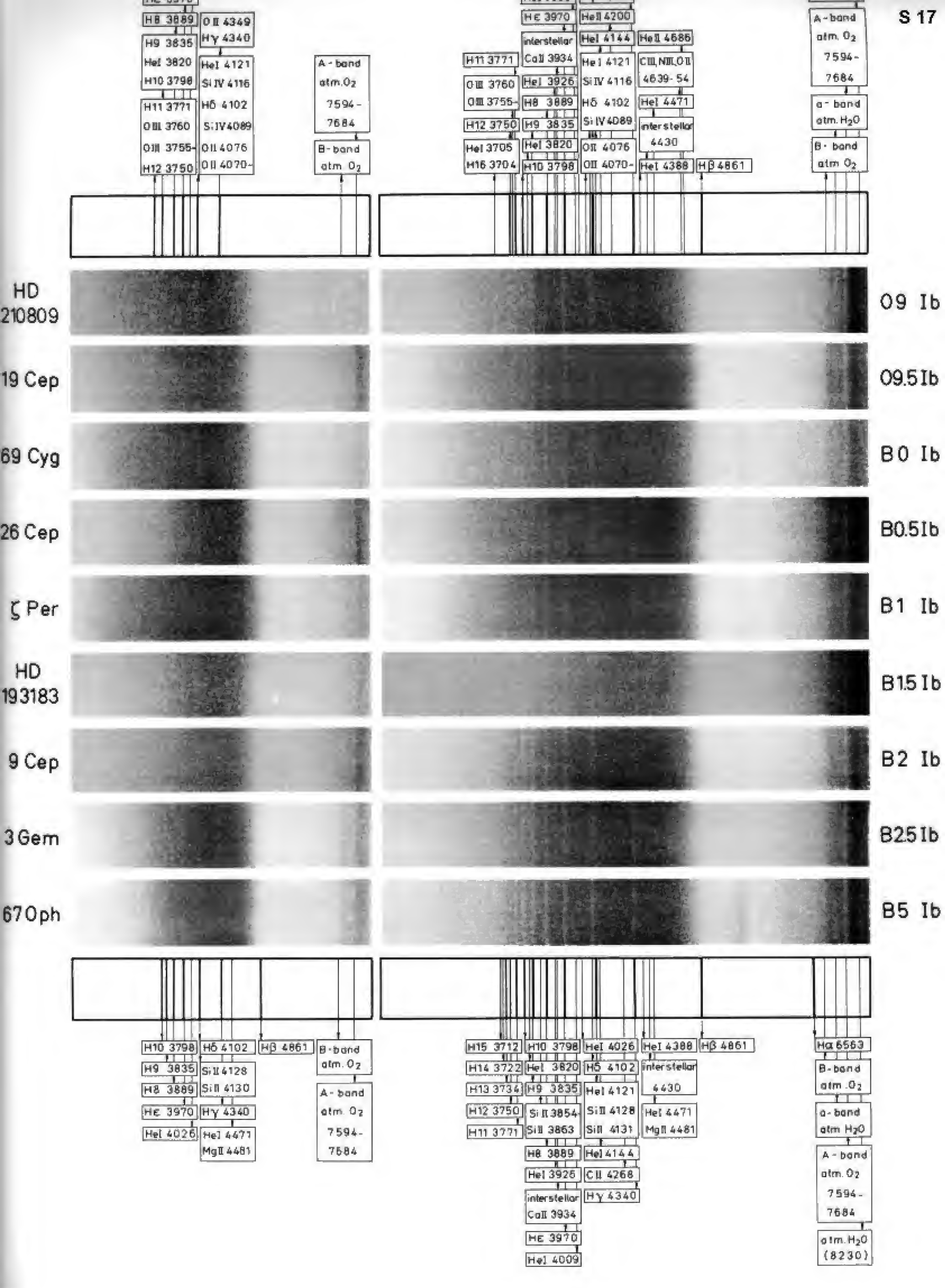
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SiIV 4089
OII 4076
OII 4070-
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B-band atm. O_2
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interstellar CaII 3934
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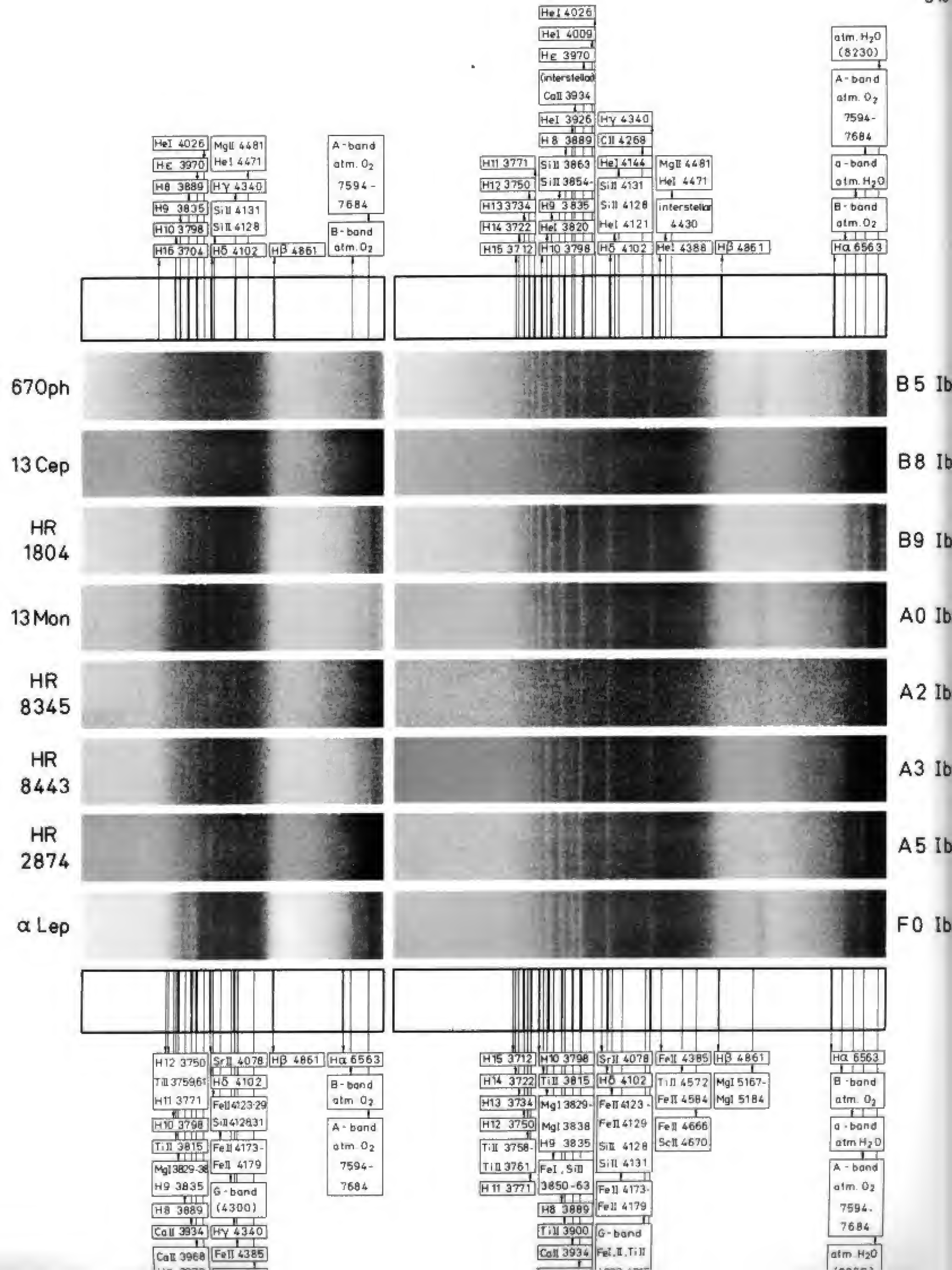
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A-band atm. O2 7594-7684
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SiII 4128
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Hβ 4861
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B-band atm. O2
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13 Cep
B8 Ib
HR 1804
B9 Ib
13 Mon
A0 Ib
HR 8345
A2 Ib
HR 8443
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HR 2874
A5 Ib
α Lep
F0 Ib
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FeII 4173-
FeII 4179
MgI 3829-38
H9 3835
G-band (4300)
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CaII 3934
Hγ 4340
CaII 3968
FeII 4385
H15 3712
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Hδ 4102
TiII 4572
FeII 4584
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MgI 5184
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MgI 3829-
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MgI 3838
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FeII 4666
ScII 4670
a-band atm H2O
TiII 3758-
TiII 3761
H9 3835
SiII 4128
SiII 4131
FeI, SiII 3850-63
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A-band atm. O2 7594-7684
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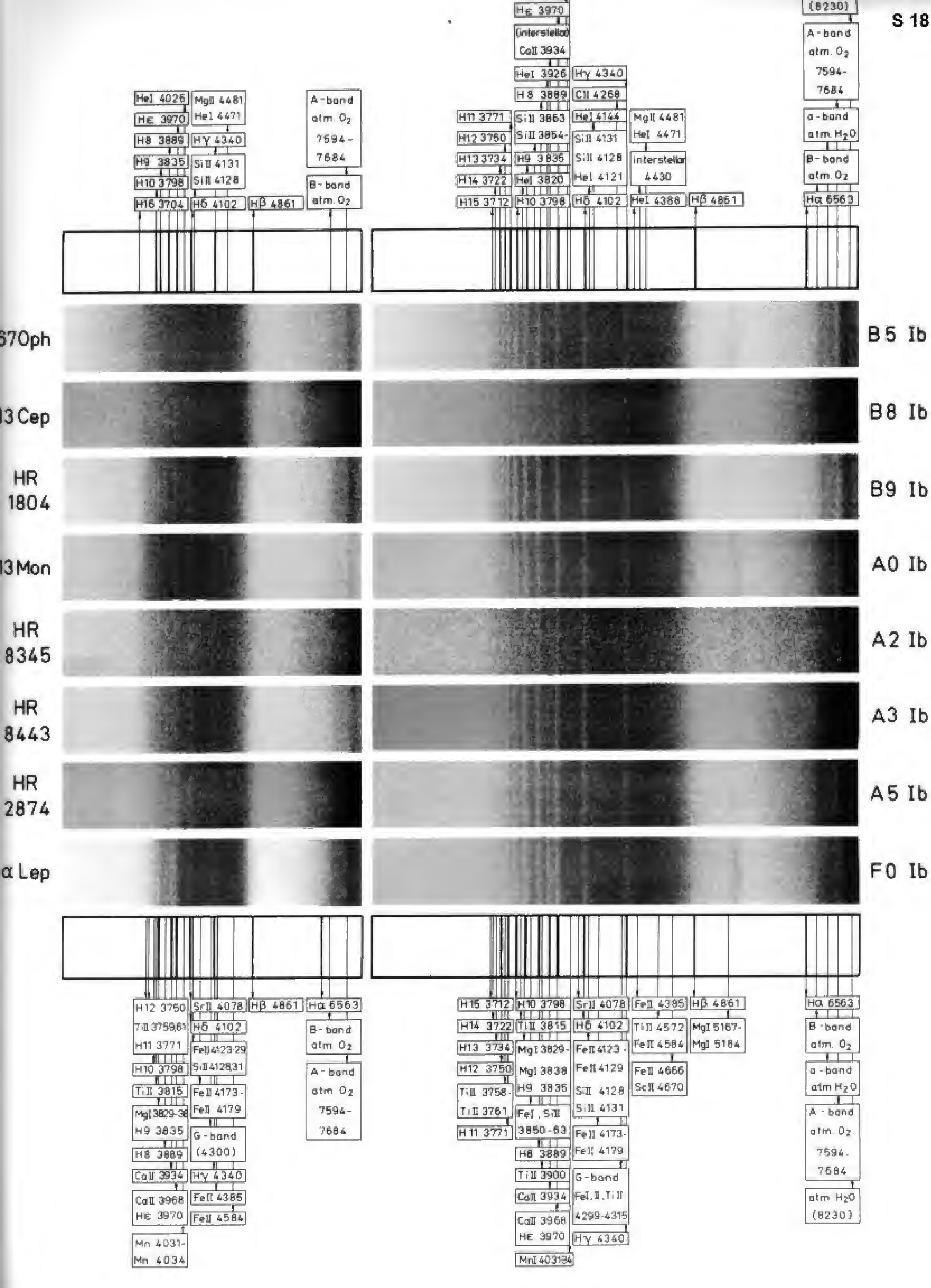

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B-band atm. O2
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HR 1804
3 Mon
HR 8345
HR 8443
HR 2874
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H11 3771
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HE 3970
Mn 4031-
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FeII 4173-
FeII 4179
G-band (4300)
Hγ 4340
FeII 4385
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Hβ 4861
Hα 6563
B-band atm. O2
A-band atm. O2 7594-7684
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H14 3722
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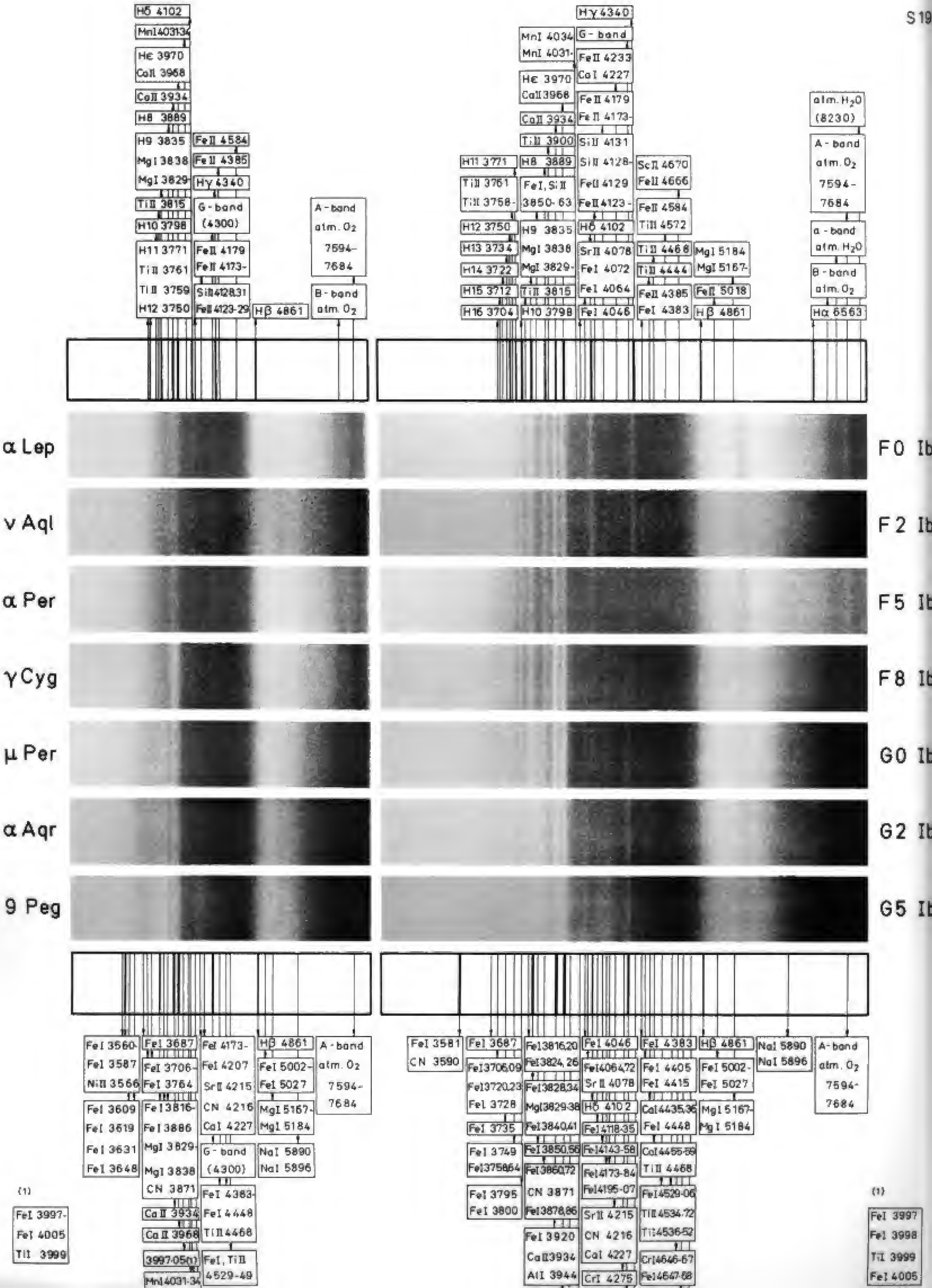

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ν Aql
F2 Ib
α Per
F5 Ib
γ Cyg
F8 Ib
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α Aqr
G2 Ib
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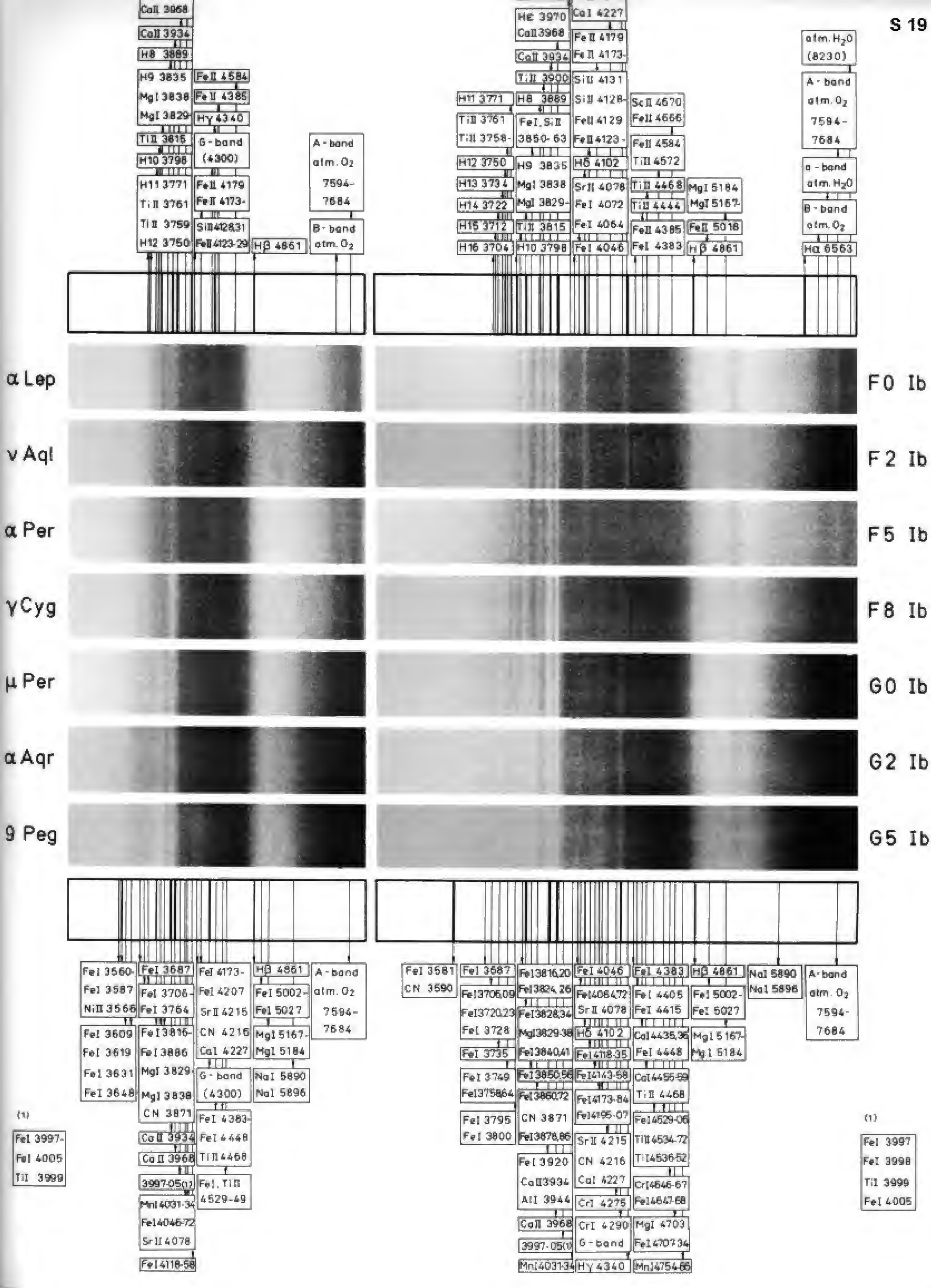
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SiII 4128-
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FeII 4123-
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a-band
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Hα 6563
α Lep
ν Aql
α Per
γ Cyg
μ Per
α Aqr
9 Peg
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F5 Ib
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G2 Ib
G5 Ib
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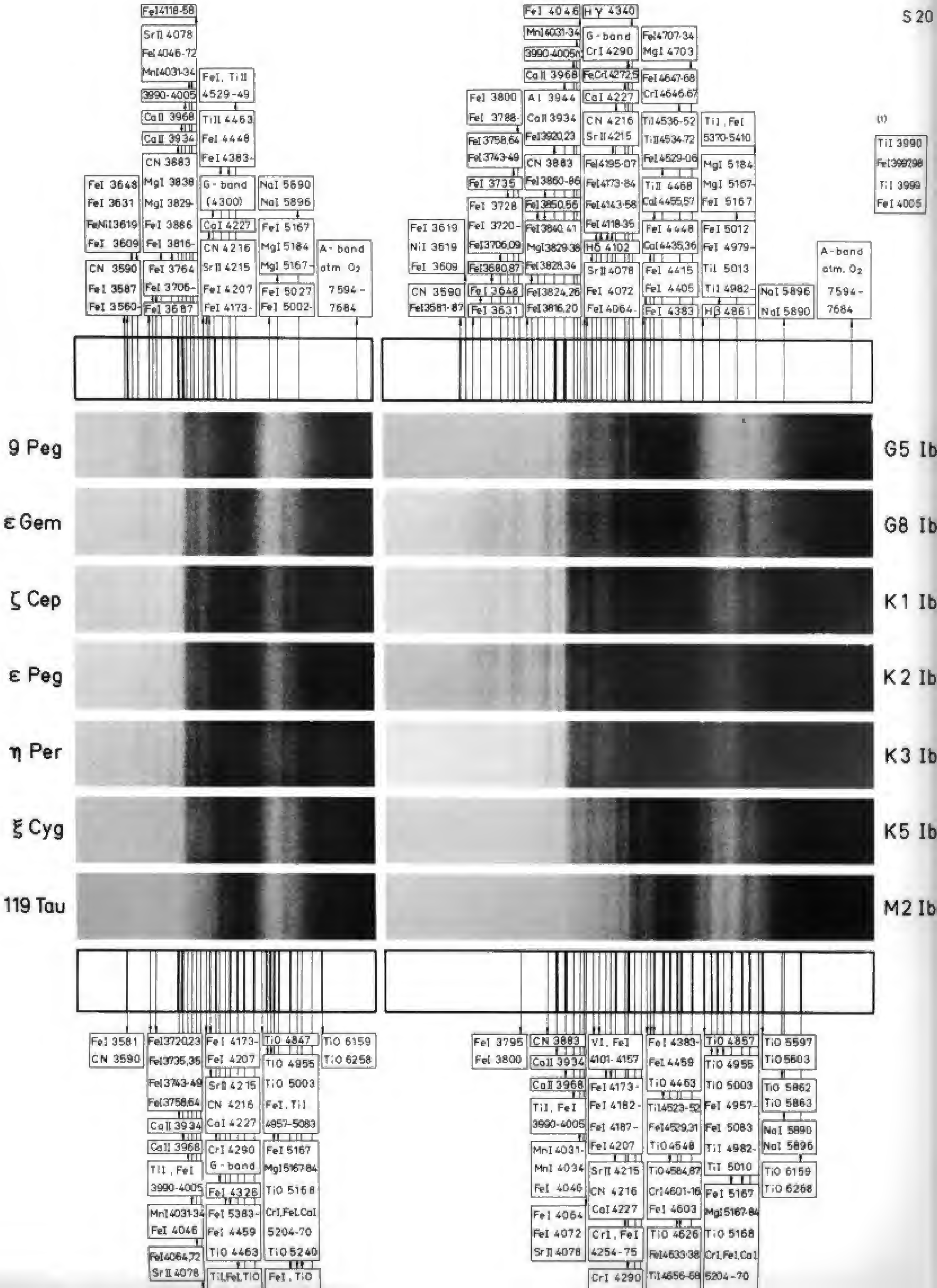
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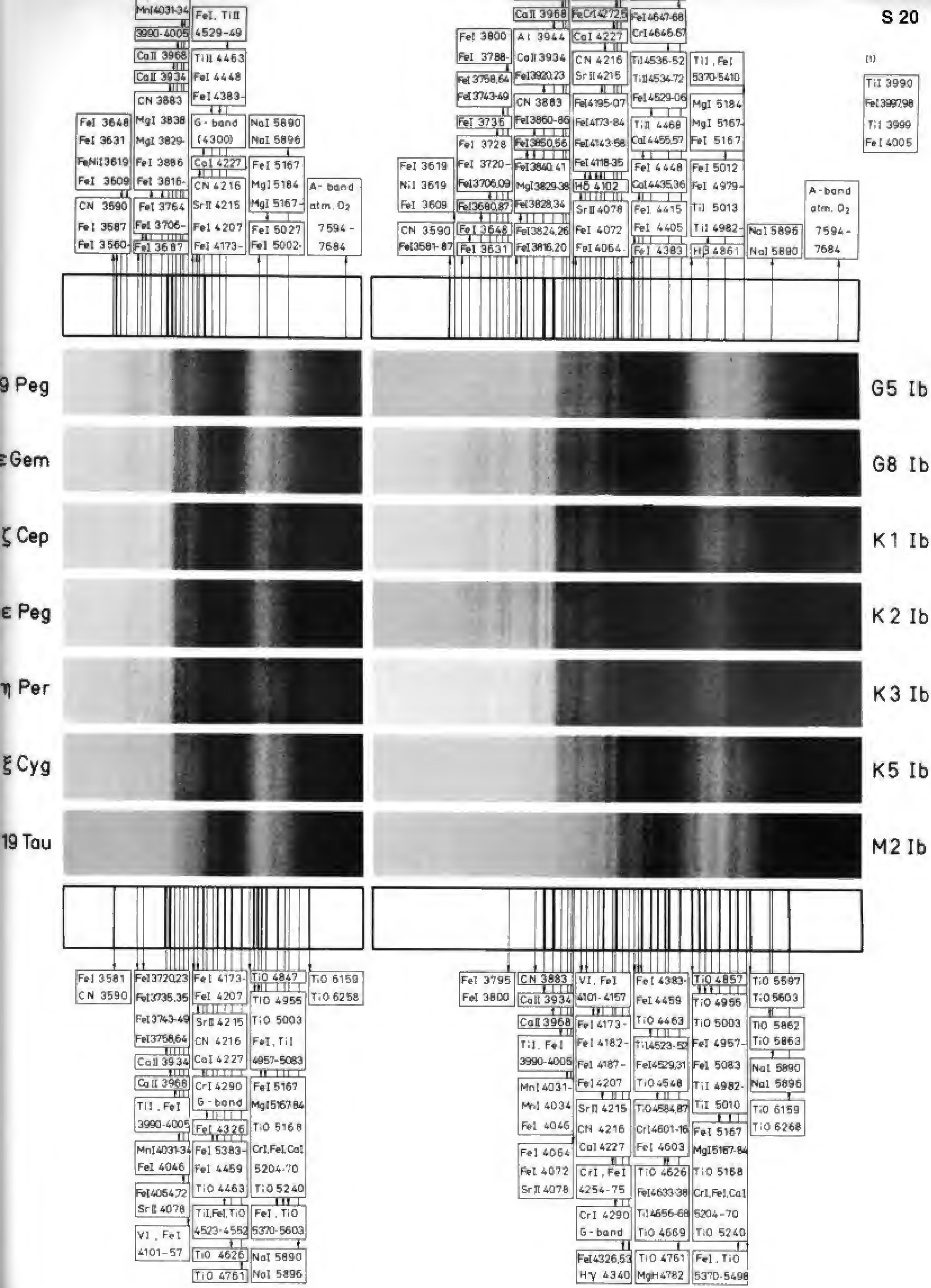
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A-band atm. O2 7594-7684
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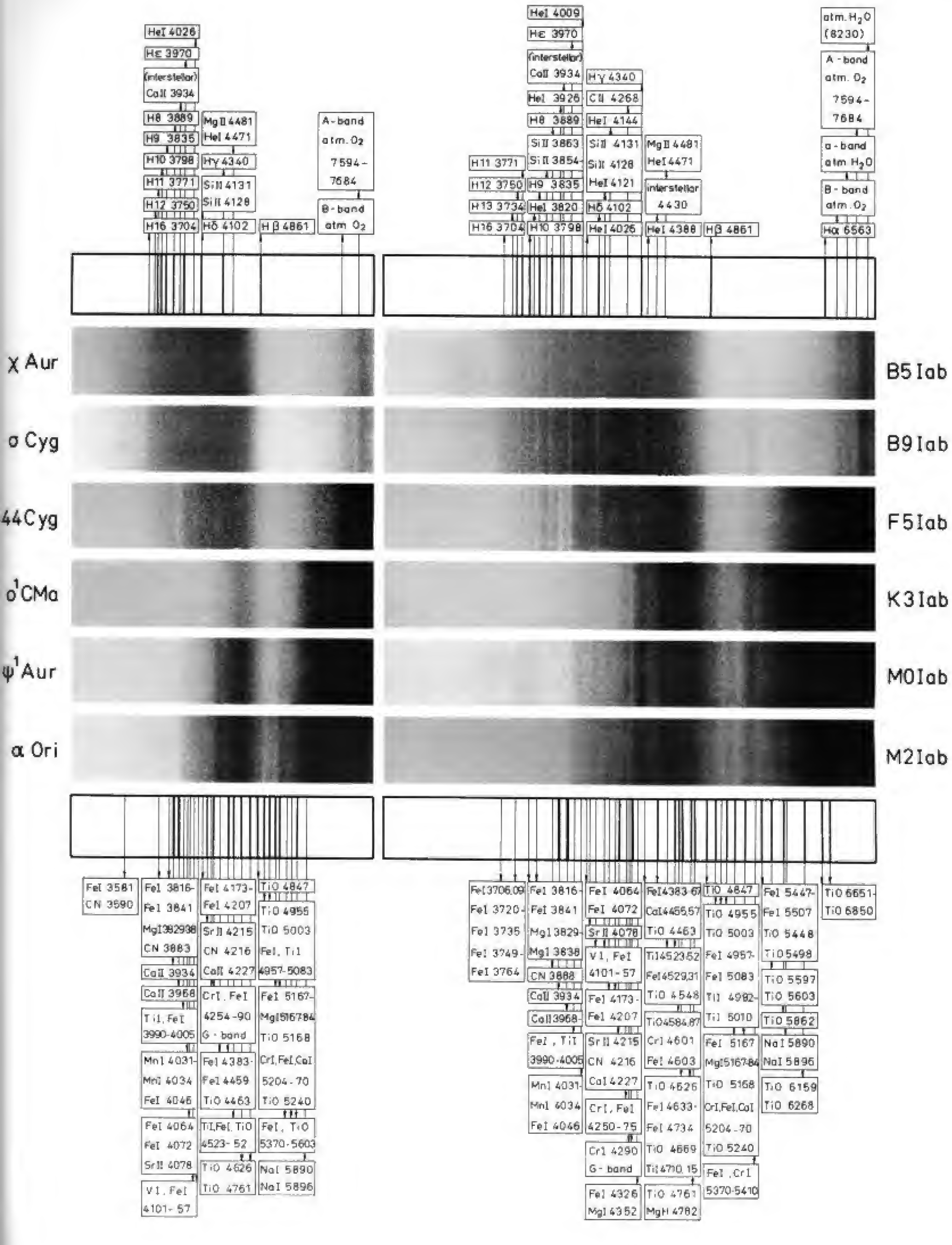

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Hδ 4102
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H12 3750
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HeI 4471
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Hβ 4861
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B-band atm. O2
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σ Cyg
44 Cyg
o¹ CMa
ψ¹ Aur
α Ori
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B9 Iab
F5 Iab
K3 Iab
M0 Iab
M2 Iab
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FeI 3816-
FeI 3841
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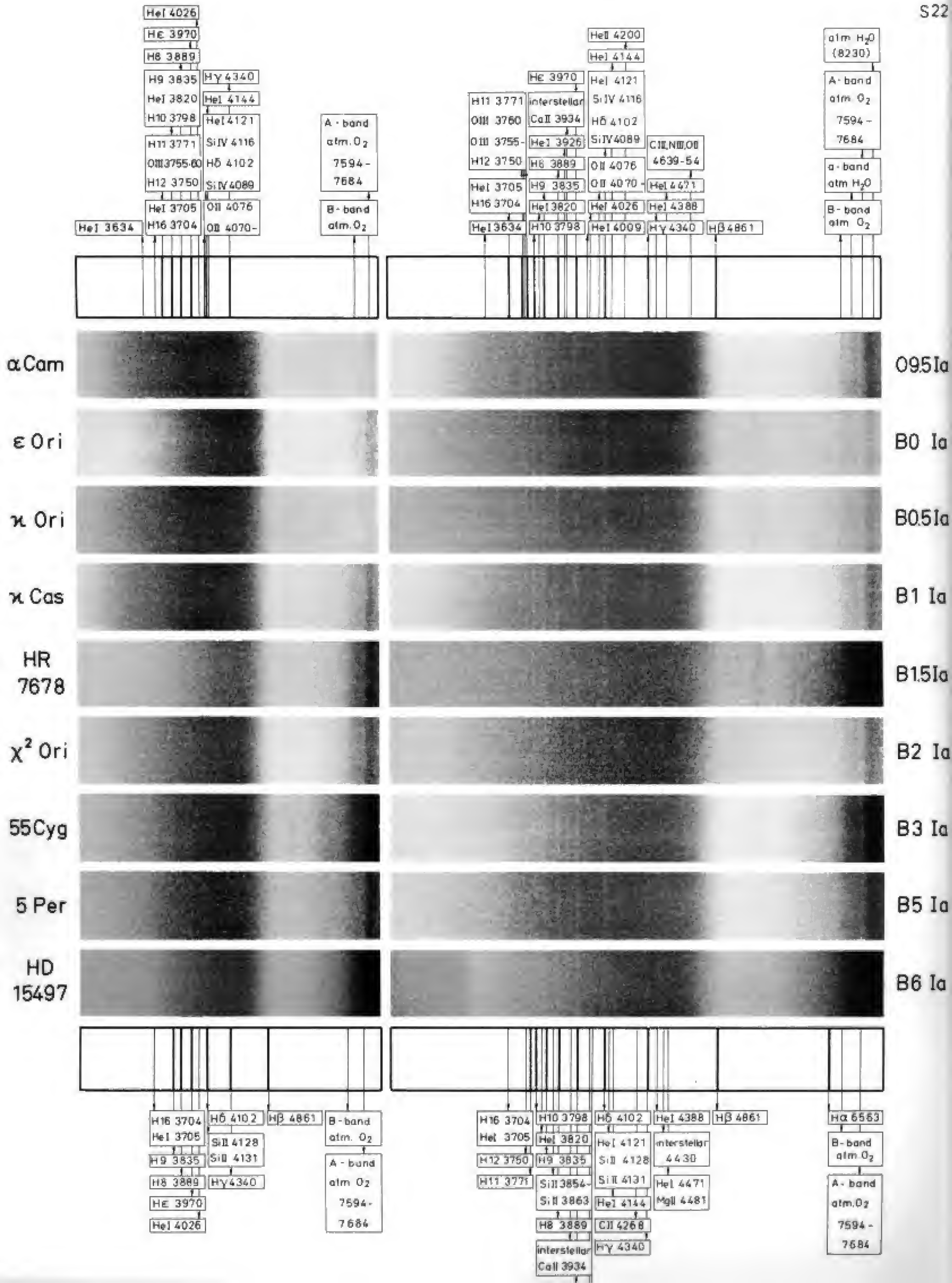
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7594-
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B - band
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SiIV 4116
Hδ 4102
SiIV 4089
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OIII 3755-
H12 3750
interstellar
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HeI 3926
H8 3889
H9 3835
HeI 3820
H10 3798
CIII,NIII,OII
4639-54
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(8230)
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atm. O2
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7684
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atm H2O
B - band
atm O2
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ε Ori
κ Ori
κ Cas
HR
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5 Per
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A - band
atm O2
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interstellar
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SiII 4131
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interstellar
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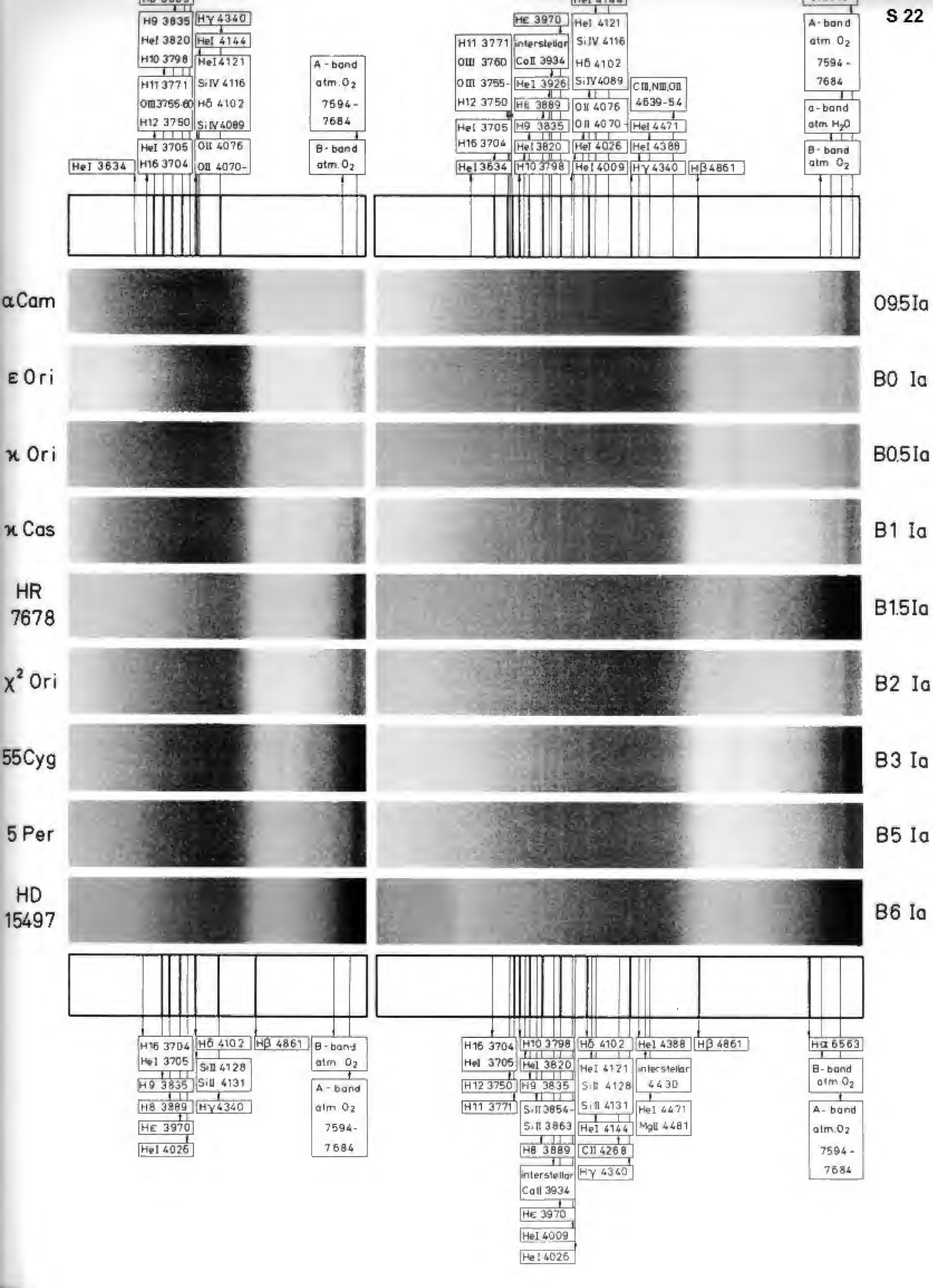
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atm. O_2
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interstellar
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SiIV 4089
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HeI 4388
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atm. H_2O
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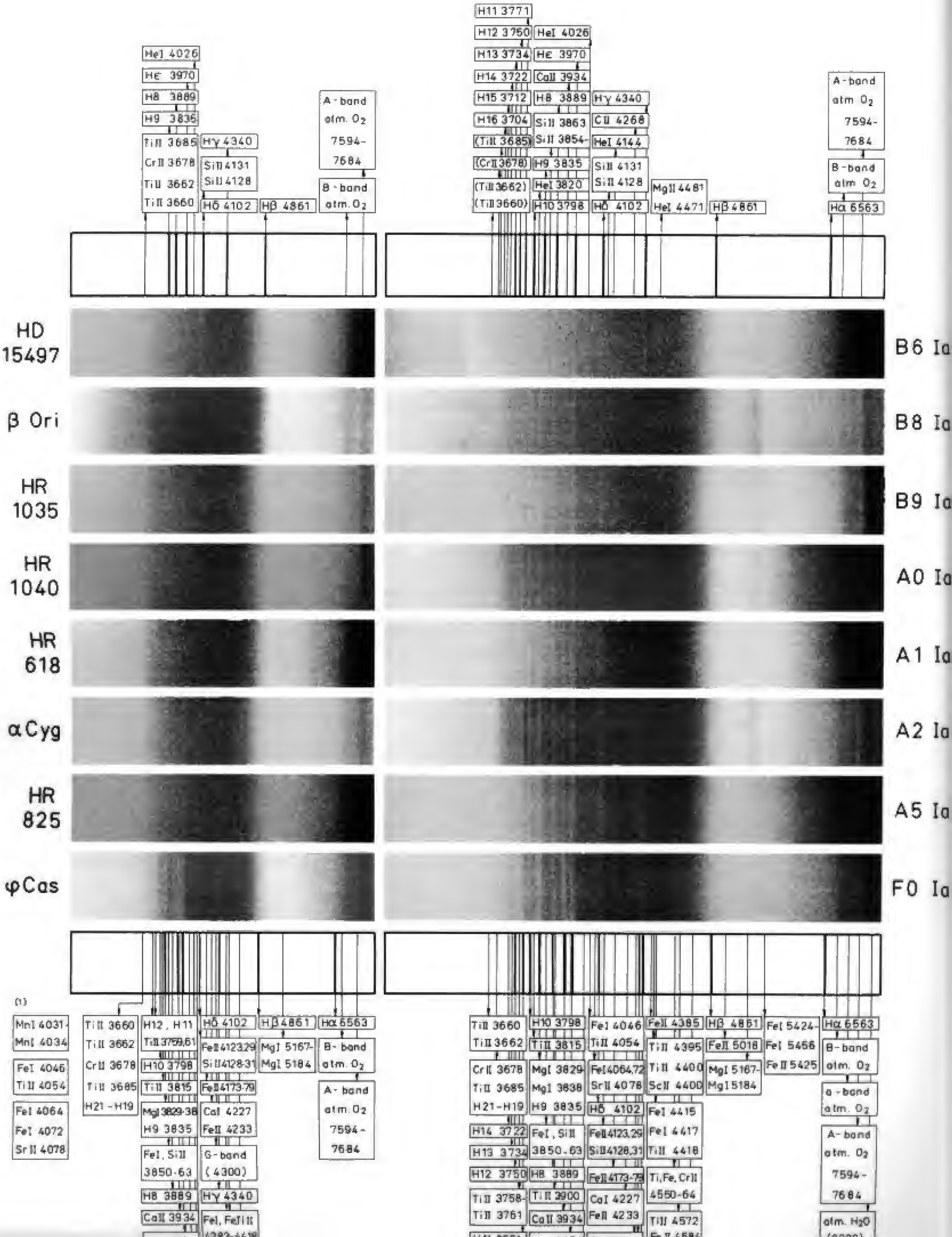
Hδ 4102
HeI 4121
SiII 4128
SiII 4131
HeI 4144
CII 4268
Hγ 4340
HeI 4388
interstellar
4430
HeI 4471
MgII 4481
Hβ 4861
Hα 6563
B - band
atm. O_2
A - band
atm. O_2
7594-
7684



HeI 4026
Hε 3970
H8 3889
H9 3835
TiII 3685
CrII 3678
TiII 3662
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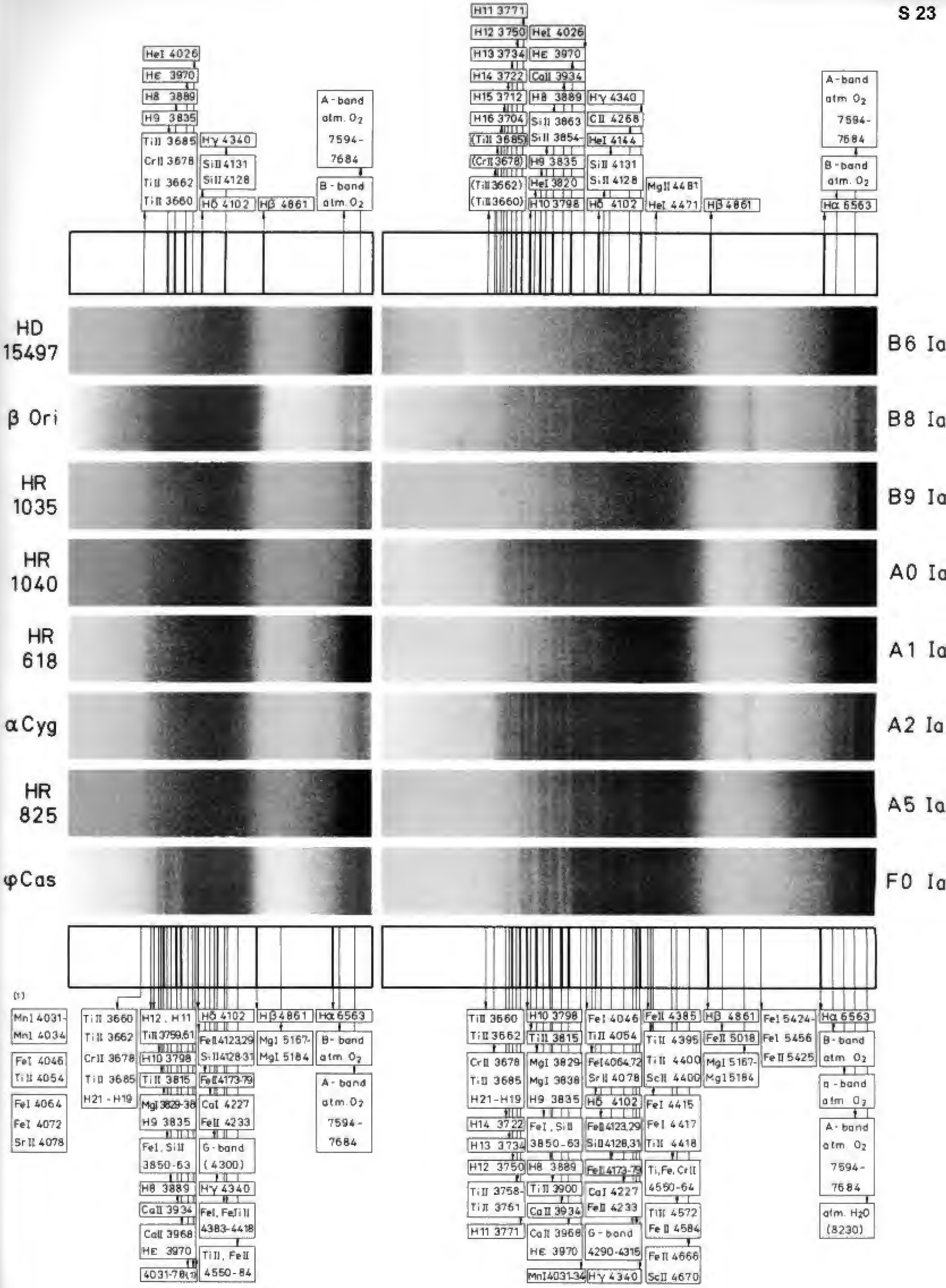
Hγ 4340
SiII 4131
SiII 4128
Hδ 4102
Hβ 4861
A-band
atm. O2
7594-
7684
B-band
atm. O2
H11 3771
H12 3750
H13 3734
H14 3722
H15 3712
H16 3704
(TiII 3685)
(CrII 3678)
(TiII 3662)
(TiII 3660)
HeI 4026
Hε 3970
CaII 3934
H8 3889
SiII 3863
SiII 3854-
H9 3835
HeI 3820
H10 3798
Hγ 4340
CII 4268
HeI 4144
SiII 4131
SiII 4128
Hδ 4102
MgII 4481
HeI 4471
Hβ 4861
Hα 6563
HD
15497
B6 Ia
β Ori
B8 Ia
HR
1035
B9 Ia
HR
1040
A0 Ia
HR
618
A1 Ia
α Cyg
A2 Ia
HR
825
A5 Ia
φ Cas
F0 Ia
(1)
MnI 4031-
MnI 4034
FeI 4046
TiII 4054
FeI 4064
FeI 4072
SrII 4078
TiII 3660
TiII 3662
CrII 3678
TiII 3685
H21-H19
H12, H11
TiII 3759,61
H10 3798
TiII 3815
MgI 3829-38
H9 3835
FeI, SiII
3850-63
H8 3889
CaII 3934
Hδ 4102
FeII 4123,29
SiII 4128-31
FeII 4173-79
CaI 4227
FeII 4233
G-band
(4300)
Hγ 4340
Fe, FeII
Hβ 4861
MgI 5167-
MgI 5184
Hα 6563
B-band
atm. O2
A-band
atm. O2
7594-
7684
TiII 3660
TiII 3662
CrII 3678
TiII 3685
H21-H19
H14 3722
H13 3734
H12 3750
TiII 3758-
TiII 3761
H10 3798
TiII 3815
MgI 3829-
MgI 3838
H9 3835
FeI, SiII
3850-63
H8 3889
TiII 3900
CaII 3934
FeI 4046
TiII 4054
FeI 4064,72
SrII 4078
Hδ 4102
FeII 4123,29
SiII 4128,31
FeII 4173-79
CaI 4227
FeII 4233
FeII 4385
TiII 4395
TiII 4400
ScII 4400
FeI 4415
FeI 4417
TiII 4418
Ti, Fe, CrII
4550-64
TiII 4572
Hβ 4861
FeII 5018
MgI 5167-
MgI 5184
FeI 5424-
FeI 5456
FeII 5425
Hα 6563
B-band
atm. O2
a-band
atm. O2
A-band
atm. O2
7594-
7684
atm. H2O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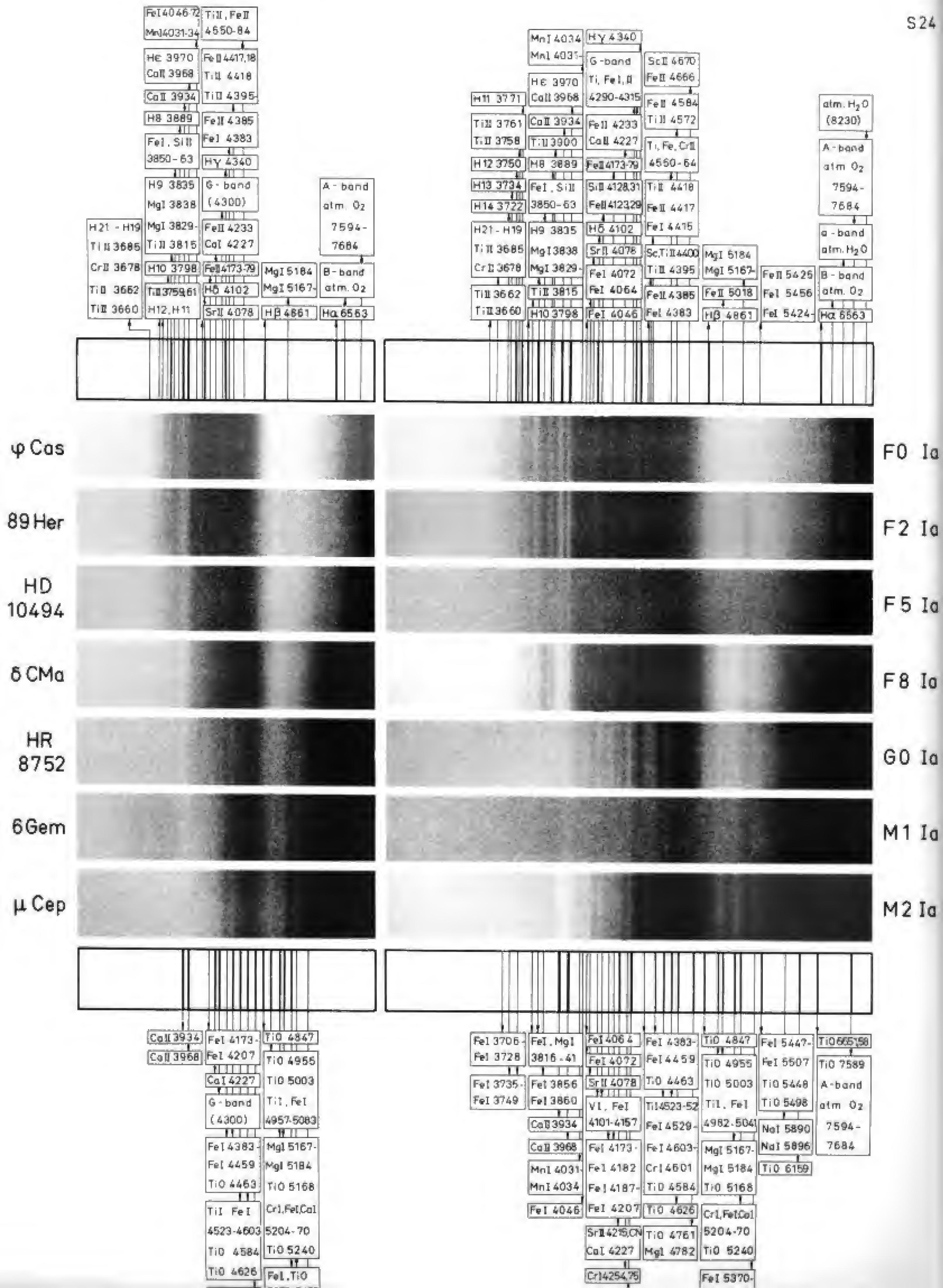
β Ori
B8 Ia
HR 1035
B9 Ia
HR 1040
A0 Ia
HR 618
A1 Ia
α Cyg
A2 Ia
HR 825
A5 Ia
φ Cas
F0 Ia
HeI 4026
Hε 3970
H8 3889
H9 3835
TiII 3685
CrII 3678
TiII 3662
TiII 3660
Hγ 4340
SiII 4131
SiII 4128
Hδ 4102
Hβ 4861
A-band atm. O2 7594-7684
B-band atm. O2
H11 3771
H12 3750
H13 3734
H14 3722
H15 3712
H16 3704
CaII 3934
SiII 3863
SiII 3854-
HeI 3820
H10 3798
CII 4268
HeI 4144
MgII 4481
HeI 4471
Hα 6563
MnI 4031-
MnI 4034
FeI 4046
TiII 4054
FeI 4064
FeI 4072
SrII 4078
TiII 3759,61
MgI 3829-38
FeI, SiII 3850-63
CaII 3968
4031-78
FeII 4123,29
SiII 4128-31
FeII 4173-79
CaI 4227
FeII 4233
G-band (4300)
FeI, FeII 4383-4418
TiII, FeII 4550-84
MgI 5167-
MgI 5184
H21-H19
TiII 3815
MgI 3829-
MgI 3838
TiII 3758-
TiII 3761
TiII 3900
FeI 4064,72
SrII 4078
G-band 4290-4315
MnI 4031-34
FeII 4385
TiII 4395
TiII 4400
ScII 4400
FeI 4415
FeI 4417
TiII 4418
Ti, Fe, CrII 4550-64
TiII 4572
FeII 4584
FeII 4666
ScII 4670
FeII 5018
FeI 5424-
FeI 5456
FeII 5425
a-band atm. O2
atm. H2O (8230)



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TiII, FeII 4550-84
Hε 3970
CaII 3968
FeII 4417,18
TiII 4418
CaII 3934
TiII 4395
H8 3889
FeII 4385
FeI 4383
FeI, SiII 3850-63
Hγ 4340
H9 3835
MgI 3838
MgI 3829
TiII 3815
G-band (4300)
FeII 4233
CaI 4227
A-band atm. O_2 7594-7684
H21 - H19
TiII 3685
CrII 3678
TiII 3662
TiII 3660
H10 3798
TiII 3759,61
H12, H11
FeII 4173-79
Hδ 4102
SrII 4078
MgI 5184
MgI 5167
Hβ 4861
B-band atm. O_2
Hα 6563
MnI 4034
MnI 4031
Hγ 4340
G-band Ti, FeI, II 4290-4315
ScII 4670
FeII 4666
H11 3771
Hε 3970
CaII 3968
FeII 4584
TiII 4572
atm. H_2O (8230)
TiII 3761
TiII 3758
CaII 3934
TiII 3900
FeII 4233
CaII 4227
Ti, Fe, CrII 4550-64
A-band atm. O_2 7594-7684
H12 3750
H8 3889
FeII 4173-79
H13 3734
H14 3722
FeI, SiII 3850-63
SiII 4128,31
FeII 4123,29
TiII 4418
FeII 4417
FeI 4415
H21-H19
TiII 3685
CrII 3678
H9 3835
MgI 3838
MgI 3829
Hδ 4102
SrII 4078
FeI 4072
FeI 4064
Sc,TiII 4400
TiII 4395
MgI 5184
MgI 5167
a-band atm. H_2O
FeII 5425
FeI 5456
FeI 5424
B-band atm. O_2
TiII 3662
TiII 3660
TiII 3815
H10 3798
FeI 4046
FeII 4385
FeI 4383
FeII 5018
Hβ 4861
Hα 6563
φ Cas
F0 Ia
89 Her
F2 Ia
HD 10494
F5 Ia
δ CMa
F8 Ia
HR 8752
G0 Ia
6 Gem
M1 Ia
μ Cep
M2 Ia
CaII 3934
CaII 3968
FeI 4173-
FeI 4207
CaI 4227
G-band (4300)
TiO 4847
TiO 4955
TiO 5003
TiI, FeI 4957-5083
FeI 4383
FeI 4459
TiO 4463
MgI 5167
MgI 5184
TiO 5168
TiI FeI 4523-4603
TiO 4584
TiO 4626
CrI, FeI, CaI 5204-70
TiO 5240
FeI, TiO
FeI 3706
FeI 3728
FeI 3735
FeI 3749
FeI, MgI 3816-41
FeI 3856
FeI 3860
CaII 3934
CaII 3968
MnI 4031
MnI 4034
FeI 4046
FeI 4064
FeI 4072
SrII 4078
VI, FeI 4101-4157
FeI 4173
FeI 4182
FeI 4187
FeI 4207
SrII 4215, CN
CaI 4227
CrI 4254,75
FeI 4383
FeI 4459
TiO 4463
TiI 4523-52
FeI 4529
FeI 4603
CrI 4601
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TiO 4761
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TiO 4847
TiO 4955
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TiO 5168
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FeI 5370
FeI 5447
FeI 5507
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TiO 6159
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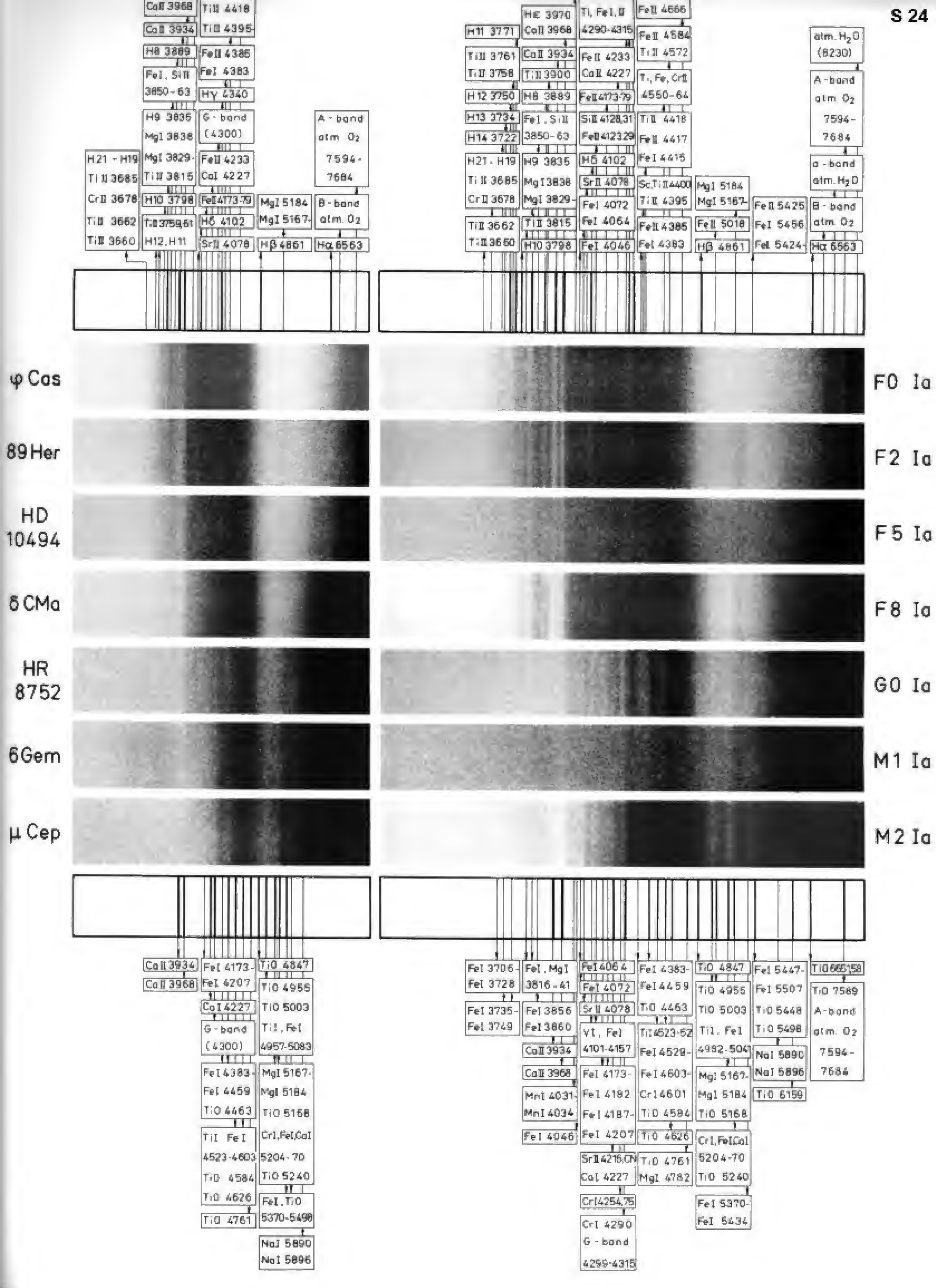
TiO 7589
A-band atm. O_2 7594-7684



CaII 3968
CaII 3934
H8 3889
FeI, SiII 3850-63
H9 3835
MgI 3838
MgI 3829-
TiII 3815
H10 3798
TiII 3759,61
H12, H11
H21 - H19
TiII 3685
CrII 3678
TiII 3662
TiII 3660
TiII 4418
TiII 4395-
FeII 4385
FeI 4383
Hγ 4340
G - band (4300)
FeII 4233
CaI 4227
FeII 4173-79
Hδ 4102
SrII 4078
MgI 5184
MgI 5167-
Hβ 4861
A - band atm. O2 7594-7684
B - band atm. O2
Hα 6563
Hε 3970
CaII 3968
H11 3771
TiII 3761
TiII 3758
CaII 3934
TiII 3900
H12 3750
H8 3889
H13 3734
H14 3722
FeI, SiII 3850-63
H21 - H19
TiII 3685
CrII 3678
H9 3835
MgI 3838
MgI 3829-
TiII 3662
TiII 3660
TiII 3815
H10 3798
Ti, FeI, II 4290-4315
FeII 4233
CaII 4227
FeII 4173-79
SiII 4128,31
FeII 4123,29
Hδ 4102
SrII 4078
FeI 4072
FeI 4064
FeI 4046
FeII 4666
FeII 4584
TiII 4572
Ti, Fe, CrII 4550-64
TiII 4418
FeII 4417
FeI 4415
Sc,TiII 4400
TiII 4395
FeII 4385
FeI 4383
MgI 5184
MgI 5167-
FeII 5018
Hβ 4861
FeII 5425
FeI 5456
FeI 5424-
atm. H2O (8230)
A - band atm. O2 7594-7684
a - band atm. H2O
B - band atm. O2
Hα 6563
φ Cas
89 Her
HD 10494
δ CMa
HR 8752
6 Gem
μ Cep
F0 Ia
F2 Ia
F5 Ia
F8 Ia
G0 Ia
M1 Ia
M2 Ia
CaII 3934
CaII 3968
FeI 4173-
FeI 4207
CaI 4227
G - band (4300)
FeI 4383-
FeI 4459
TiO 4463
TiI FeI 4523-4603
TiO 4584
TiO 4626
TiO 4761
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TiO 4955
TiO 5003
TiI, FeI 4957-5083
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MgI 5184
TiO 5168
CrI, FeI, CaI 5204-70
TiO 5240
FeI, TiO 5370-5498
NaI 5890
NaI 5896
FeI 3706-
FeI 3728
FeI 3735-
FeI 3749
FeI, MgI 3816-41
FeI 3856
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FeI 4046
FeI 4064
FeI 4072
SrII 4078
VI, FeI 4101-4157
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FeI 4182
FeI 4187-
FeI 4207
SrII 4215,CN
CaI 4227
CrI 4254,75
CrI 4290
G - band 4299-4315
FeI 4383-
FeI 4459
TiO 4463
TiI 4523-52
FeI 4529-
FeI 4603-
CrI 4601
TiO 4584
TiO 4626
TiO 4761
MgI 4782
TiO 4847
TiO 4955
TiO 5003
TiI, FeI 4982-5041
MgI 5167-
MgI 5184
TiO 5168
CrI, FeI, CaI 5204-70
TiO 5240
FeI 5370-
FeI 5434
FeI 5447-
FeI 5507
TiO 5448
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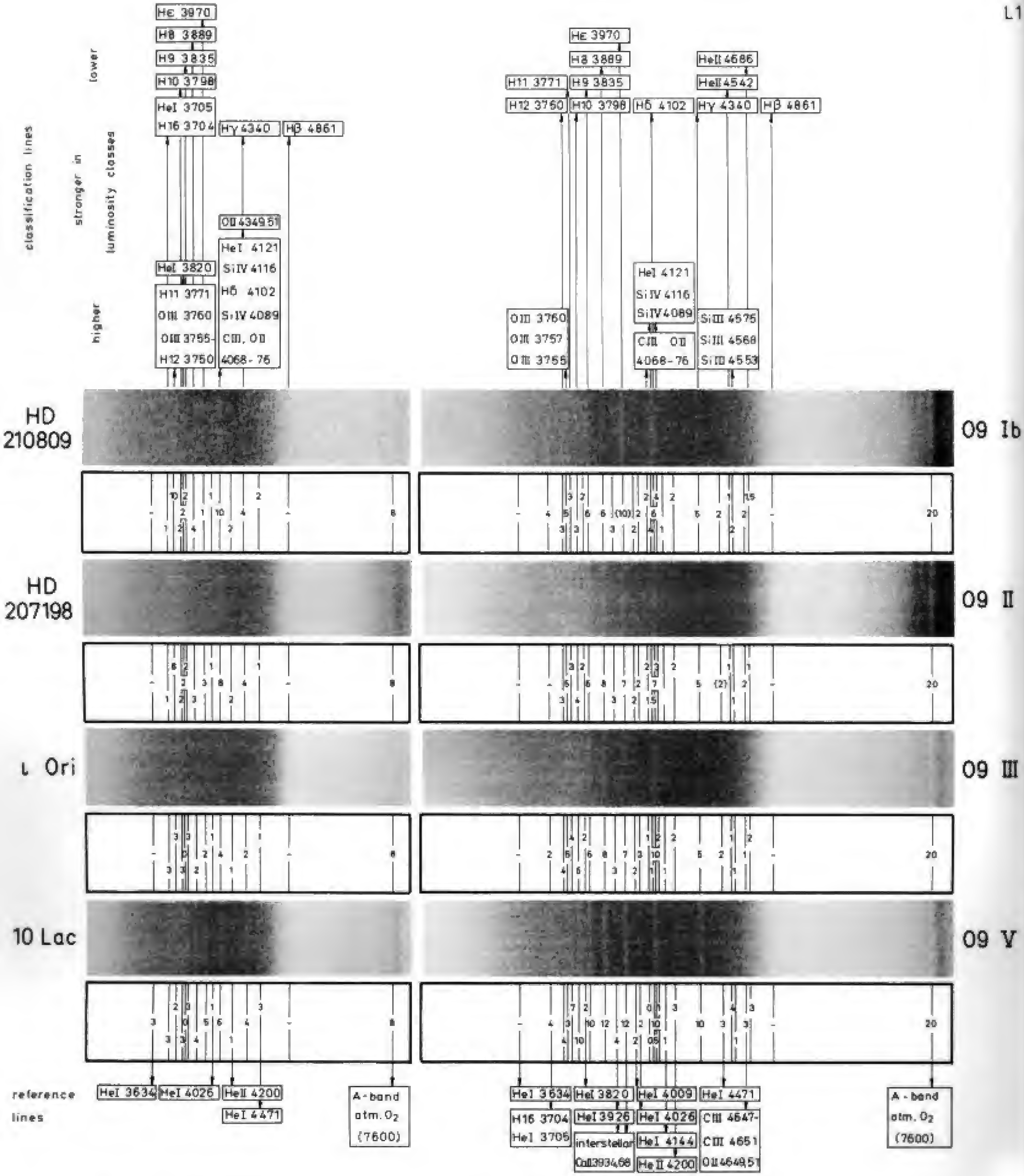
NaI 5890
NaI 5896
TiO 6159
TiO 6651,58
TiO 7589
A - band atm. O2 7594-7684

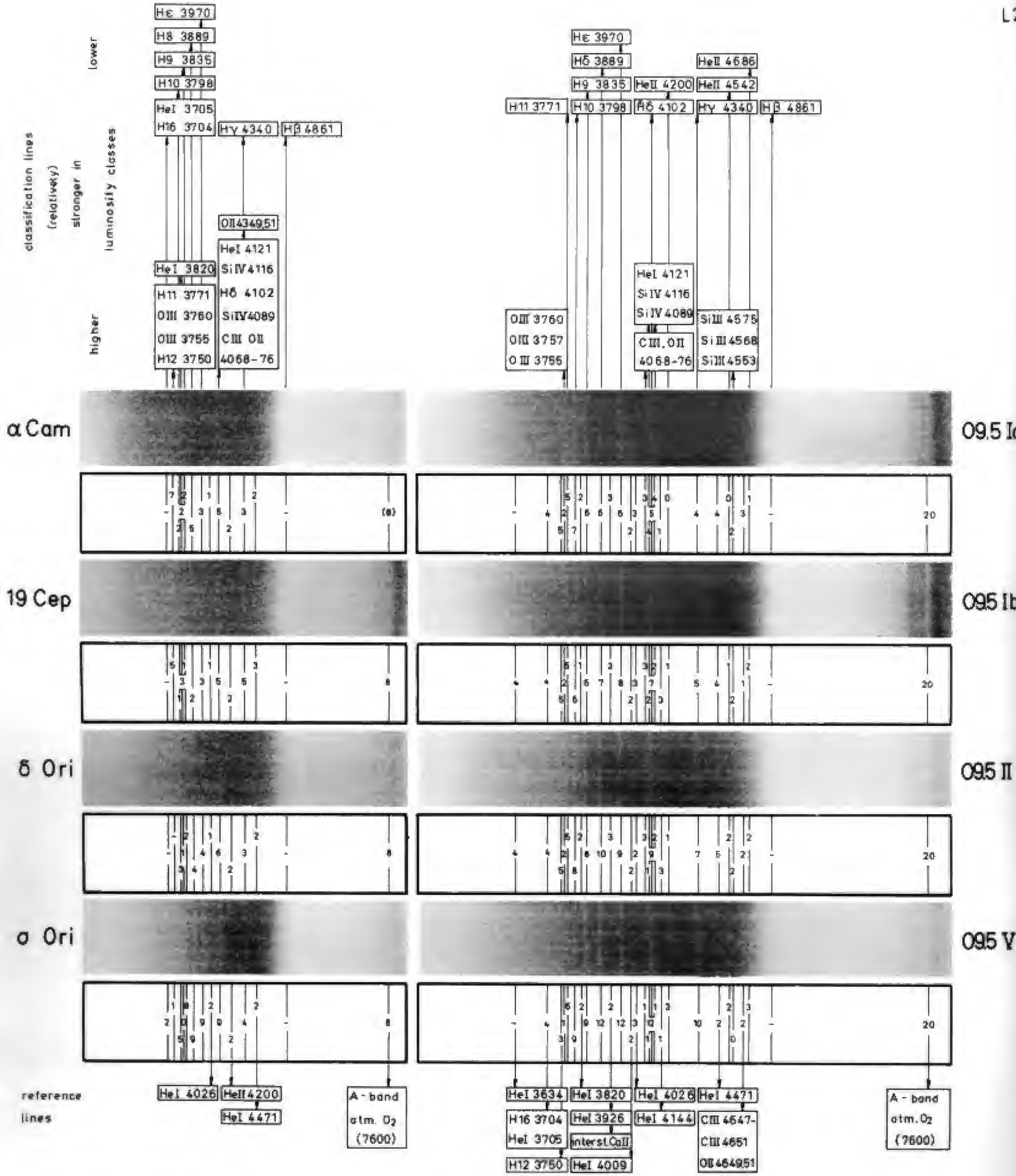


Dispersion 1280 Å/mm at Hγ:

1. H-lines stronger in lower luminosity classes.
2. Stronger in higher classes: blends of H-lines with CIII, OIII, OII, SiIV as listed above.
3. Important ratio:
   H12, H11, OIII 3750-71 : CIII, OII, SiIV, Hδ, HeI 4089-4121 = 1 in II and Ib
   < 1 in V and III
4. Structural difference:
   broad blend H10, HeI, H9 (with HeI 3820 apparently stronger) in higher classes.

Dispersion 645 Å/mm at Hγ:

1. H-lines stronger in lower luminosity classes.
2. Stronger in higher luminosity classes: blends of CIII, OIII, OII, SiIV, SiIII, as listed above
3. Stronger in lower luminosity classes: HeII 4542, HeII 4686
4. Structural differences: region H9-H16 dominated by H-lines in lower luminosity classes, smoother appearance through fill-in of HeI 3820 and OIII 3755-60 in higher luminosity classes.

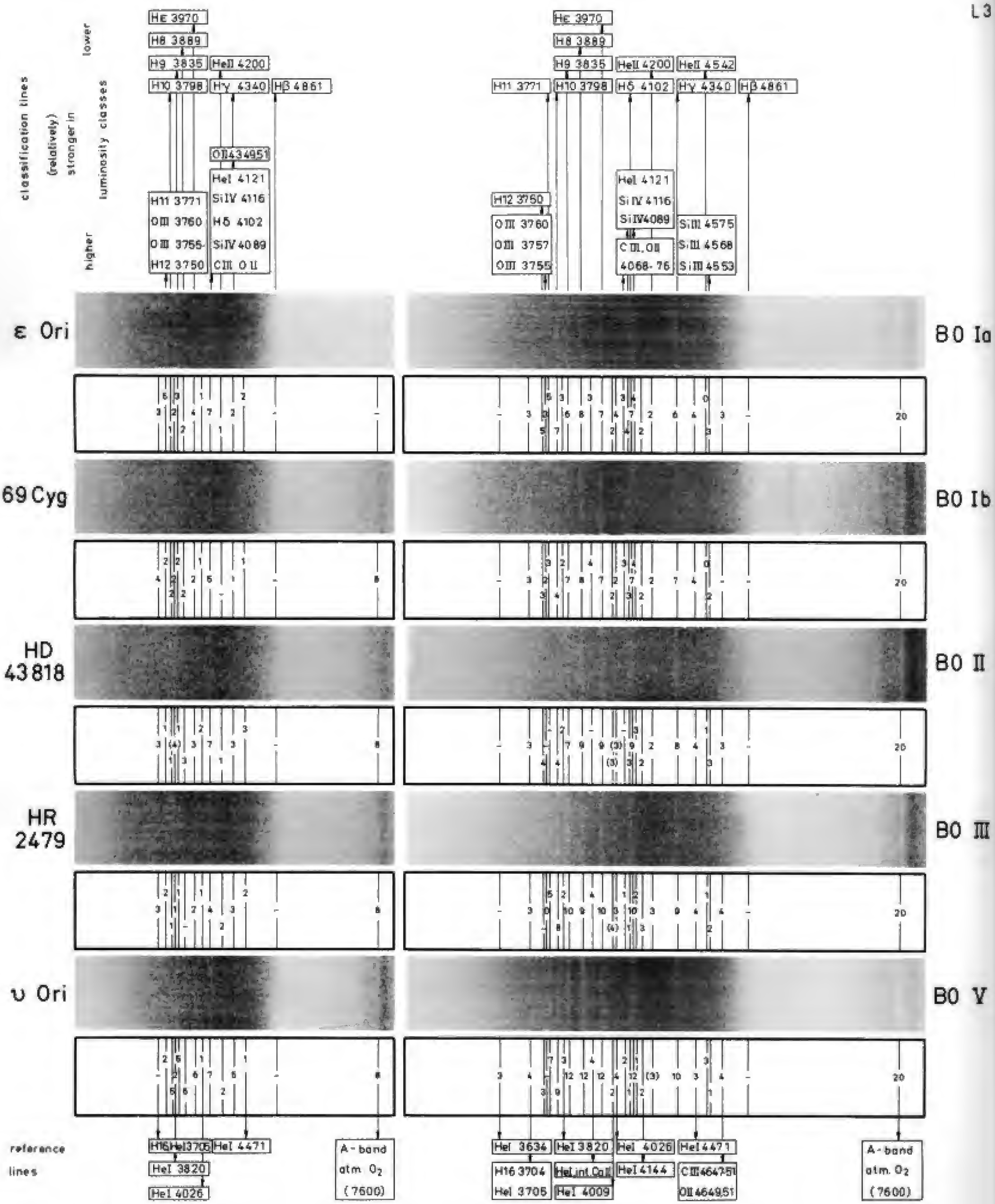


Dispersion 1280 Å/mm at Hγ:

1. H-lines stronger in lower luminosity classes.
2. Stronger in higher classes: blends of H-lines with CIII, OIII, OII, SiIV as listed above relative to unblended H-lines
3. Important ratio:
   H12, H11, OIII 3750-71 : CIII, OII, SiIV, Hδ, HeI 4089-4121 = 1 in Ib
   > 1 in Ia; < 1 in V, II
4. Structural difference:
   broad blend H10, HeI, H9 (with HeI 3820 apparently stronger) in higher classes

Dispersion 645 A/mm at Hγ:

1. H-lines stronger in lower luminosity classes.
2. Stronger in higher luminosity classes: blends of CIII, OIII, OII, SiIV, SiIII, as listed above.
3. Stronger in lower luminosity classes: HeII 4200, HeII 4542, HeII 4686
4. Important ratio:
   HeII 4542 : SiIII 4553-75 = 1 in II; > 1 in V; < 1 in supergiants.

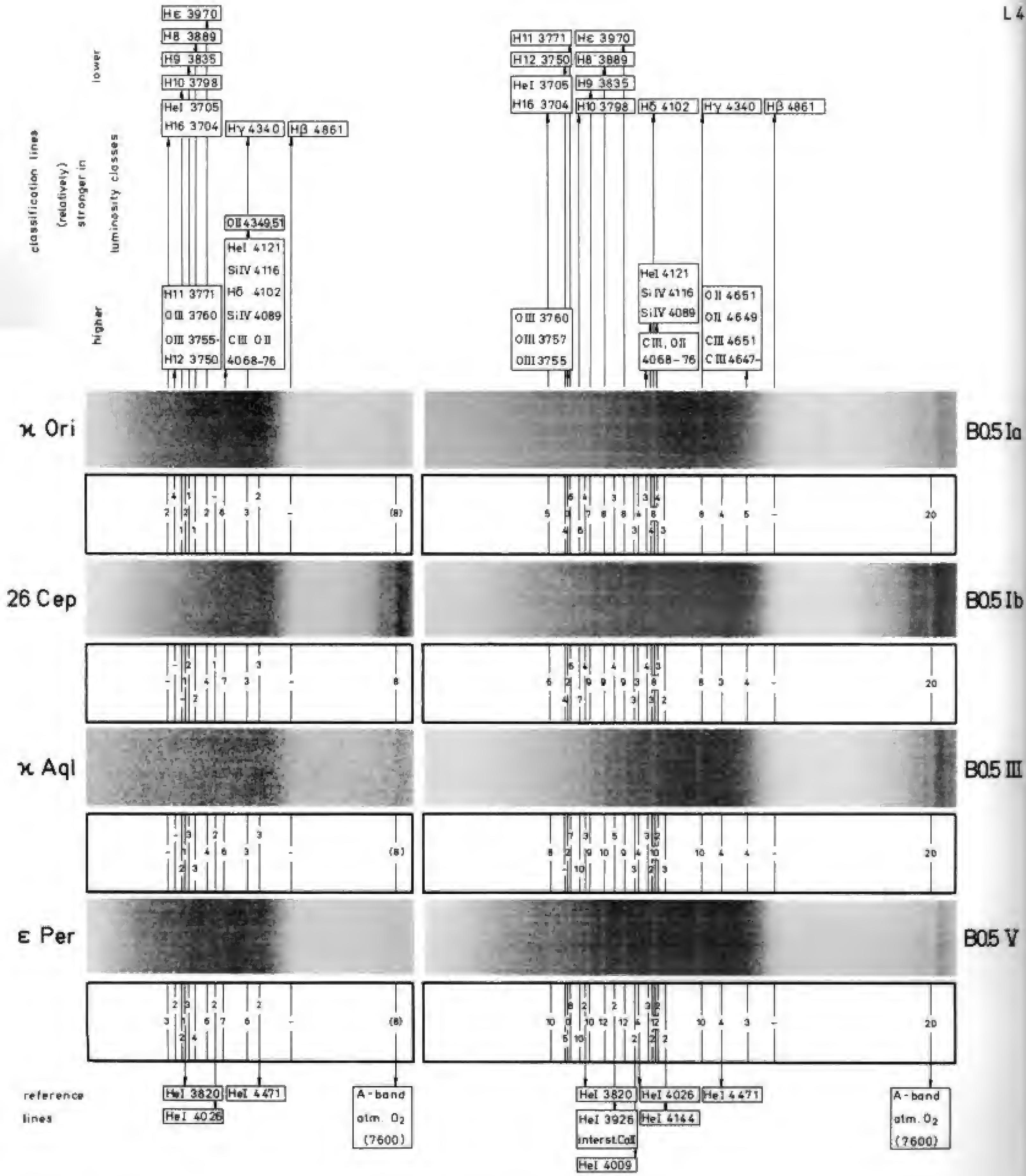


Dispersion 1280 Å/mm at Hγ:

1. H-lines stronger in lower luminosity classes.
2. Stronger in higher classes: blends of H-lines with CIII, OIII, OII, SiIV as listed above relative to unblended H-lines.

Dispersion 645 Å/mm at Hγ:

1. H-lines stronger in lower luminosity classes, except high series members.
2. Stronger in higher luminosity classes: blends of CIII, OIII, OII, SiIV, SiIII as listed above.
3. Stronger in lower luminosity classes: HeII 4200, HeII 4542.



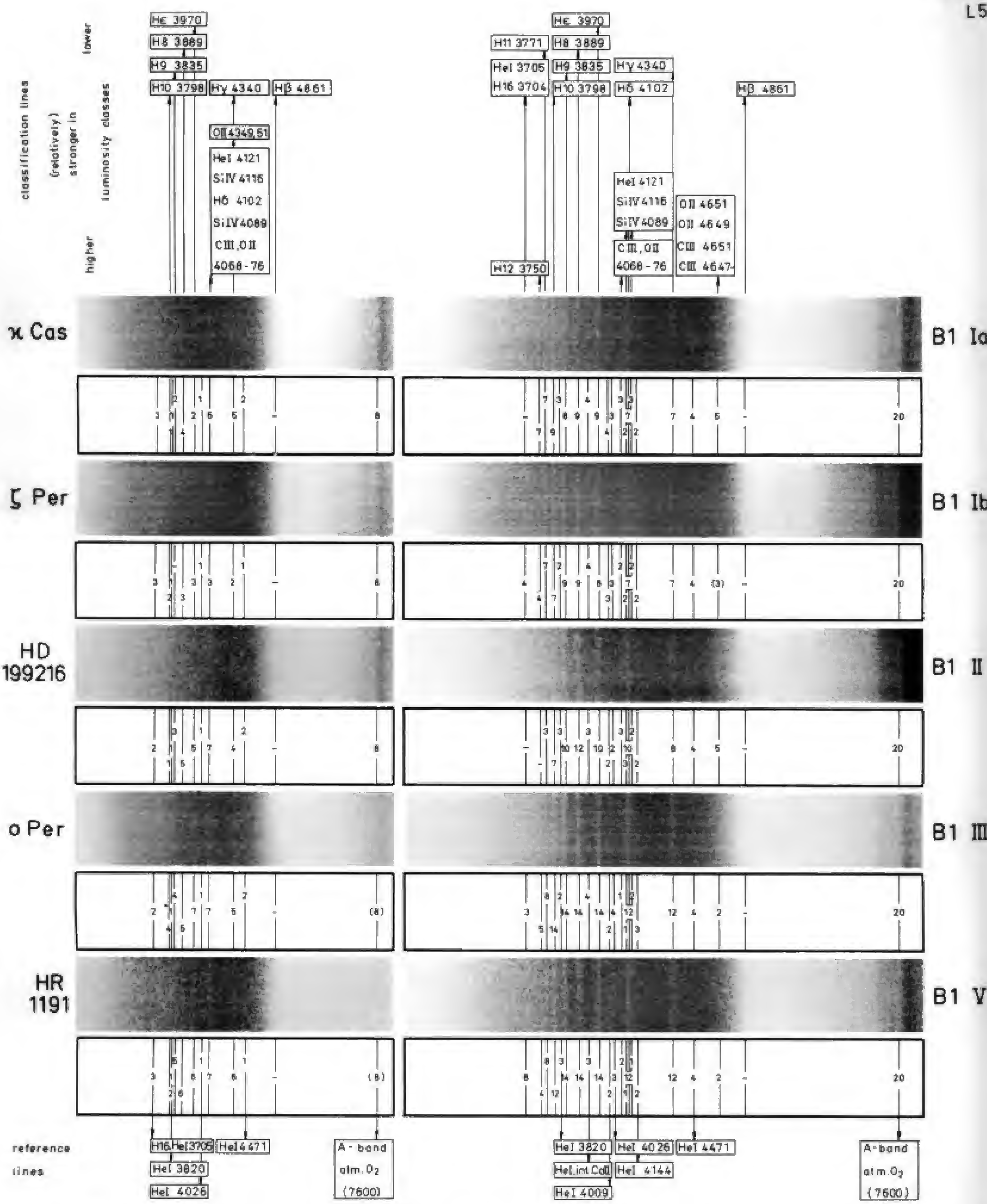
Dispersion 1280 Å/mm at Hγ:

1. H-lines stronger in lower luminosity classes.
2. Stronger in higher classes: blends of H-lines with CIII, OIII, OII, SiIV as listed above relative to unblended H-lines.

Dispersion 645 Å/mm at Hγ:

1. H-lines stronger in lower luminosity classes.
2. Blend H16 3704, HeI 3705 stronger in lower luminosity classes.
3. Stronger in higher luminosity classes: blends of CIII, OIII, OII, SiIV as listed above.
4. Important ratio:

HeI 4471 : CIII, OII 4647-51 = 1 in III; < 1 in supergiants; > 1 in V



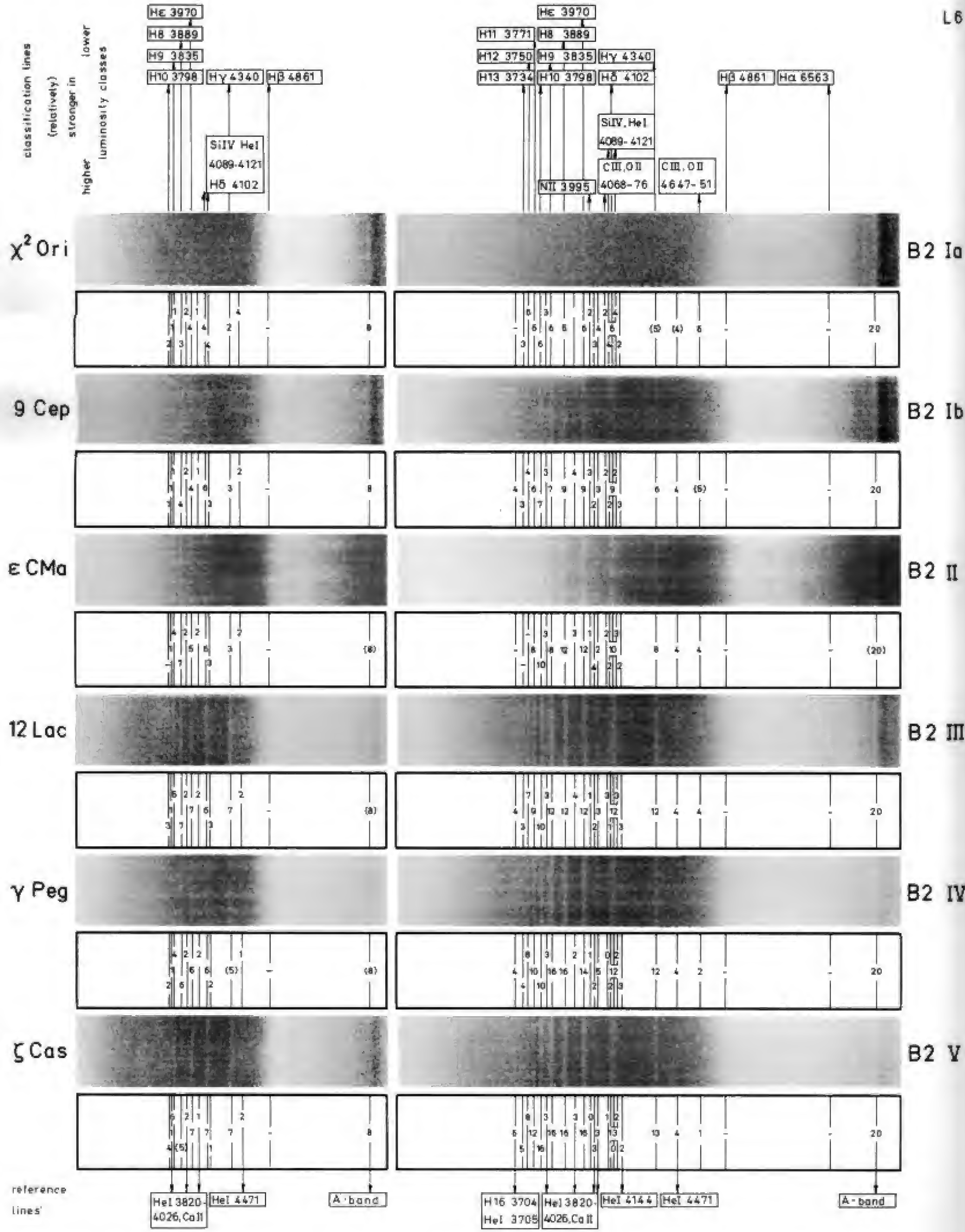
Dispersion 1280 Å/mm at Hγ:

1. H-lines stronger in lower luminosity classes
2. Stronger in higher classes: blends of H-lines with CIII, OII, SiIV as listed above relative to unblended H-lines.

Dispersion 645 Å/mm at Hγ:

1. H-lines stronger in lower luminosity classes except high series members.
2. Blend H16 3704, HeI 3705 stronger in lower luminosity classes
3. Stronger in higher luminosity classes: blends of CIII, OII, SiIV as listed above.
4. Important ratio:

HeI 4471 : CIII, OII 4647-51 > 1 in V and III; < 1 in II and supergiants



Dispersion 1280 Å/mm at Hγ:

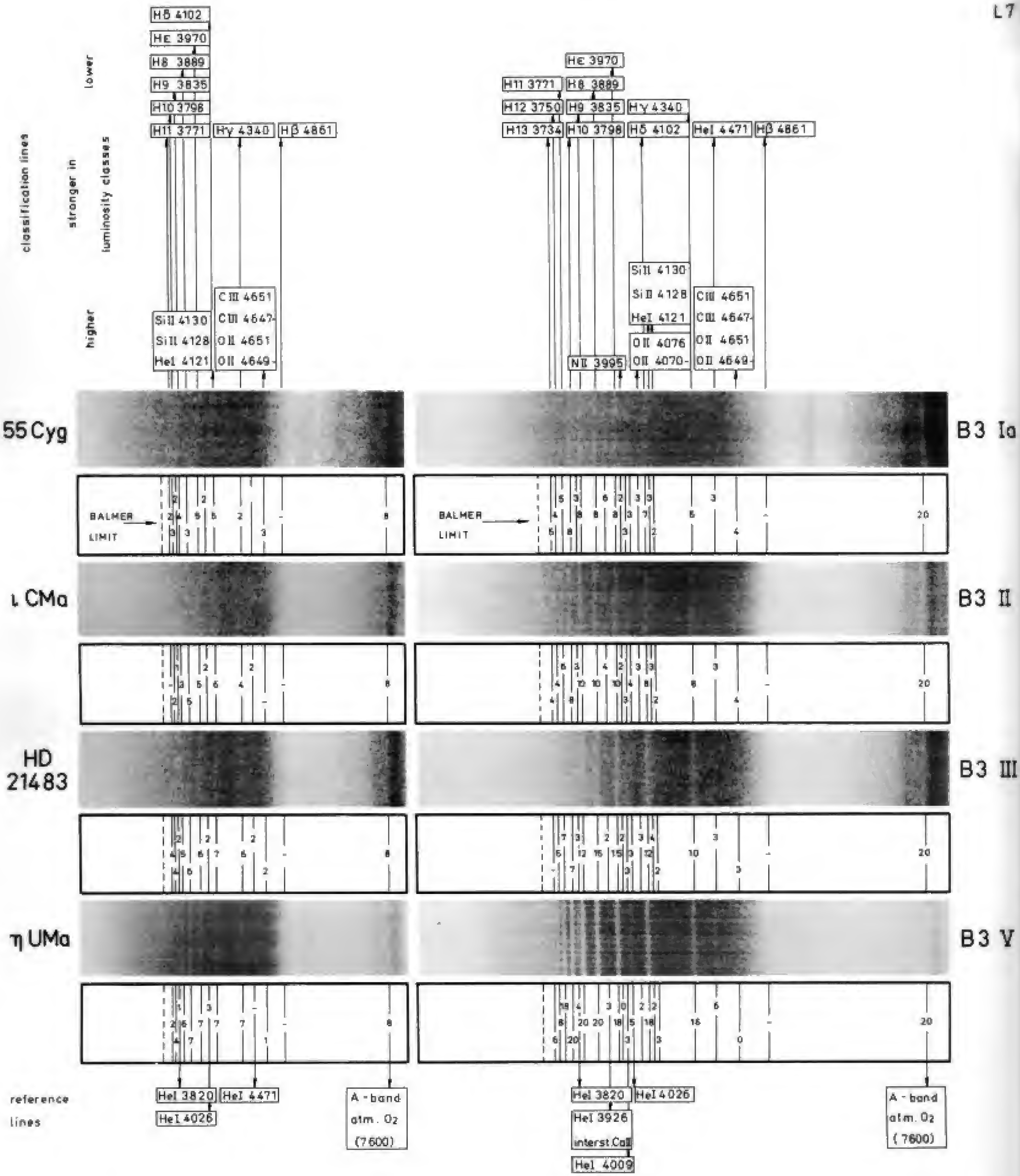
1. H-lines stronger in lower luminosity classes.
2. Stronger in higher classes: blend of Hδ with SiIV and HeI relative to unblended H-lines.
3. Important ratio:

Hγ : HeI 4471 = 1 in Ib, II; < 1 in Ia; > 1 in V - III

Dispersion 645 Å/mm at Hγ:

1. H-lines stronger in lower luminosity classes.
2. Stronger in higher luminosity classes: CIII, NII, OII, SiIV as listed above.
3. Important ratio:

HeI 4471 : CIII, OII 4647-51 = 1 in III, II; > 1 in V, IV; < 1 in supergiants

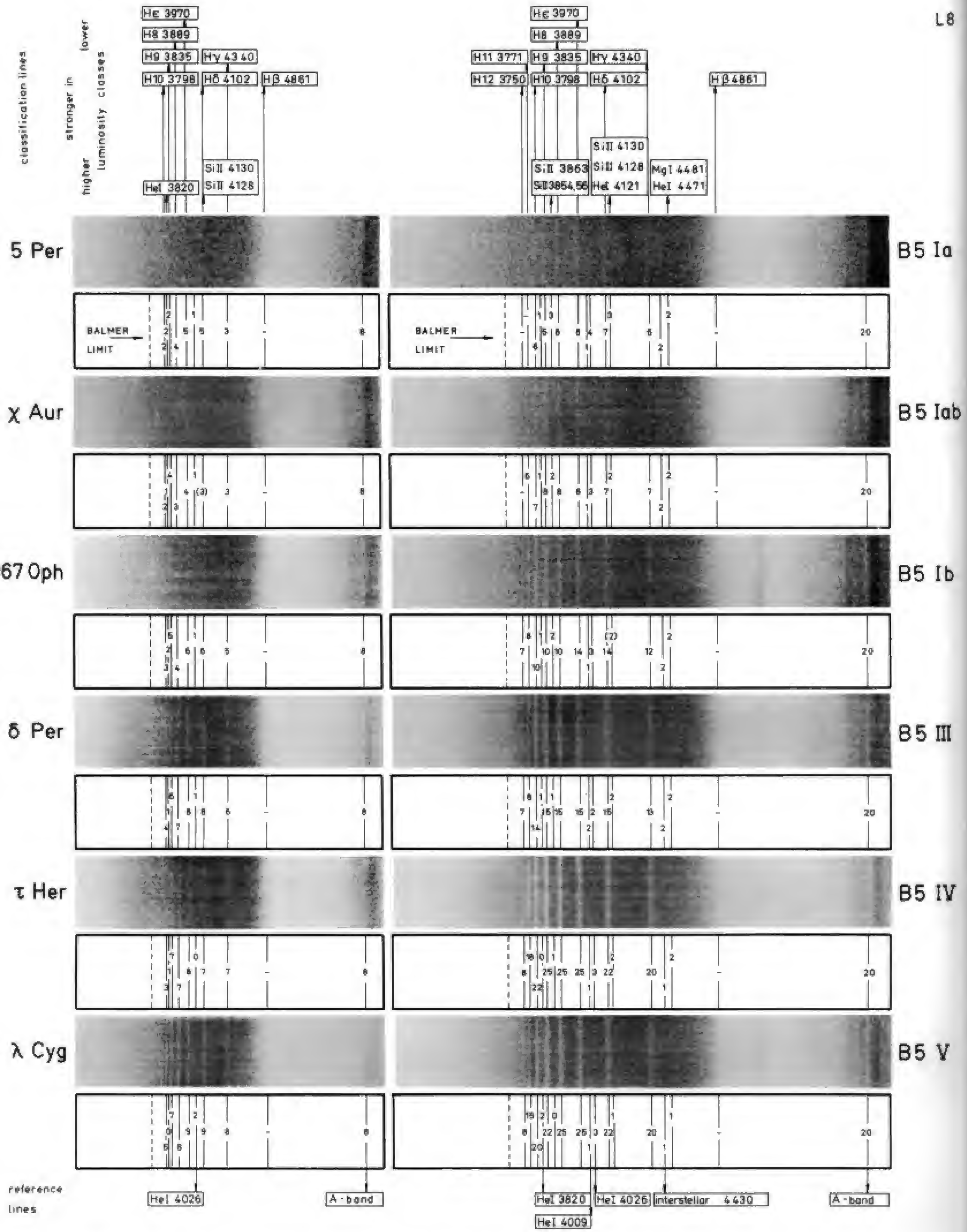


Dispersion 1280 Å/mm at Hγ:

1. H-lines stronger in lower classes.
2. Stronger in higher classes: CIII, OII, SiII as listed above.
3. Structural differences:
   a) blend Hδ, HeI, SiII 4102 - 30 appears as broad feature in high luminosity classes; Hδ dominates as a single line in lower classes.
   b) broad blend H10, HeI 3820, H9 (with HeI apparently stronger) in higher classes.

Dispersion 645 Å/mm at Hγ:

1. H-lines stronger in lower luminosity classes.
2. Stronger in higher luminosity classes: CIII NII, OII, OII, SiII as listed above.
3. Important ratio:
   HeI 4471 : CIII, OII 4647 - 51 = 1 in III; < 1 in II and Ia; > 1 in V.

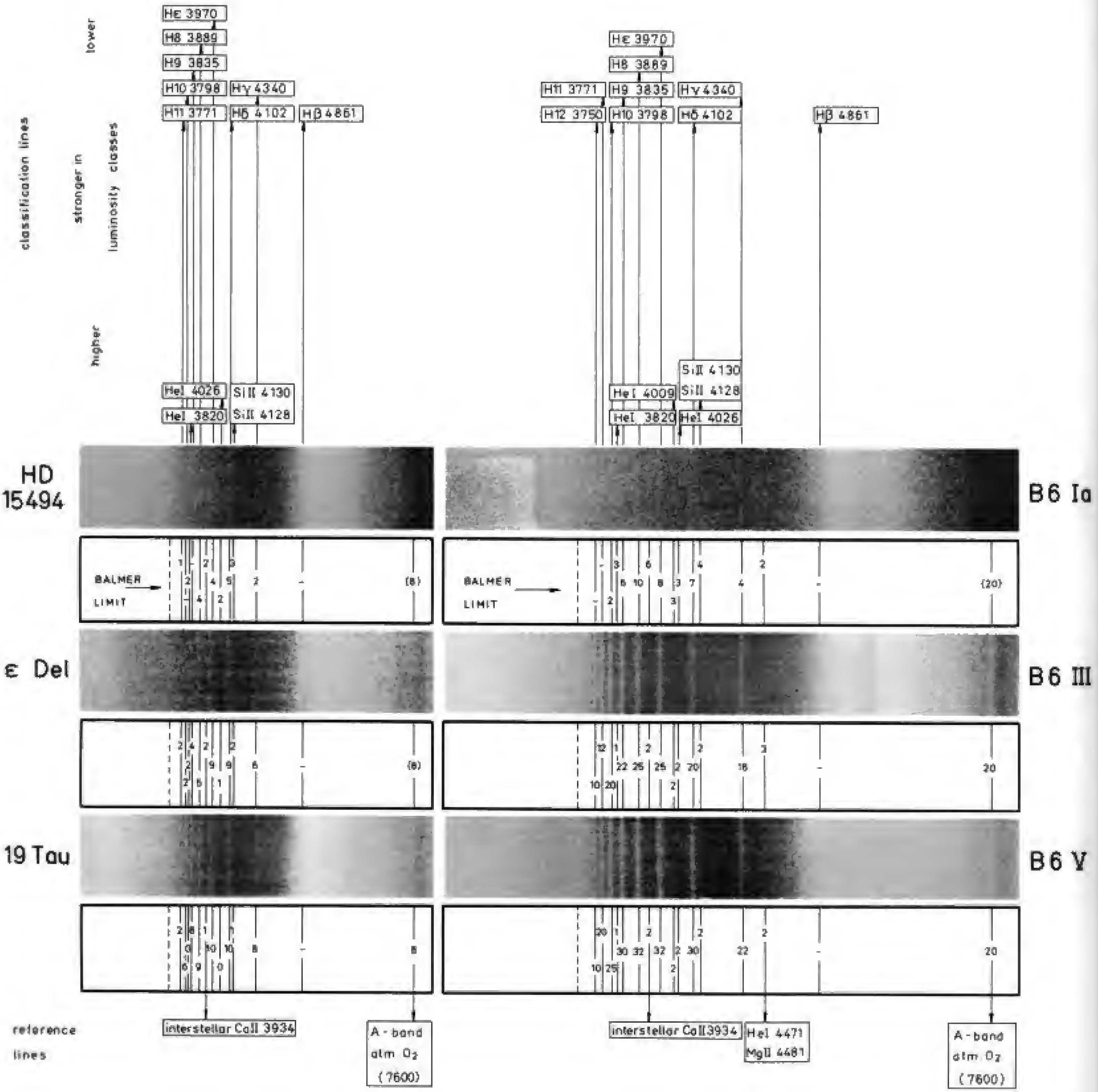


Dispersion 1280 Å/mm

1. H-lines stronger in lower luminosity classes
2. see L9, 2
3. see L9, 3
3. Structural difference: broad blend H10, HeI 3820, H9 (with HeI apparently stronger) in higher classes

Dispersion 645 Å/mm at Hγ:

1. H-lines stronger in lower luminosity classes.
2. Balmer discontinuity at shorter wavelengths and of smaller amplitude in higher luminosity classes.
3. Stronger in higher luminosity classes: blends HeI, MgI, SiII as listed above.

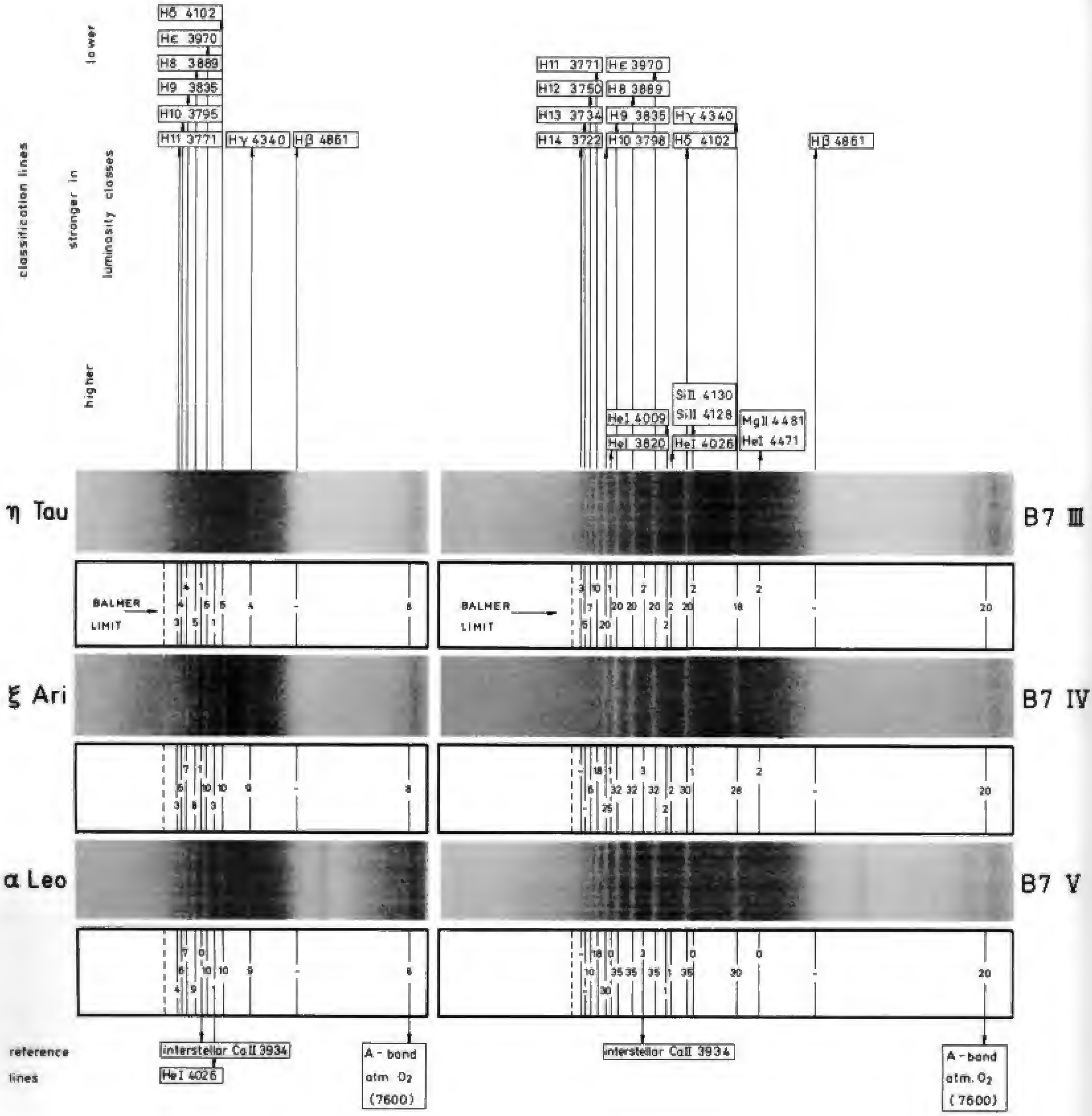


Dispersion 1280 Å/mm at Hγ:

1. H-lines stronger in lower luminosity classes.
2. Balmer discontinuity at shorter wavelengths and of smaller amplitude in higher classes.
3. Broad absorption feature redward of Balmer discontinuity (blend of high series members) stronger in lower luminosity classes.
4. Stronger in higher classes: HeI 3820, HeI 4026, SiII 4128-30.

Dispersion 645 Å/mm at Hγ:

1. H-lines stronger in lower luminosity classes.
2. Balmer discontinuity at shorter wavelengths and of smaller amplitude in higher luminosity classes.
3. Weak and broad feature redward of Balmer discontinuity (blend of high members of the Balmer series against the ultraviolet continuum) stronger in lower luminosity classes.
4. Stronger in higher luminosity classes: HeI 3820, HeI 4009, HeI 4026, SiII 4128-30.

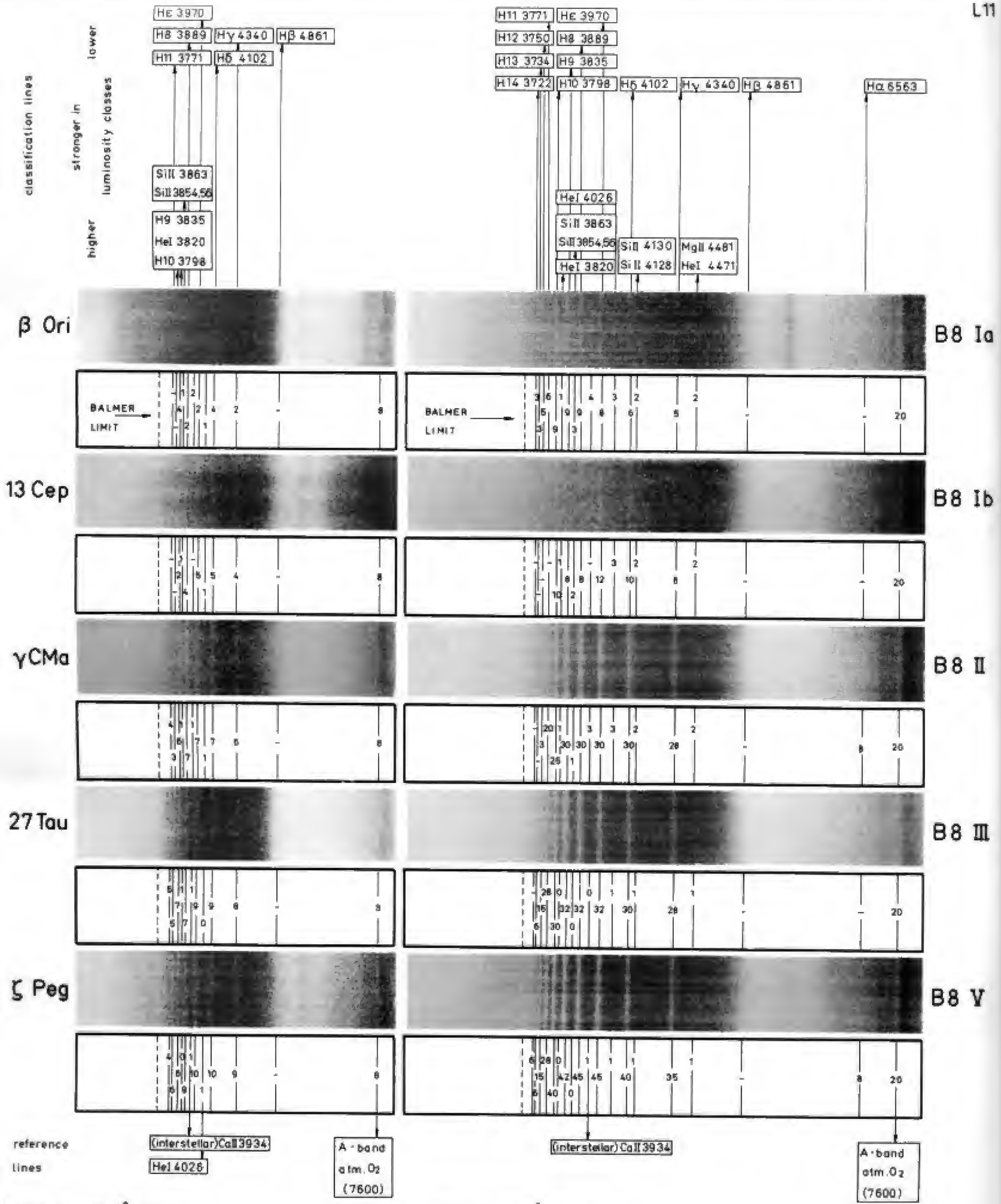


Dispersion 1280 Å/mm at Hγ:

1. H-lines slightly stronger in lower luminosity classes.
2. Balmer discontinuity at slightly shorter wavelengths in class III.

Dispersion 645 Å/mm at Hγ:

1. H- lines slightly stronger in classes V and IV than in class III.
2. Balmer discontinuity at slightly shorter wavelengths and more abrupt in class III.
3. HeI - lines stronger in higher luminosity classes.

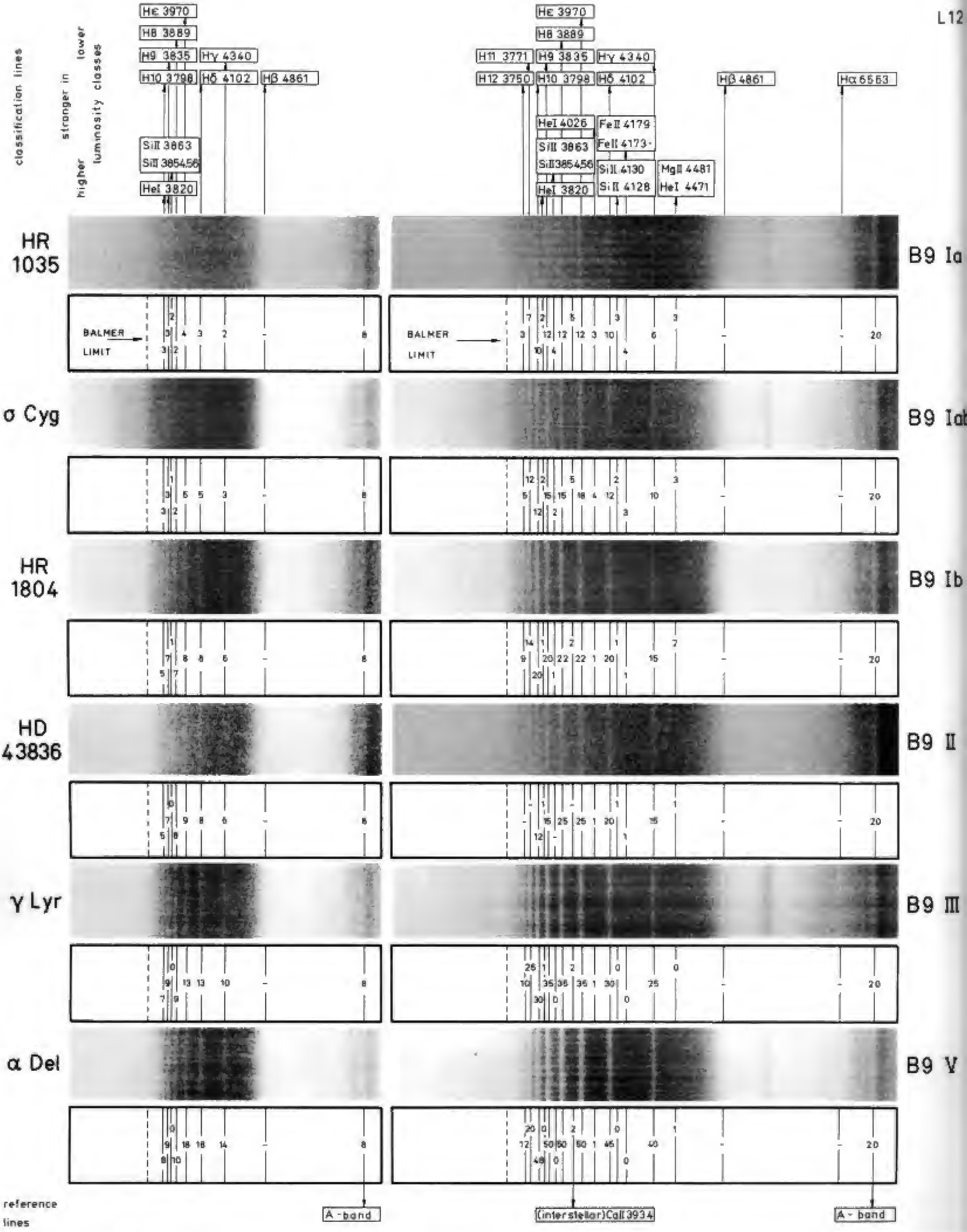


Dispersion 1280 Å/mm at Hγ:

1. H-lines stronger and broader in lower classes.
2. Balmer discontinuity at shorter wavelengths and more abrupt in higher luminosity classes.
3. Blend H9, HeI 3820, H10 strong in supergiants
4. SiII 3854-63 clearly present in supergiants.

Dispersion 645 Å/mm at Hγ:

1. H-lines stronger and broader in lower luminosity classes
2. Balmer discontinuity at shorter wavelengths and more abrupt in higher luminosity classes.
3. HeI-lines stronger in higher luminosity classes.
4. SiII stronger in higher luminosity classes.

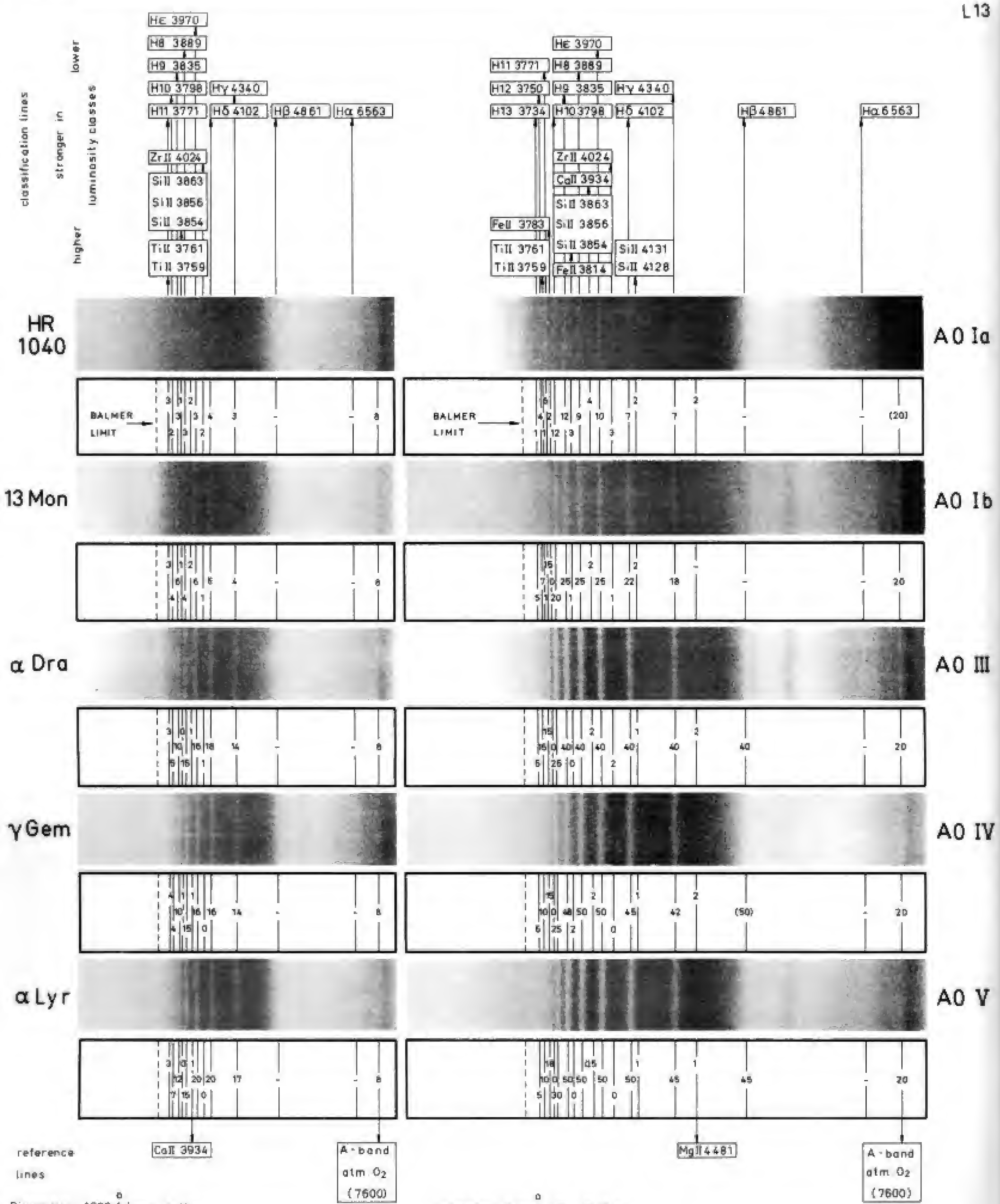


Dispersion 1280 Å/mm at Hγ:

1. H-lines stronger and broader in lower classes.
2. Balmer discontinuity at shorter wavelengths and more abrupt in higher luminosity classes.
3. Blend H9, HeI 3820, H10 strong in Ia and Iab.
4. SiII 3854-63 clearly present in supergiants.

Dispersion 645 A/mm at Hγ:

1. H-lines stronger and broader in lower luminosity classes
2. Balmer discontinuity at shorter wavelengths and more abrupt in higher classes.
3. HeI-lines stronger in higher luminosity classes.
4. SiII, FeII stronger in higher luminosity classes.

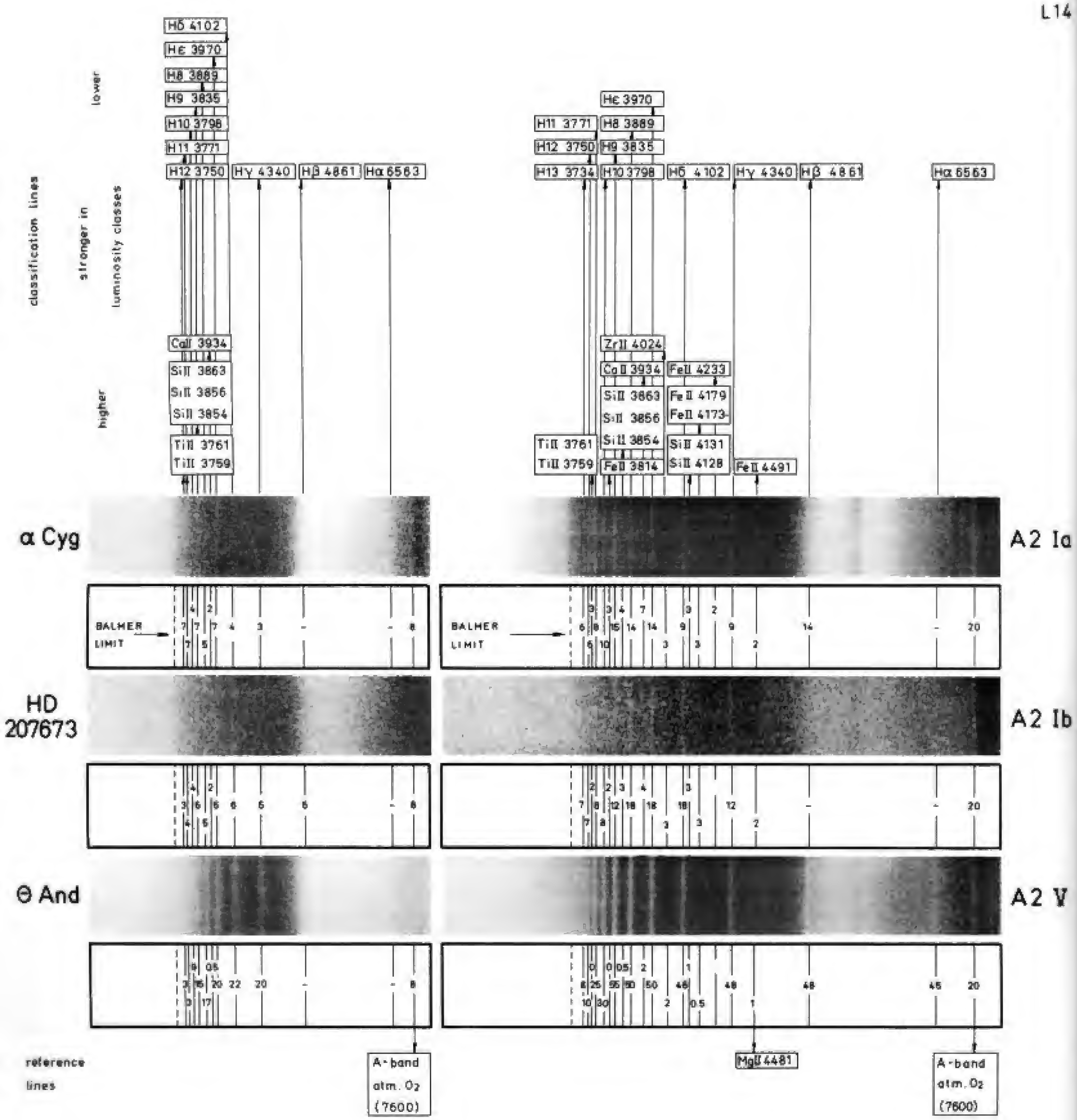


Dispersion 1280 Å/mm at Hγ:

1. H - lines stronger and broader in lower luminosity classes.
2. Balmer discontinuity at shorter wavelengths and more abrupt in higher luminosity classes.
3. In Ia little structure between HE and Balmer limit ; exceptions : blend H8, SiII, H9 and blend H11, TiII, H12.

Dispersion 645 Å/mm at Hγ:

1. H - lines stronger and broader in lower luminosity classes.
2. Balmer discontinuity at shorter wavelengths and more abrupt in higher luminosity classes.
3. SiII, TiII, FeII, ZrII present in high luminosity classes.
4. CaII 3934 (apparently) stronger in higher luminosity classes.

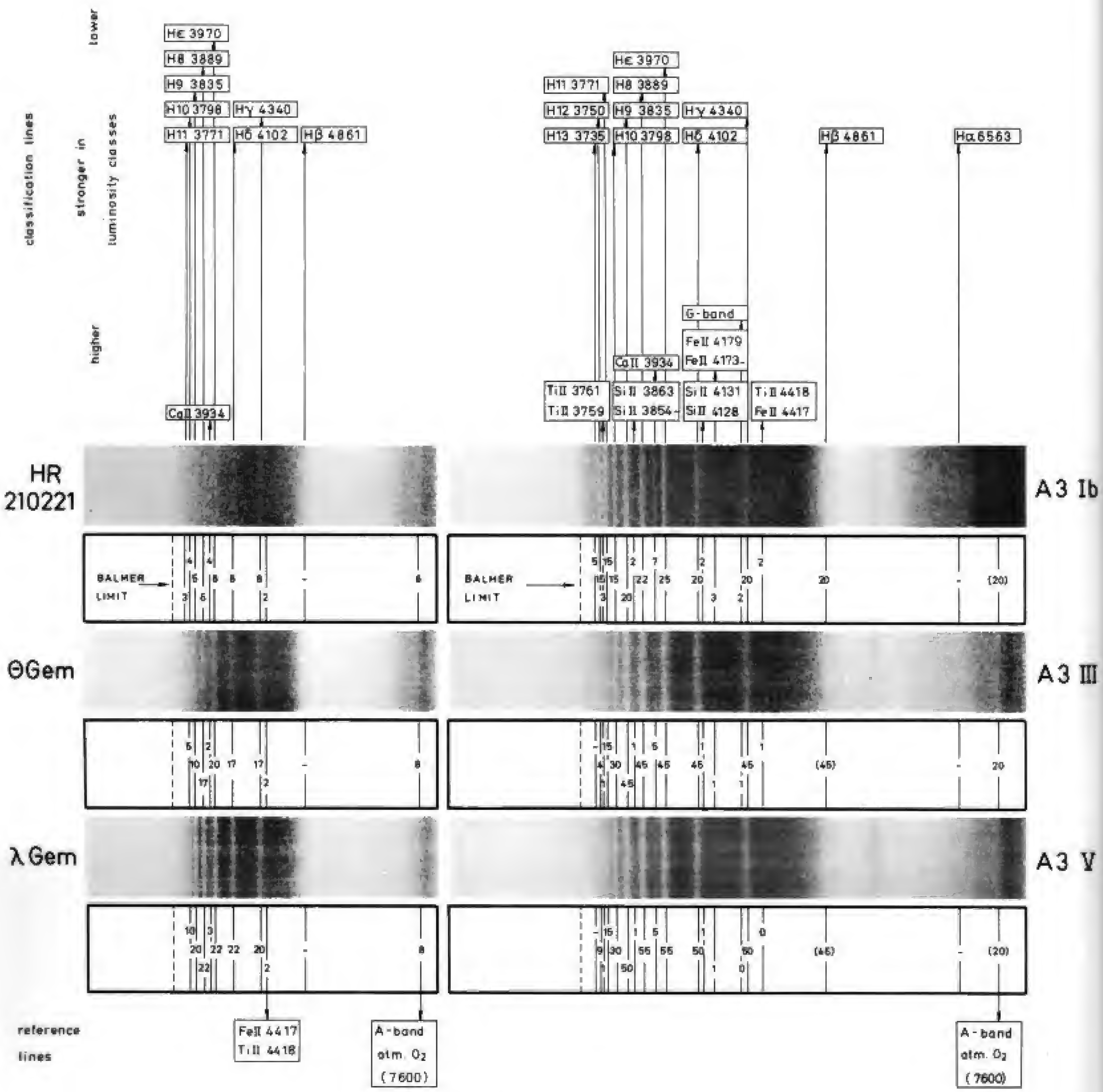


Dispersion 1280 Å/mm at Hγ:

1. H- lines stronger and broader in lower luminosity classes.
2. Balmer discontinuity at shorter wavelengths and more abrupt in higher luminosity classes.
3. Strong features in class Ia are the blends H8 - SiII - H9 and H11 - TiII - H12
4. CaII 3934 (apparently) stronger in higher luminosity classes.

Dispersion 645 Å/mm at Hγ:

1. H - lines stronger and broader in lower luminosity classes.
2. H - lines visible to higher series members in higher luminosity classes (in Ia to H17, in V to H13)
3. Balmer discontinuity at shorter wavelengths and more abrupt in higher luminosity classes.
4. SiII, TiII, FeII, ZrII stronger in higher luminosity classes
5. CaII 3934 (apparently) stronger in higher luminosity classes.

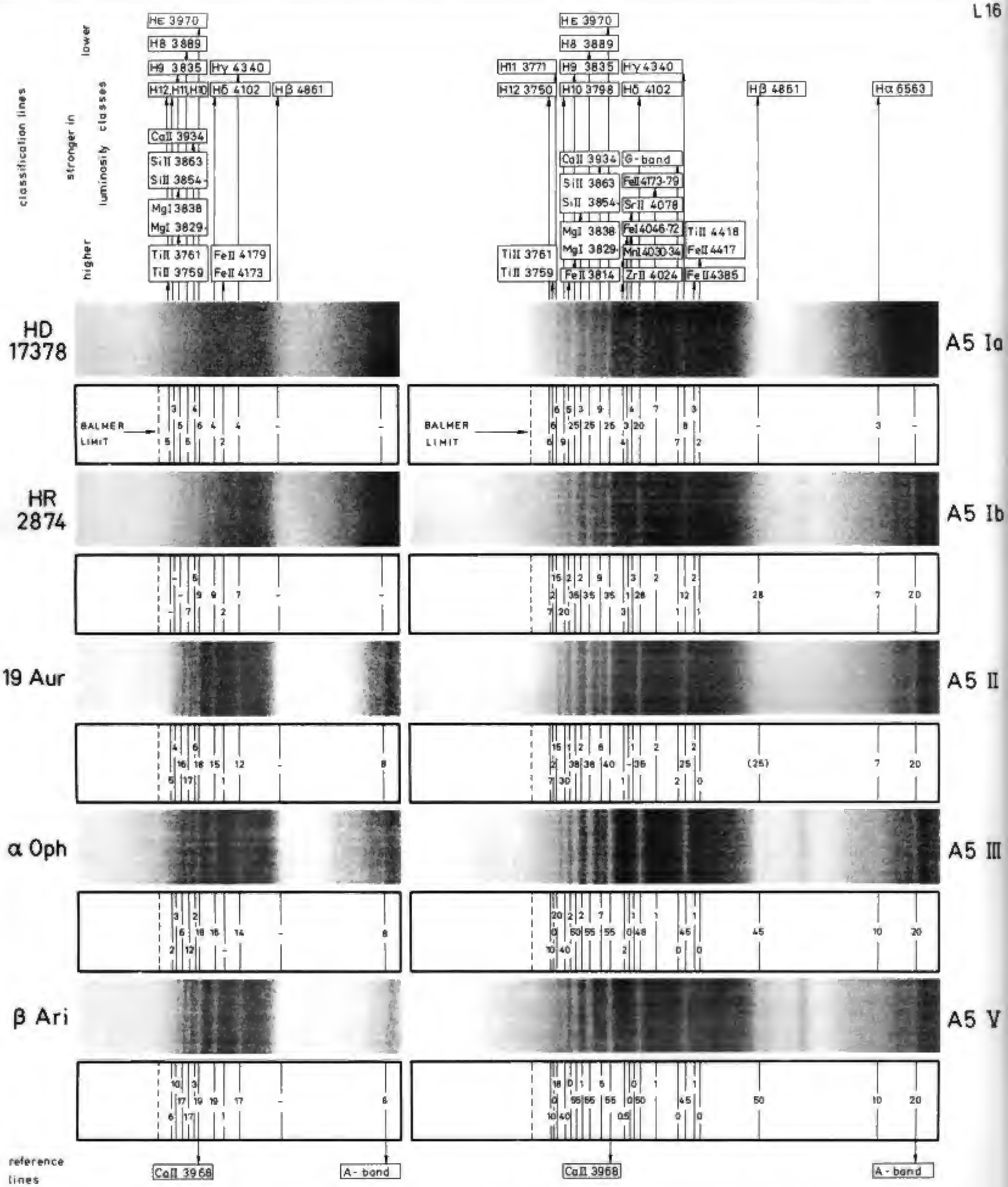


Dispersion 1280 Å/mm at Hγ:

1. H-lines stronger and broader in lower luminosity classes.
2. Balmer discontinuity at shorter wavelengths and more abrupt in higher luminosity classes.
3. CaII 3934 apparently stronger in higher luminosity classes.

Dispersion 645 Å/mm at Hγ:

1. H-lines stronger and broader in lower luminosity classes.
2. H-lines visible to higher series members in higher luminosity classes (in Ib to H15; in V to H13)
3. Balmer discontinuity at shorter wavelengths and more abrupt in higher luminosity classes.
4. SiII, TiII, FeII stronger in higher luminosity classes. G-band appears.
5. CaII 3934 (apparently) stronger in higher luminosity classes.

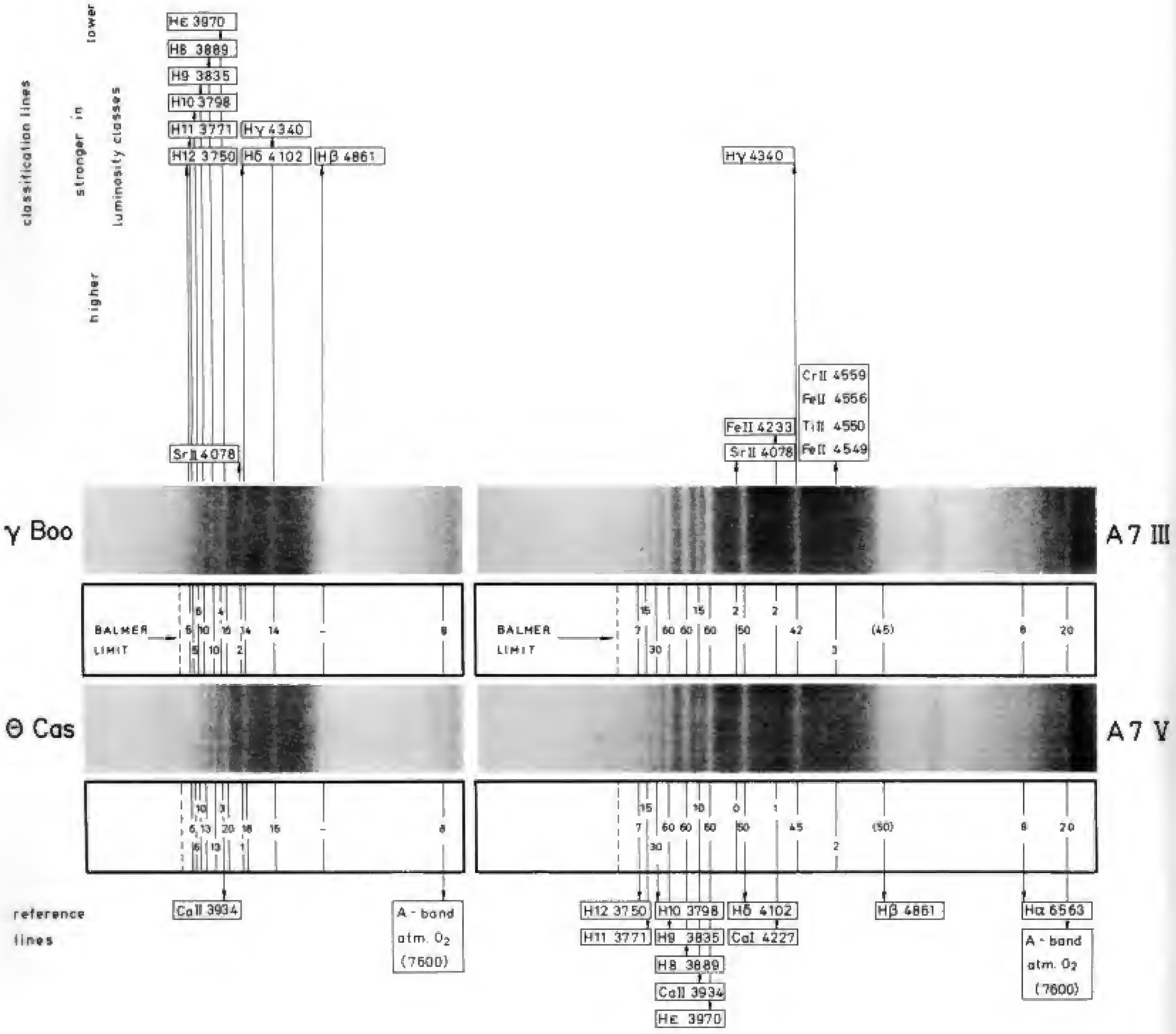


Dispersion 1280 Å/mm at Hγ:

1. H - lines stronger and broader in lower classes.
2. Balmer discontinuity at shorter wavelengths and more abrupt in higher luminosity classes
3. FeII 4173 - 79 stronger in higher luminosity classes
4. Blend SiII, H9, MgI stronger in higher luminosity classes
5. Blend H11, TiII, H12 stronger in higher luminosity classes,

Dispersion 645 Å/mm at Hγ:

1. H - lines stronger and broader in lower luminosity classes.
2. Balmer discontinuity at shorter wavelengths and more abrupt in higher classes
3. SiII, TiII, FeII, ZrII stronger in higher luminosity classes.
4. G - band stronger in higher luminosity classes
5. CaII 3934 (apparently) stronger in higher luminosity classes.
6. Blend H9, MgI 3829 - 38 stronger than neighbouring H - lines in higher classes.
7. FeI contributes to strong blends with ionized metals in higher luminosity classes.

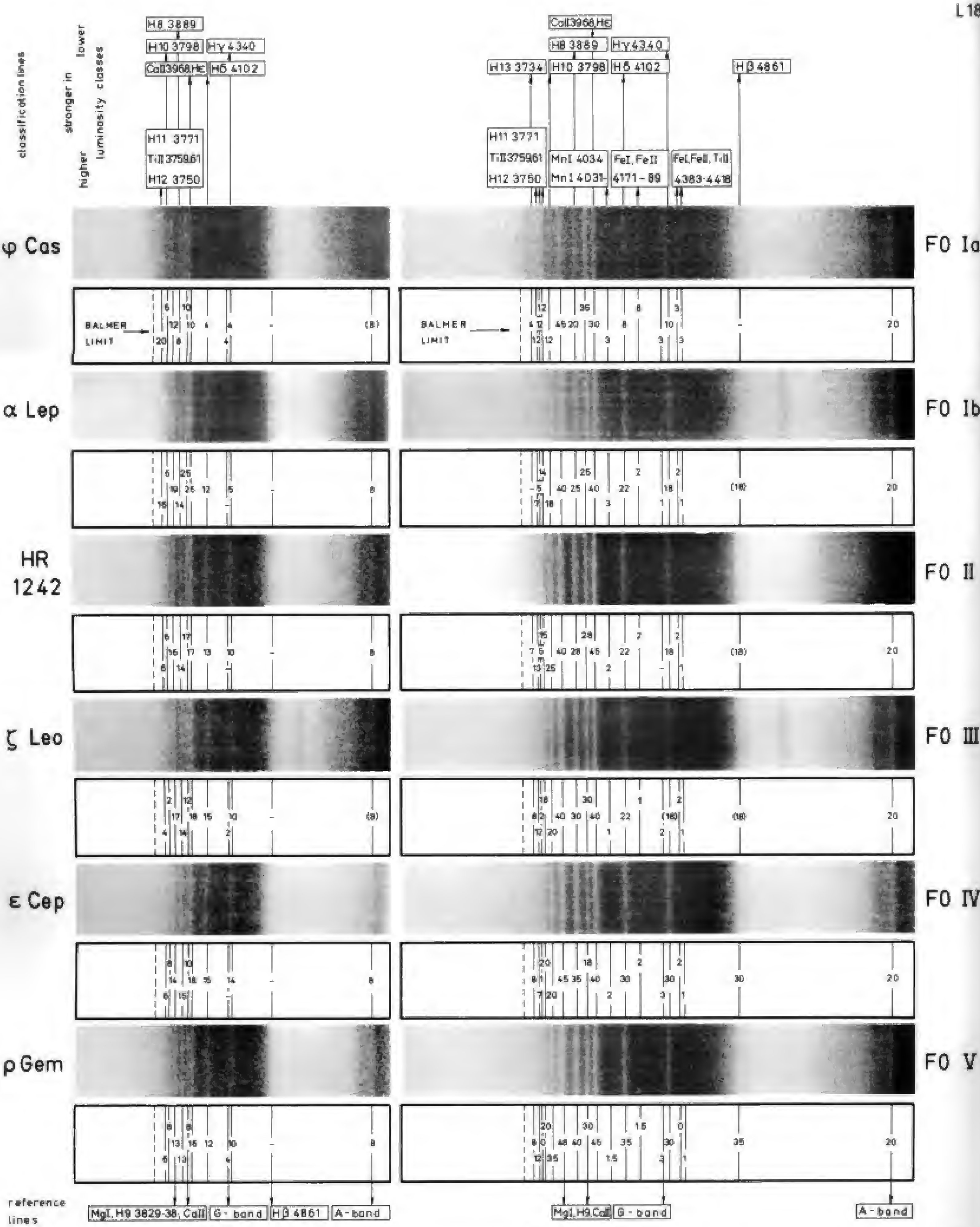


Dispersion 1280 Å/mm at Hγ:

1. H-lines slightly stronger in class V than in III.
2. Balmer discontinuity slightly more abrupt in class III.
3. Sr II 4078 slightly stronger in class III.

Dispersion 645 Å/mm at Hγ:

1. No noticeable difference in H-lines between classes V and III.
2. Fe II 4233 (enhanced through blend with Ca I 4227) stronger in III.
3. Sr II 4078 stronger in class III.
4. Blend at 4550 stronger in class III.



Dispersion 1280 Å/mm at Hγ:

1. H - lines stronger in lower luminosity classes.
2. Balmer discontinuity abrupt in II to Ia.
3. Important ratios

H8 3889 $\overset{<}{\underset{\geq}{=}}$ CaII 3934 $\overset{<}{\underset{=}{=}}$ CaII 3968

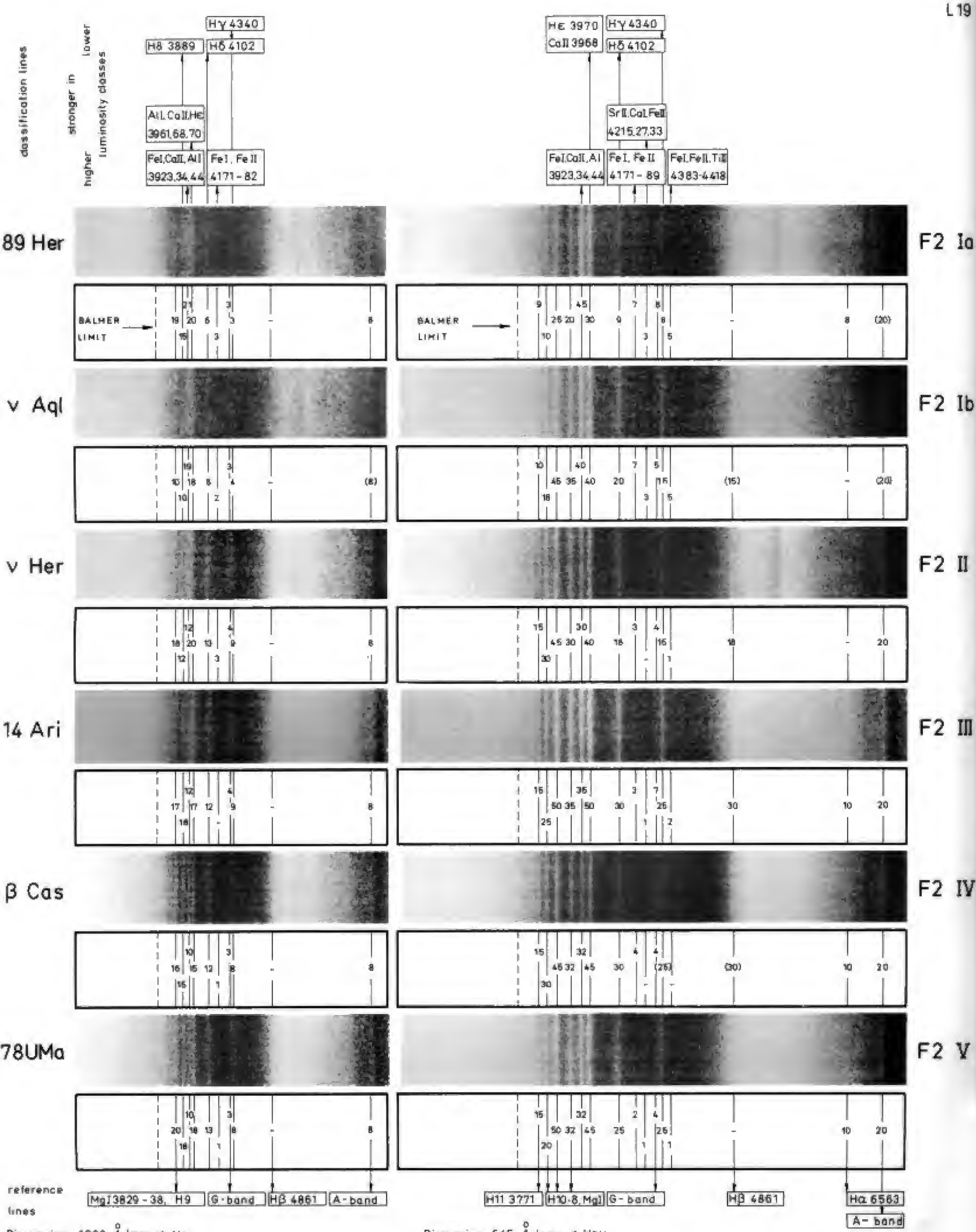
in V and IV, III; II to Ia; respectively.

Dispersion 645 Å/mm at Hγ:

1. H - lines stronger in lower luminosity classes
2. Balmer discontinuity abrupt in classes II to Ia
3. Important ratios,

H8 3889 $\overset{>}{\underset{<}{=}}$ CaII 3934 $\overset{<}{\underset{>}{\leq}}$ CaII 3968 in V and IV; III to Ib; Ia; respectively

Hδ 4102 : FeI, FeII 4171 – 89 $\cong$ 1 in Ia, >> 1 in V to Ib



Dispersion 1280 Å/mm at Hγ:

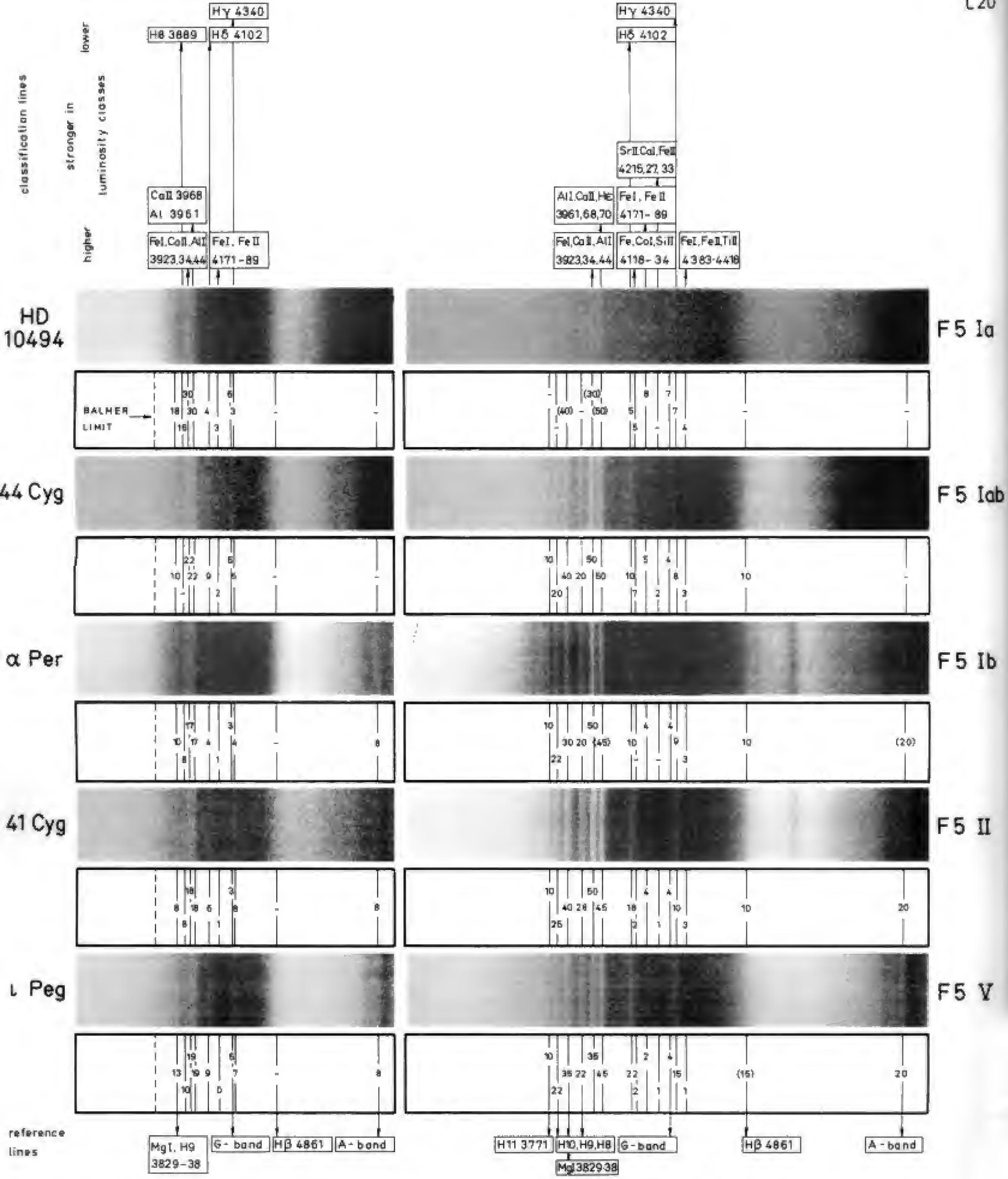
1. H - lines slightly stronger in lower luminosity classes.
2. Balmer discontinuity noticeable in supergiants.
3. Stronger in higher classes: blends of ionized metals.
4. Important ratio:

H8 3889 : CaII 3934 = 1 in II ; > 1 in V to III
< 1 in supergiants

Dispersion 645 Å/mm at Hγ:

1. Hγ and Hδ stronger in lower luminosity classes.
2. Balmer discontinuity noticeable in supergiants.
3. Stronger in higher luminosity classes: blends as indicated above.
4. Important ratios:

H8 3889 : CaII 3934 = 1 in V to II ; < 1 in supergiants
CaII 3934 : CaII 3968, Hε = 1 in Ib ; > 1 in Ia ; < 1 in V to II.

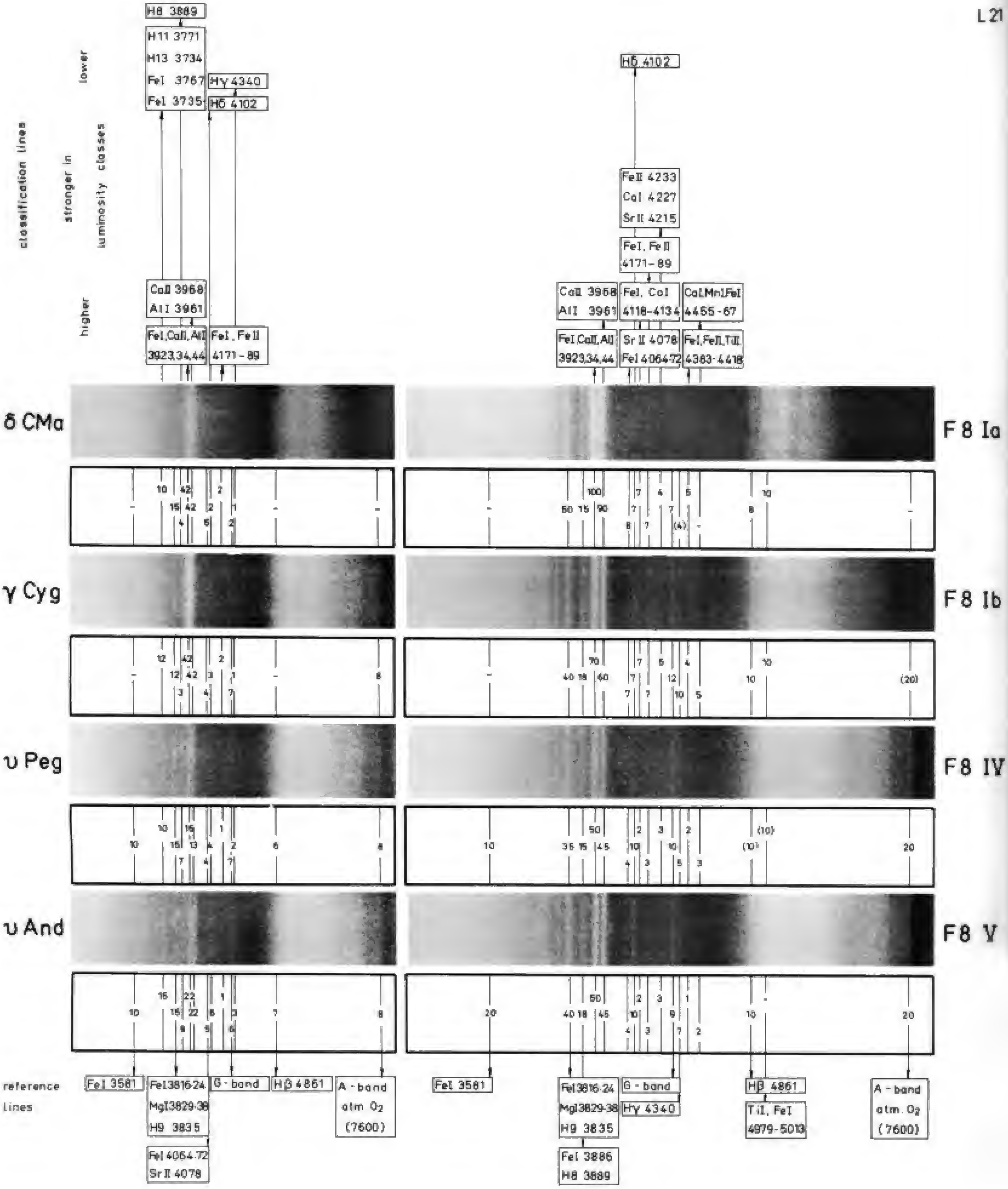


Dispersion 1280 Å/mm at Hγ:

1. Hγ, Hδ and H8 slightly stronger in lower classes.
2. Balmer discontinuity marginal in supergiants.
3. Stronger in higher classes: blends with ionized metals as listed above.

Dispersion 645 Å/mm at Hγ

1. Hγ and Hδ stronger in lower luminosity classes.
2. Stronger in higher luminosity classes; blends with lines of ionized metals as indicated above.
3. Important ratio:
   FeI, FeII 4171-89 : G-band = 1 in II and Ib ; > 1 in Iab and Ia ; < 1 in V
4. Structural differences: pattern of faint absorptions between Hβ and Hε in higher luminosity classes



Dispersion 1280 Å/mm at Hγ:

1. Stronger in higher classes: three blends as listed.
2. Stronger in lower classes: four features as listed.
3. Important ratios:

FeI, H 3735-71 : CaII 3968 < 1 in V and IV, ≪ 1 in Ib and Ia

FeI, MgI, H 3816-38 : CaII 3968 $\lesseqgtr$ 1 in V and IV, ≪ 1 in Ib and Ia

FeI, FeII 4171-89 : G-band = 1 in Ia; < 1 in V to Ib

4. Structural difference: region λ 3968-4300 smoother in higher classes.

Dispersion 645 Å/mm at Hγ:

1. Stronger in higher luminosity classes: eight blends as listed above and more
2. Stronger in lower luminosity classes: Hδ 4102
3. Important ratios:

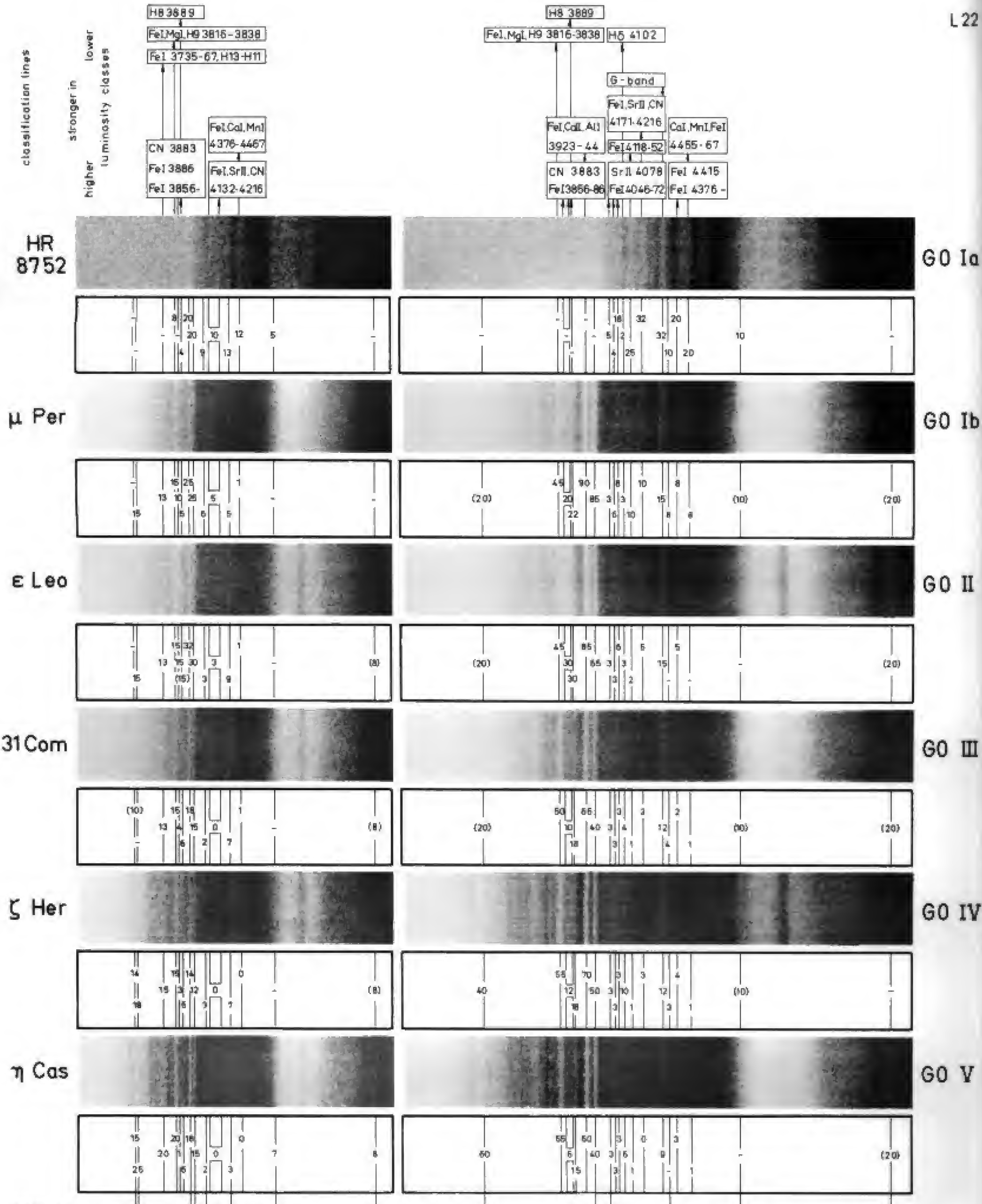
FeI, SrII 4064-78 : Hδ 4102 = 1 in Ib; > 1 in Ia; < 1 in V and IV

Hδ 4102 : FeI, CaI 4118-34 = 1 in Ia and Ib; > 1 in V and IV

Hδ 4102 : FeI, FeII 4171-89 = 1 in Ia and Ib; > 1 in V and IV

FeI 4171-82 : Hγ 4340 > 1 in Ia; < 1 in Ib to V.

4. Structural differences: Hδ and G-band stand out as strong lines in V and IV, in supergiants numerous features of comparable strength in λ 3968 - 4300.



Dispersion 1280 Å/mm at Hγ;

Important ratios:

FeI, MgI, H9 3816-38 : FeI, CN 3856-83 ≅ 1 in II and higher
>> 1 in V and III

MnI, FeI 4031-78 : FeI, SrII, CN 4132-4216 ≅ 1 in II-Ia ; > 1 in V-III

G-band : FeI, CaI, MnI 4373-4467 ≅ 1 in Ia ; >> 1 in V to Ib

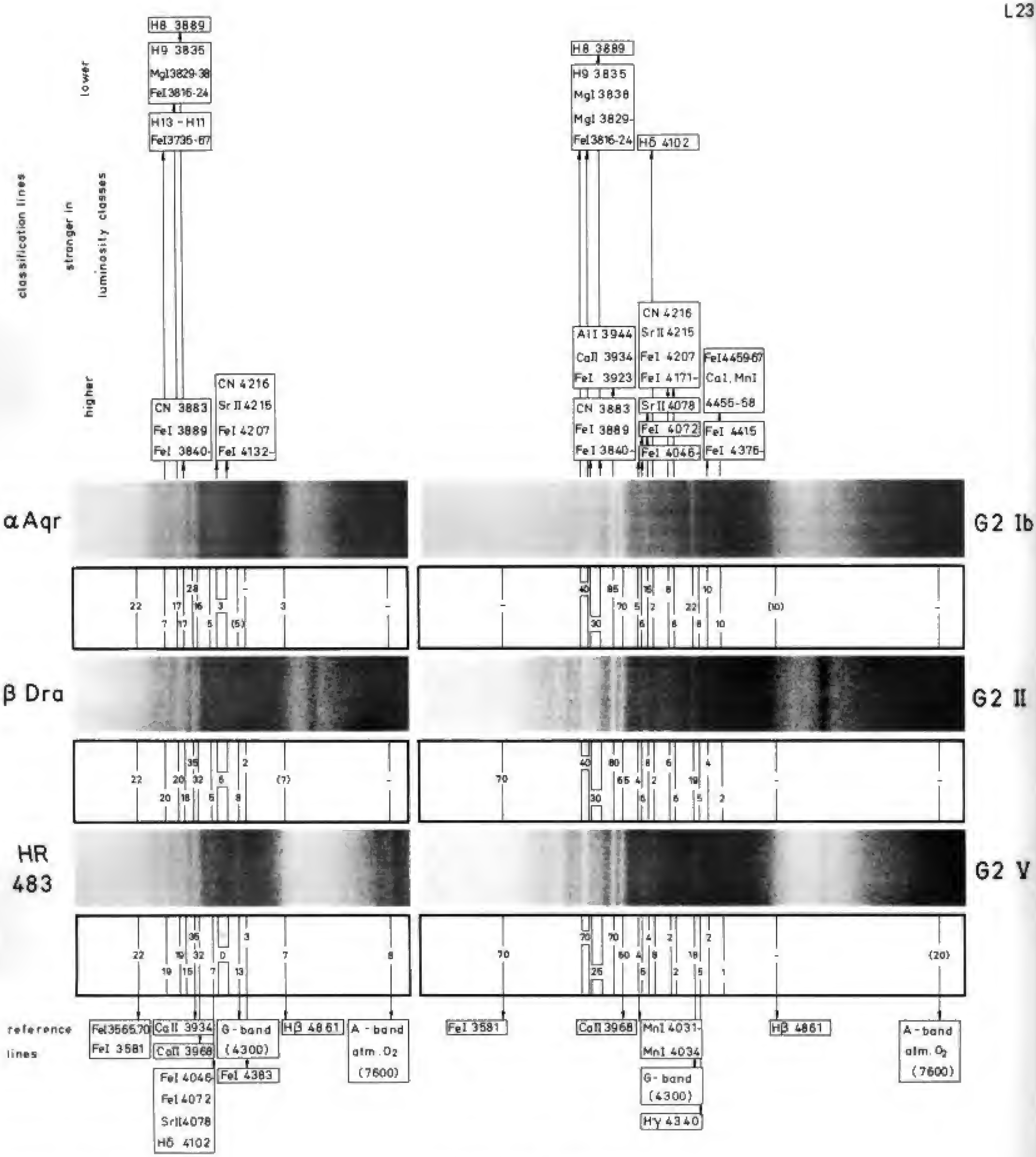
Structural differences λ 3706-3934 ; λ 3968-Hβ

Dispersion 645 Å/mm at Hγ

Important ratios: FeI, MgI H9 3816-38 : CaII 3934 ≅ 1 in V to III ; ≅ 1/2 in II to Ia

FeI 3856-86	Hδ 3889	≅ 1 in II and higher ; < 1 in V, IV and III
FeI, SrII 4046-78	Hδ 4102	> 1 in II and Ia, < 1 in V to III
FeI, SrII, CN	G-band	= 1 in Ia ; < in Ib ; << in V-II
FeI 4376-4415	CaI, MnI, FeI 4455-67	= 1 in Ia, Ib ; > 1 in V to II.

Structural differences λ 3706-3934 λ 3968-G-band ; G-band to Hβ



Dispersion 1280 Å/mm at Hγ:

1. Stronger in higher classes : two blends as listed
2. Stronger in lower classes : three features as listed
3. Important ratios:

FeI, H 3735-67 : FeI, MgI, H3816-38 = 1 in V to II < 1 in I

FeI, MgI, H 3816-38 : FeI, CN 3840-89 $\gtreqless$ 1 in II, Ib ; > 1 in V

FeI, SrII, H 4046-4102 : FeI, SrII, CN 4132-4216 $\cong$ 1 in II, Ib ≫ 1 in V

FeI, SrII, H4046-4102 : G-band = 1 in Ib ; < 1 in V to II

4. Structural differences : λ 3706 – 3934

Dispersion 645 Å/mm at Hγ :

1. Stronger in higher luminosity classes : eight blends as listed above
2. Stronger in lower luminosity classes : three features as listed above
3. Important ratios : (for wide blends take surface brightness)

FeI, MgI, H3816-38 : FeI, CN 3840 – 89 > 1 in Ib and II ; ≫ in V

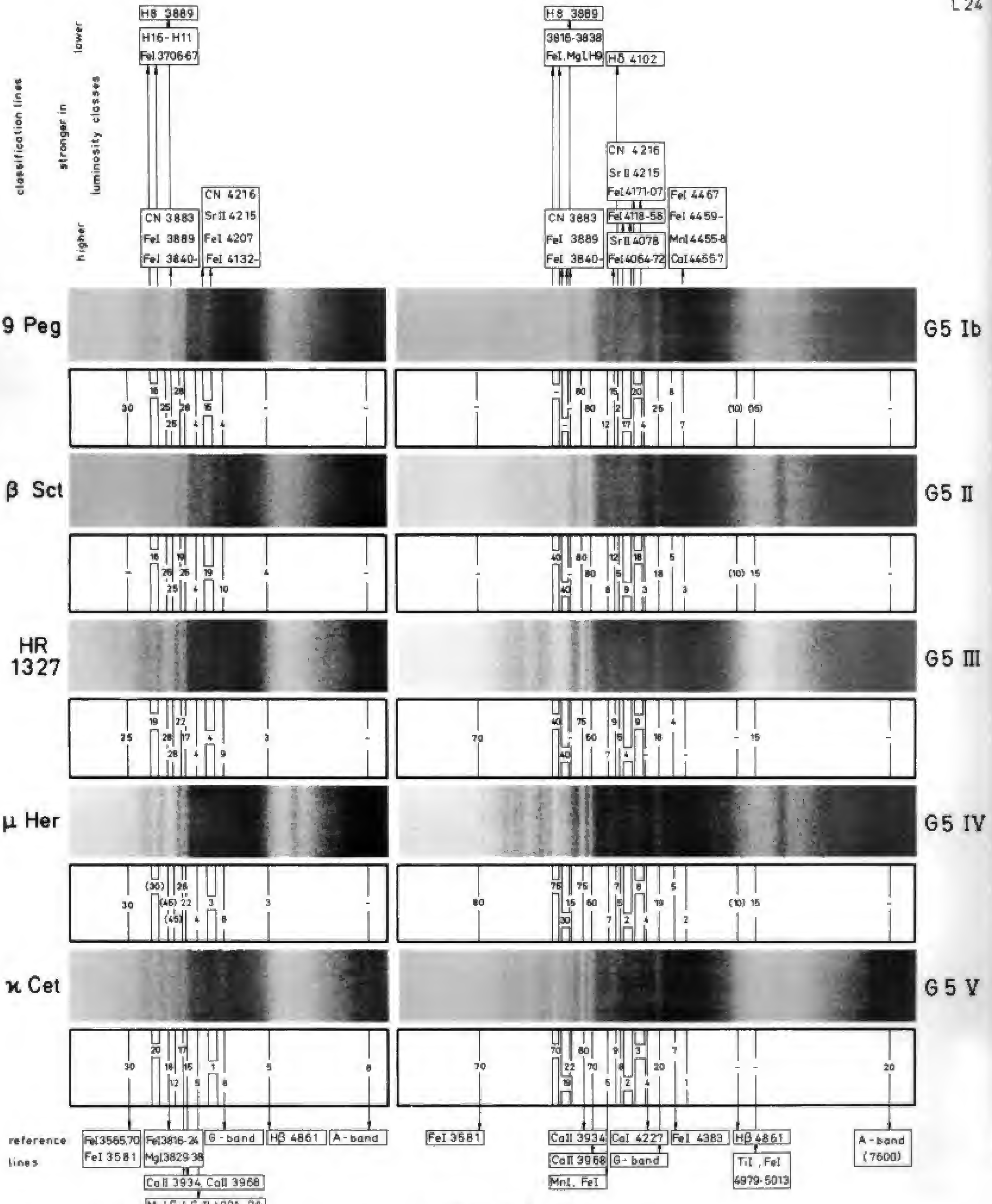
FeI, MgI, H 3816-38 : FeI, CaII, AlI 3923-44 = 1 in V ; < 1 in II and Ib

FeI, SrII 4072-78 : Hδ 4102 < 1 in V ; > 1 in II and Ib

Hδ 4102 : FeI, SrII, CN 4171-4216 > 1 in V ; < 1 in II and Ib

FeI 4376- 4415 : CaI, MnI, FeI 4455-67 = 1 in Ib ; > 1 in V and II

4. Structural differences : λ 3816 – 3944



Dispersion 1280 Å/mm at Hγ:

1. Stronger in higher classes: two blends as listed
2. Stronger in lower classes: two features as listed
3. Important ratios:

FeI, H 3706 - 3771 : FeI, CN 3840 - 89 > 1 in V < 1 in III - Ib

FeI, H3706 - 3771 : CaII 3934, 68 ≅ 1 in V-III; < 1 in II, Ib

MnI, FeI, SrII 4031 - 78 : FeI, SrII, CN 4132 - 4216 = 1 in III
> 1 in V and IV; < 1 in II and Ib

Dispersion 645 Å/mm at Hγ:

1. Stronger in higher luminosity classes: five blends as listed above
2. Stronger in lower luminosity classes: three features as listed above
3. Important ratios:

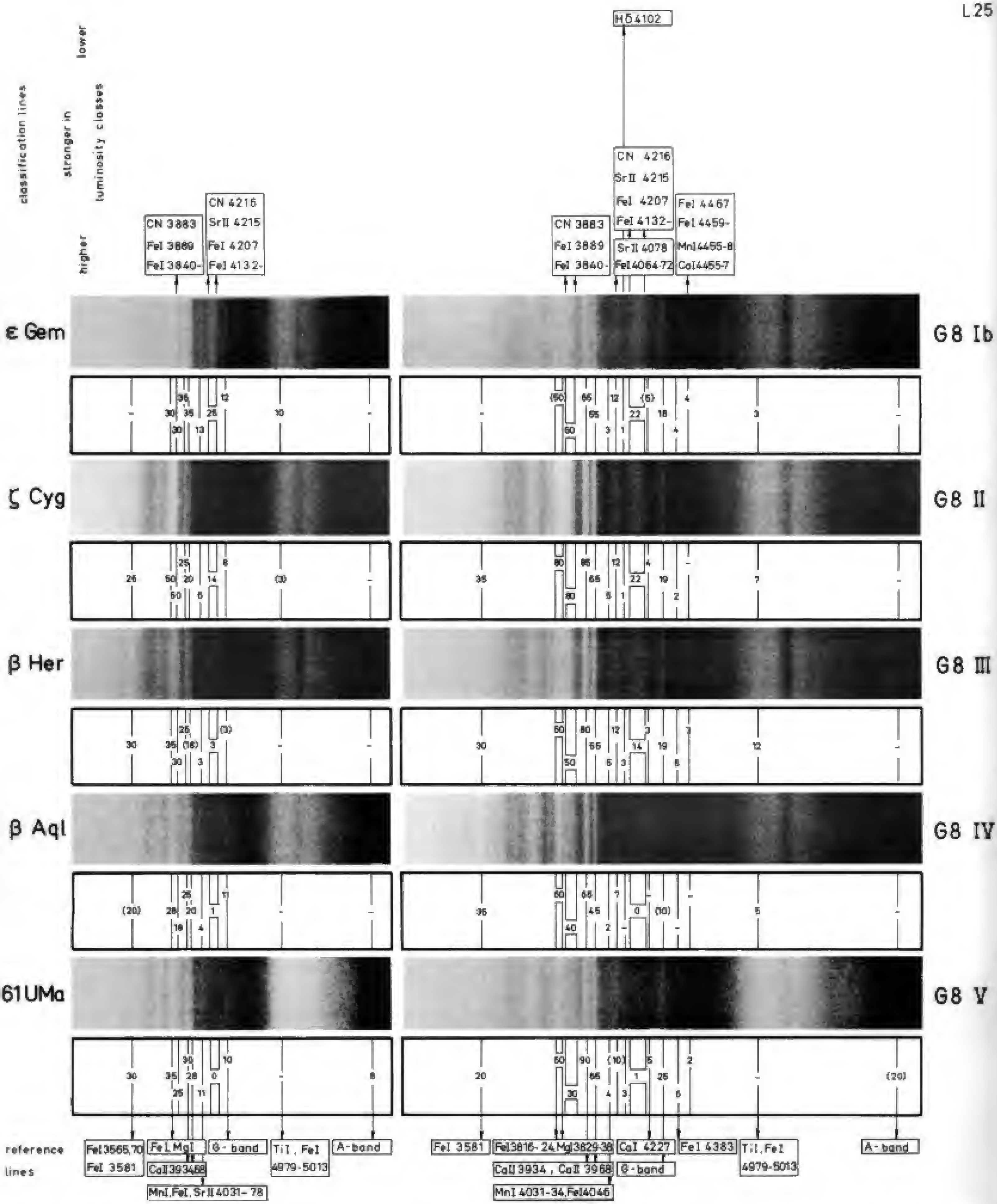
FeI, MgI, H3816 - 38 : FeI, CN 3840 - 89 = 1 in III and higher; > 1 in IV >> in V

FeI, SrII 4064 - 78 : Hδ ≅ 1 in V and IV; > 1 in III and higher

FeI, SrII 4064 - 78 : FeI 4118 - 58 ≅ 1 in Ib; > in II, III >> 1 in V and IV

FeI, SrII, CN 4171 - 4216 : G-band ≅ 1 in II and Ib; << 1 in V to III

4. Structural differences: λ 3840 - 89; λ 4102 - 4227; λ 4383 - 4861



Dispersion 1280 Å/mm at Hγ:

1. Stronger in higher classes: two blends as listed
2. Important ratios:

FeI, MgI 3816-38 : FeI, CN 3840-89 = 1 in II and higher
> 1 in V, IV and III

FeI, SrII, CN 4132-4216 : G-band = 1 in III; >> 1 in II, Ib
<< 1 in V and IV

or:
MnI, FeI SrII 4031-78 ≥ = ≤ FeI, SrII CN 4132-4207 ≤ = ≥ G-band
in V, IV; III; II and higher, respectively.

Dispersion 645 Å/mm at Hγ:

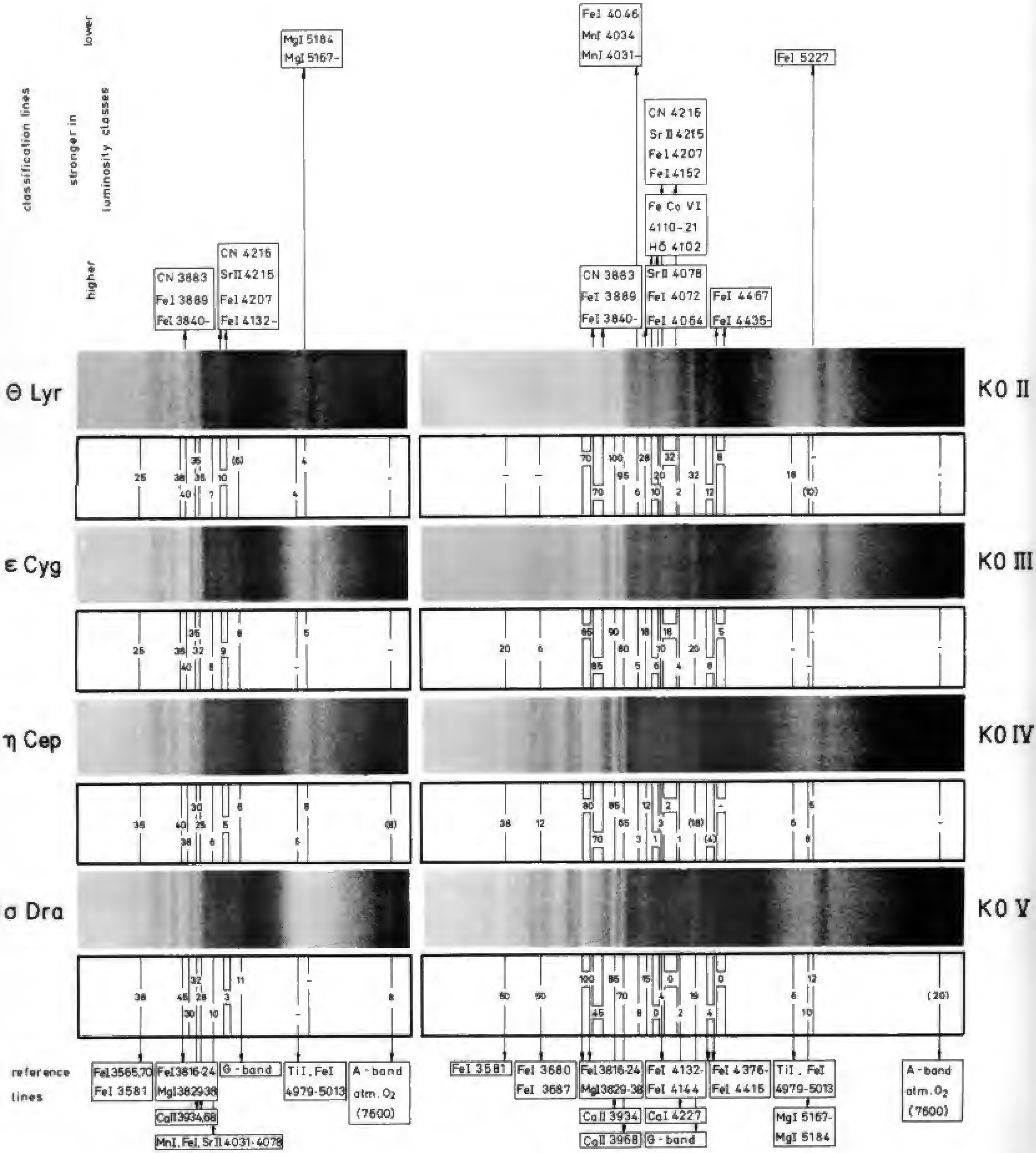
1. Stronger in higher luminosity classes: four blends as listed above.
2. Stronger in lower luminosity classes: Hδ 4102
3. Important ratios: (for wide blends take surface brightness)

FeI, MgI 3816-38 : FeI, CN 3840-89 = 1 in II and higher; > 1 in V, IV

FeI, SrII 4064-78 : FeI, SrII, CN 4132-4216 ≅ 1 in III; > 1 in V and IV; < 1 in II and Ib

FeI, SrII, CN 4132-4216 : G-band > 1 in II and higher; << 1 in V, IV
< 1 in III

4. Structural difference: at λ 4460 line-like feature in V, broader in higher classes.



Dispersion 1280 Å/mm at Hγ:

1. Stronger in higher classes: two blends as listed.

2. Important ratios:

FeI, MgI 3816 - 38 : FeI, CN 3840 - 89	< 1 in III and higher
	> 1 in V and (IV)
FeI, SrII, CN 4132 - 4216 : G - band	≅ 1 in III and IV
	> 1 in II and higher
	< 1 in V

or:

MnI, FeI, SrII 4031 - 78 (≥ ≅ ≤) FeI, SrII, CN 4132 - 4216 (≤ ≅ ≥) G - band

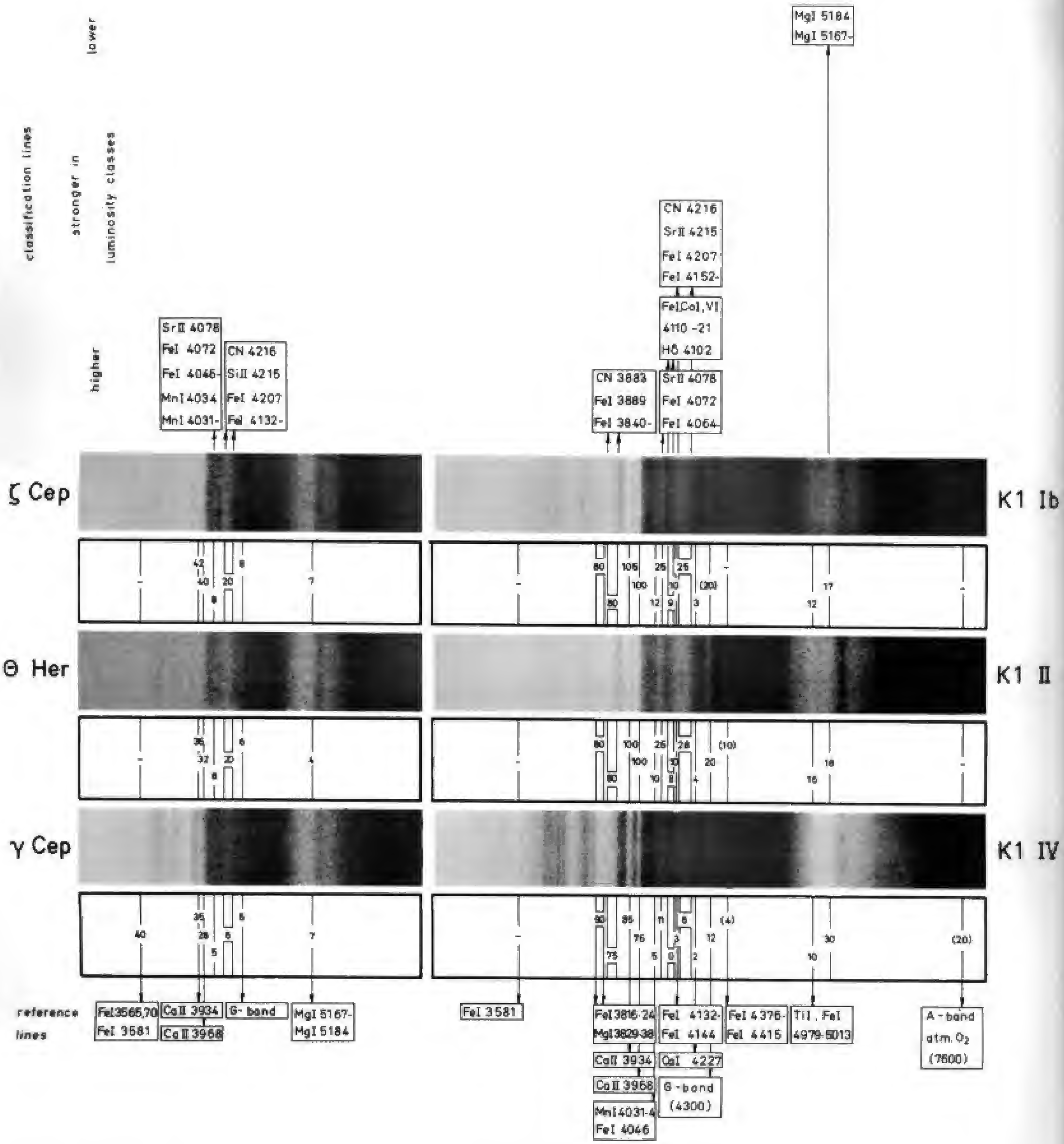
in V, VI and III, II and higher respectively.

Dispersion 645 Å/mm at Hγ:

1. Stronger in higher luminosity classes: four blends as listed above
2. Stronger in lower luminosity classes: four blends as listed above
3. Important ratios: (for wide blends take surface brightness)

FeI, MgI 3816 - 38 :	FeI, CN 3840 - 89	= 1 in III and higher > 1 in V and IV
FeI, MnI 4031 - 46 :	FeI, SrII 4064 - 78	< 1 in V ; << 1 in higher classes
FeI, SrII 4064 - 78 :	FeI, SrII, CN 4152 - 4207	≅ 1 in III and higher ; >> 1 in V and IV
FeI, SrII, CN 4152 - 4207 :	G - band	≅ 1 in III and II ; << 1 in V and IV

4. Structural difference: FeI 4132 - 4144 and CaI 4227 appear as lines in low absorption region in V and IV; strong smooth feature λ 4132 - 4227 in higher luminosity classes.



Dispersion 1280 Å/mm at Hγ:

1. Stronger in higher classes: two blends as listed
2. Important ratio:

in IV:

MnI, FeI, SrII 4031-78 ≅ FeI, SrII, CN 4132 - 4216
≅ G - band

in II and Ib:

MnI, FeI, SrII 4031-78 << FeI, SrII, CN 4132 - 4216
>> G - band

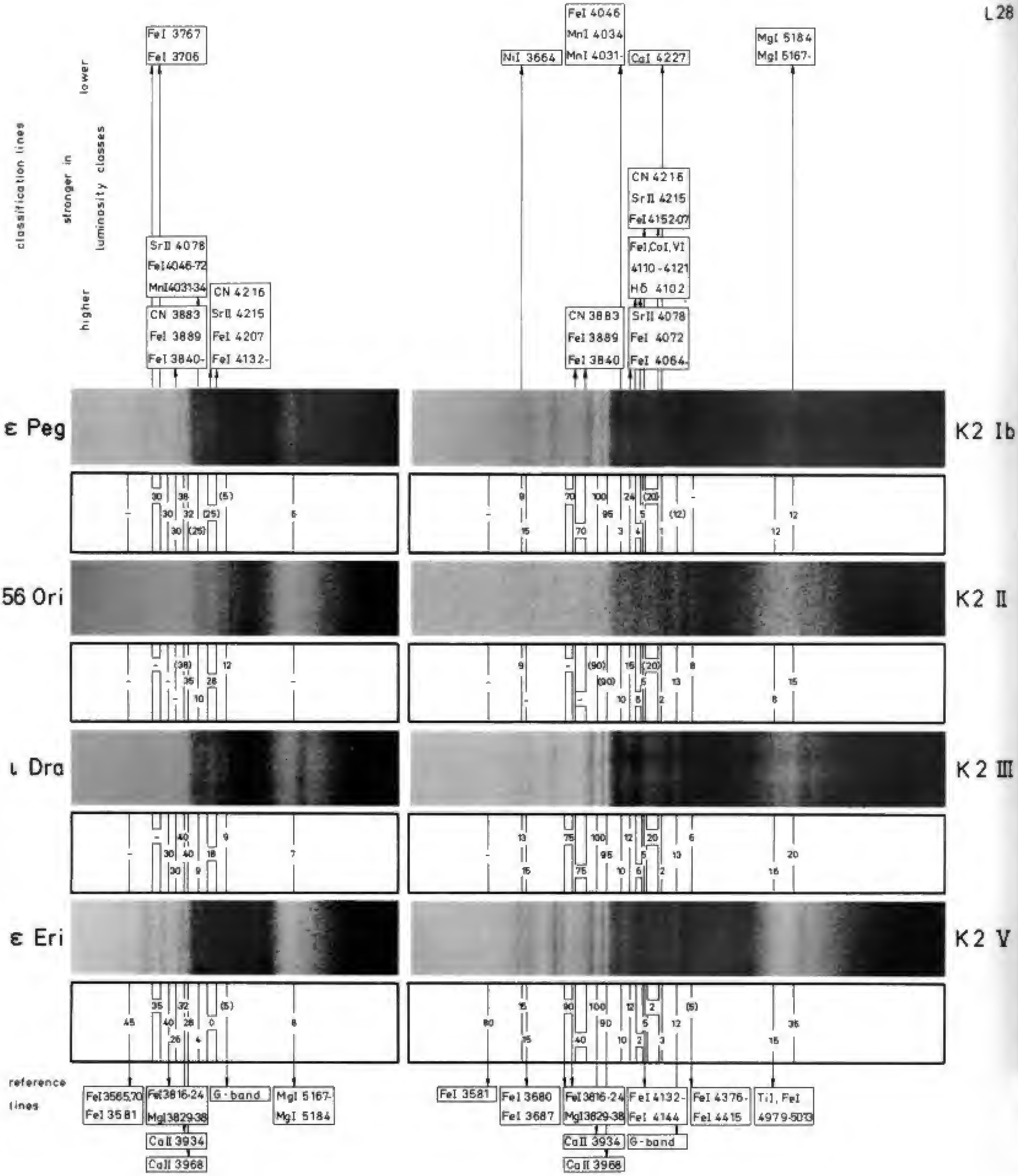
Dispersion 645 Å/mm at Hγ:

1. Stronger in higher luminosity classes: four blends as indicated above
2. Stronger in lower luminosity classes: MgI 5167 - 84
3. Important ratios: (for wide blends take surface brightness)

FeI, MgI 3816 - 38 : FeI, CN 3840 - 89 = 1 in II and Ib ; > 1 in IV

FeI, SrII 4064 - 78 : FeI, SrII, CN 4152 - 4216 ≅ 1 in II and Ib ; > 1 in IV

4. Structural difference: feature around Hδ stands out separately in IV.



Dispersion 1280 Å/mm at Hγ.

1. Stronger in higher classes: three blends as listed

2. Important ratios:

FeI, MgI 3816-38 : FeI, CN 3840-89

= 1 in III and higher, > 1 in V

MnI, FeI, SrII 4031-78 : FeI, SrII, CN 4132-4207

= 1 in Ib > 1 in V < 1 in II and III

3. Structural difference:

blend FeI 3706-67 wider in lower luminosity classes

Dispersion 645 Å/mm at Hγ:

1. Stronger in higher luminosity classes: four blends as listed above.

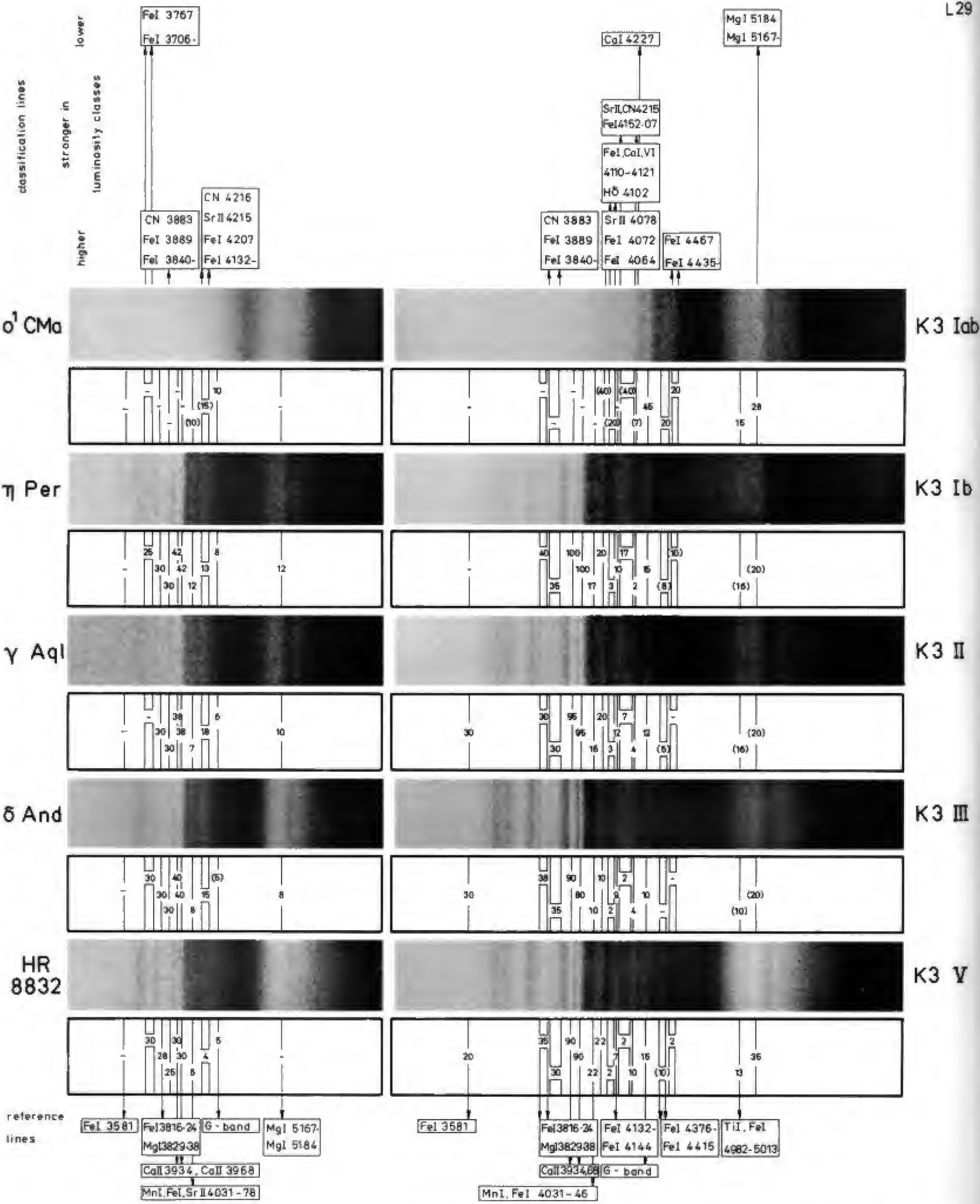
2. Stronger in lower luminosity classes: three features as listed above.

3. Important ratios: (for wide blends take surface brightness)

FeI, MgI 3816-38 : FeI, CN 3840-3889	= 1 in III and higher	> 1 in V
MnI, FeI 4031-46 : FeI, SrII 4064-78	≅ 1 in V and III	< 1 in II and Ib
MnI, FeI 4031-46 : FeI, SrII, CN 4152-4216	< 1 in III and higher	> 1 in V
FeI, SrII, CN 4152-4216 : G-band	> 1 in III and higher	< 1 in V

4. Structural differences: a) feature around Hδ stands out separately in lower classes

b) FeI 4132-44 and CaI 4227 appear as lines in low absorption region in V, strong smooth feature λ 4132-4227 in higher classes



Dispersion 1280 Å/mm at Hγ:

1. Stronger in higher classes: two features as listed.

2. Important ratio:

MnI, FeI, SrII 4031-78 : FeI, SrII, CN 4132-4216

< 1 in III and higher ; > 1 in V

3. Structural difference.

blend FeI 3706-67 noticeably wider in lower luminosity classes.

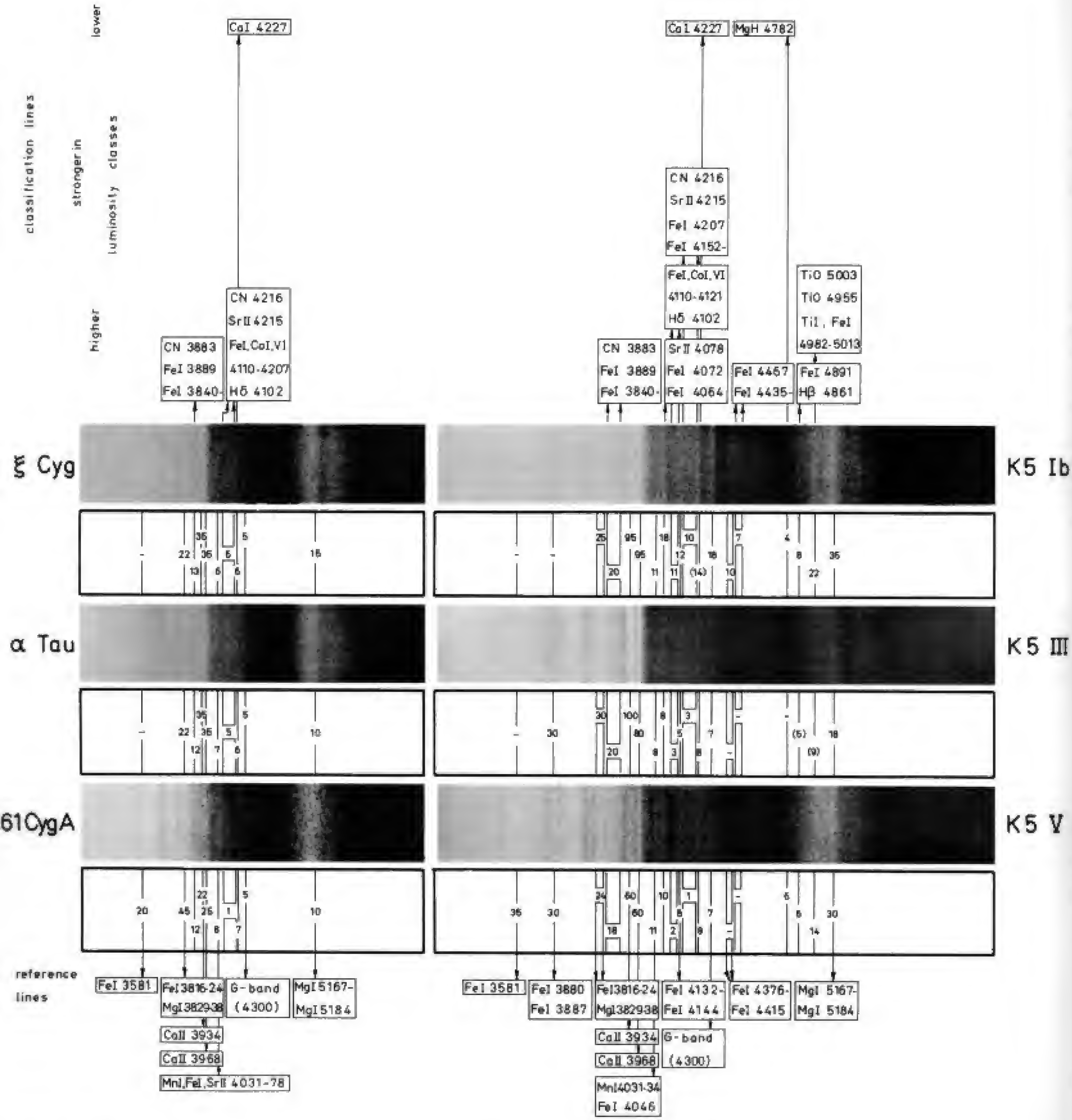
Dispersion 645 Å/mm at Hγ: Structural difference see L30 ; 4. a)

1. Stronger in higher luminosity classes: five blends as listed above.

2. Stronger in lower luminosity classes: two features as listed above.

3. Important ratios: (for wide blends take surface brightness)

MnI, FeI 4031-46 : FeI, SrII 4064-78	= 1 in V and III ; < 1 in II and supergiants
MnI, FeI 4031-46 : FeI, SrII, CN 4152-4215	= 1 in supergiants ; > 1 in II, III, V
FeI, SrII, CN 4152-4215 : CaI 4227	< 1 in V and III ; > 1 in II and supergiants
CaI 4227 : G - band	< 1 in V ; << 1 in III and higher

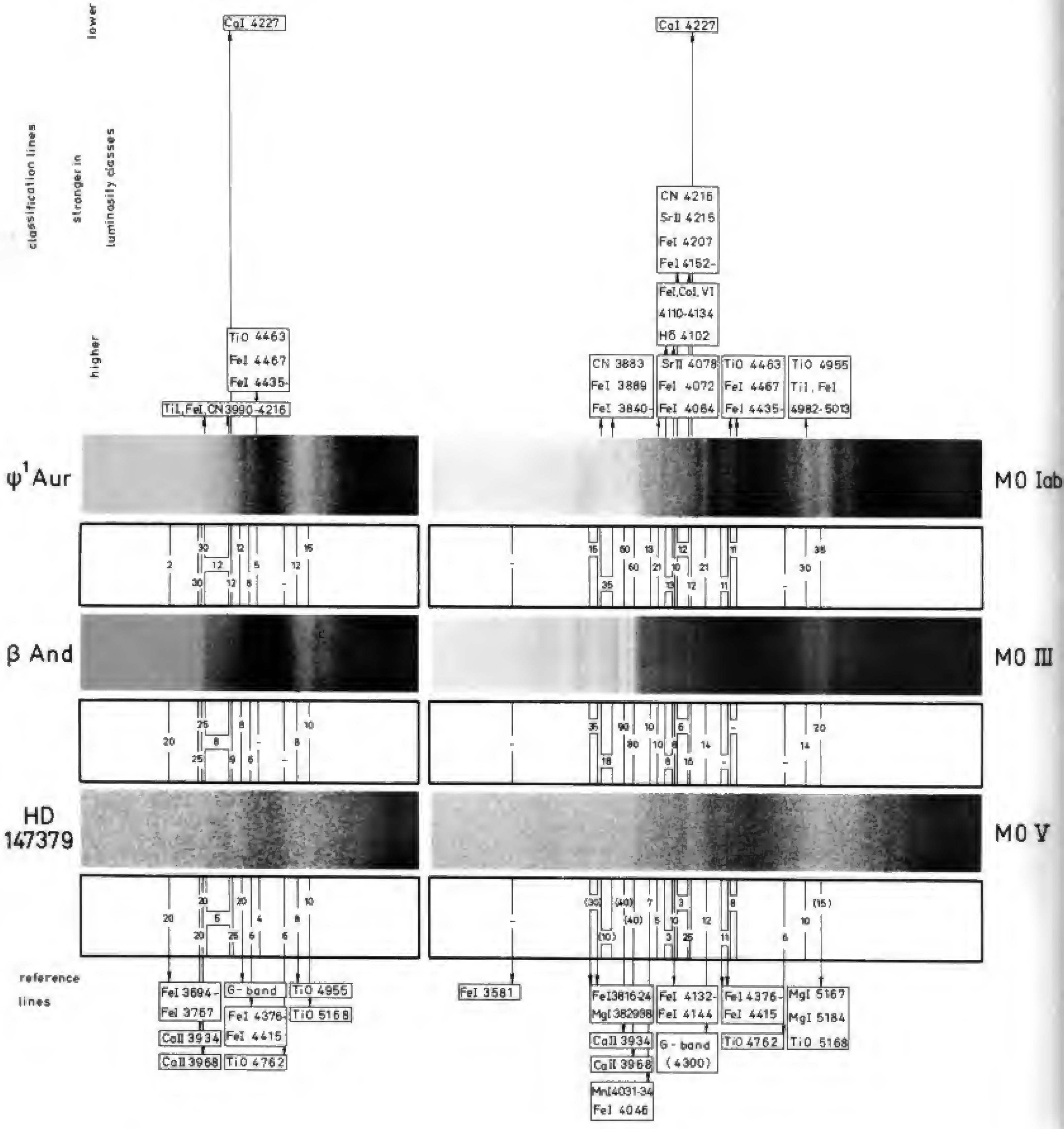


Dispersion 1280 Å/mm at Hγ:

1. Stronger in higher classes: two features as listed
2. Stronger in lower classes: CaI 4227
3. Important ratios:
   - Mn, FeI, SrII 4031 – 78 : Hδ ; FeI, CoI, VI, SrII, CN 4110 – 4216 = 1 in Ib ; > 1 in III and V
   - CaII 4227 : Hδ , FeI, CoI, VI, SrII, CN 4110 – 4216 = 1 in Ib ; > 1 in III and V
4. Structural differences: region CaII 3968 – G-band smoother in higher luminosity classes.

Dispersion 645 Å/mm at Hγ:

1. Stronger in higher luminosity classes : seven blends as listed above.
2. Stronger in lower luminosity classes : two features as listed above.
3. Important ratios: (for wide blends take surface brightness)
   - MnI, FeI 4031-46 : FeI, SrII 4064-78 = 1 in III ; > 1 in V ; < 1 in Ib
   - MnI, FeI 4031-46 : Hδ; FeI, CoI, VI 4110-21 ≅ 1 in Ib ; >> 1 in III and V
   - MnI, FeI 4031-46 : FeI, SrII, CN 4152-4216 ≅ 1 in Ib ; >> 1 in III and V
   - CaI 4227 : G-band < 1 in Ib ; > 1 in III and V
4. Structural differences : a) FeI 4132-44 and CaI 4227 appear as lines in low absorption region ; strong smooth feature between λ 4102 and λ 4227 in higher classes.
   b) Broader feature at λ 4982 – λ 5013 in higher luminosity classes.



Dispersion 1280 Å/mm at Hγ:

1. Stronger in higher classes: two features as listed
2. Stronger in lower classes: CaI 4227
3. Important ratios:

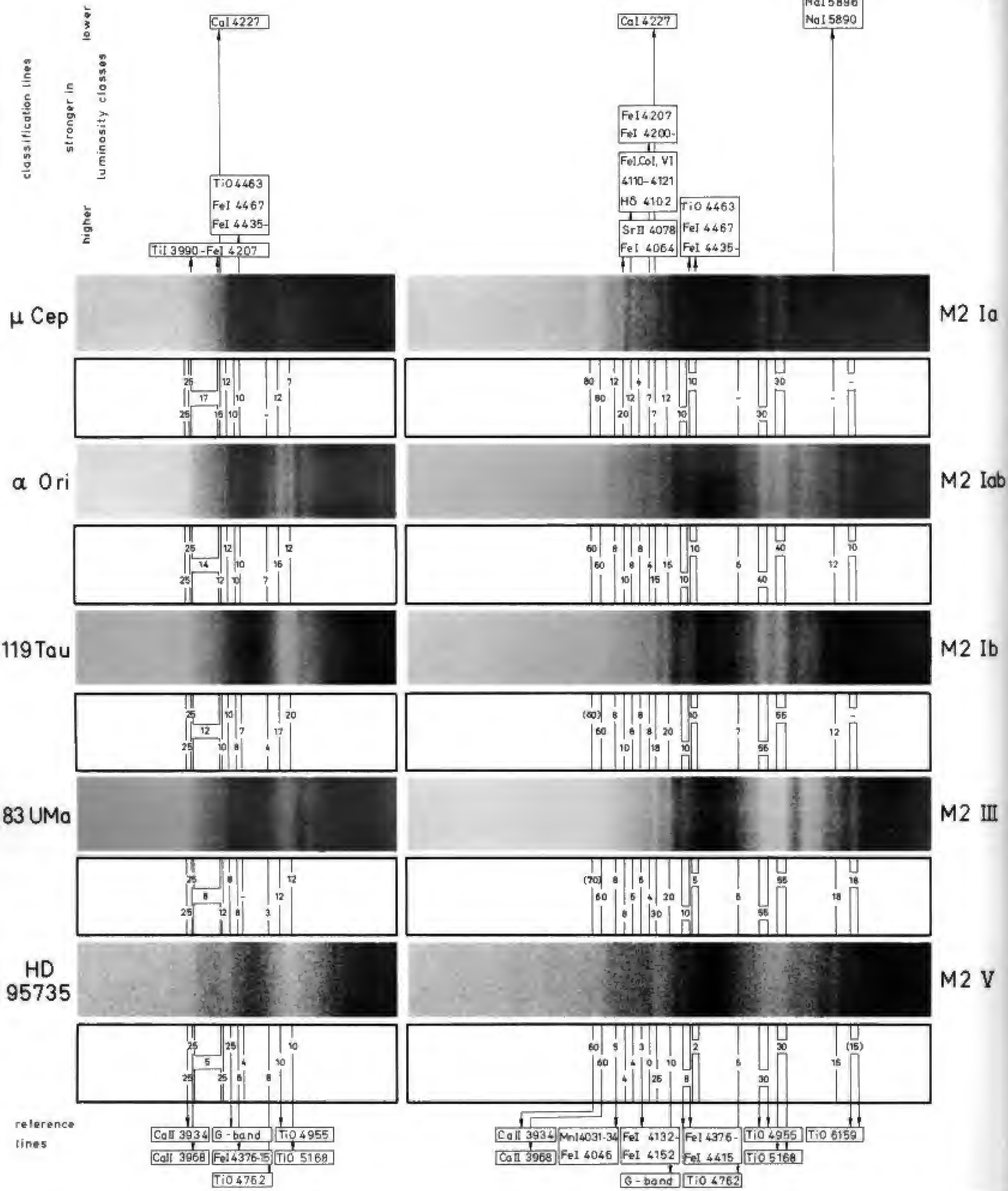
TiI, FeI, CN 3990 - 4216 : G-band	= 1	in Iab and III
	<< 1	in V
CaI 4227 : G-band	= 1	in Iab
	> 1	in III and V
CaII 3934, 68 : CaI 4227, G-band	≅ 1	in V
	> 1	in higher classes

Dispersion 645 Å/mm at Hγ:

1. Stronger in higher luminosity classes six blends as listed above
2. Stronger in lower luminosity classes: CaI 4227
3. Important ratios: (for wide blends take surface brightness)

FeI, MgI 3816-38 : FeI, CN 3840-83	< 1 in Iab ;	> 1 in III and V	
MnI, FeI 4031-46 : FeI, SrII 4064-78	= 1 in III ;	> 1 in V	< 1 in Iab
MnI, FeI 4031-46 : Hδ, FeI, CaI, VI, 4110-21	= 1 in Iab,	> 1 in III and V	
FeI, CaI, VI, SrII, CN 4152 - 4216 : G-band	< 1 in Iab	<< 1 in V and III	
CaI 4227 : G-band	< 1 in Iab	> 1 in III and V	
FeI 4376-4415 : FeI, TiO 4435-67	= 1 in Iab	> 1 in III and V	

4. Structural differences CaII 3968 - CaI 4227 smoother in higher luminosity classes. Broader feature at λ 4982 - λ 5013 in higher classes.



Dispersion 1280 Å/mm at Hγ:

1. Stronger in higher classes: two features as listed.

2. Stronger in lower classes: CaI 4227.

3. Important ratios:

TiI, FeI 3990 - 4207 : CaI 4227	> 1 in supergiants
	< 1 in V and III
Ca II 3934, 68 : CaI 4227, G-band	= 1 in V
	> 1 in higher classes

Dispersion 645 Å/mm at Hγ:

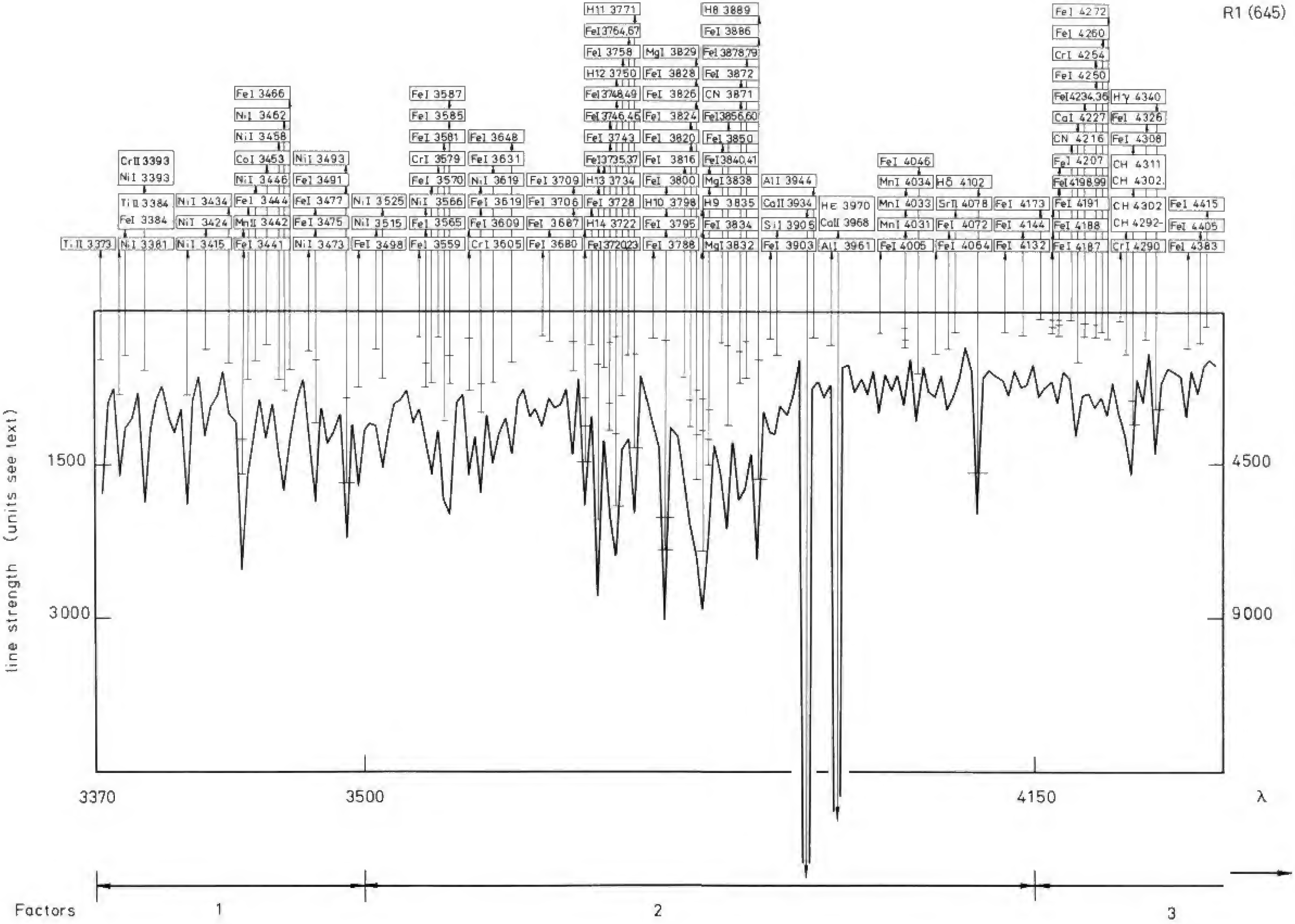
1. Stronger in higher luminosity classes - four features as indicated above

2. Stronger in lower luminosity classes: CaI 4227 and NaI 5890, 96

3. Important ratios:

MnI, FeI 4031 - 46 : FeI, SrII 4064 - 78	≳ 1 in V and III; < 1 in supergiants
Hδ; FeI, CaI, VI 4110 - 34 : FeI 4132 - 52	= 1 in Iab and Ib; > 1 in Ia; < 1 in III
FeI 4200 - 07 : CaI 4227	= 1 in Ia; < 1 in all other classes.
CaI 4227 : G - band	≃ 1 in Iab and Ib; < 1 in Ia > 1 in III and V.
FeI 4373 - 4415 . FeI, TiO 4435 - 67	= 1 in supergiants; > 1 in other classes.

R1 (645)



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Cr II 3393
Ni I 3393
Ti II 3384
Fe I 3384
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Ni I 3458
Co I 3453
Ni I 3446
Fe I 3444
Mn II 3442
Fe I 3441
Ni I 3493
Fe I 3491
Fe I 3477
Fe I 3475
Ni I 3473
Ni I 3525
Ni I 3515
Fe I 3498
Fe I 3587
Fe I 3585
Fe I 3581
Cr I 3579
Fe I 3570
Ni I 3566
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Fe I 3648
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Ni I 3619
Fe I 3619
Fe I 3609
Cr I 3605
Fe I 3709
Fe I 3706
Fe I 3687
Fe I 3680
H11 3771
Fe I 3764,67
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H12 3750
Fe I 3748,49
Fe I 3746,46
Fe I 3743
Fe I 3735,37
H13 3734
Fe I 3728
H14 3722
Fe I 3720,23
Mg I 3829
Fe I 3828
Fe I 3826
Fe I 3824
Fe I 3820
Fe I 3816
Fe I 3800
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Fe I 3795
Fe I 3788
H8 3889
Fe I 3886
Fe I 3878,79
Fe I 3872
CN 3871
Fe I 3856,60
Fe I 3850
Fe I 3840,41
Mg I 3838
H9 3835
Fe I 3834
Mg I 3832
Al I 3944
Ca II 3934
Si I 3905
Fe I 3903
H ε 3970
Ca II 3968
Al I 3961
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Mn I 4033
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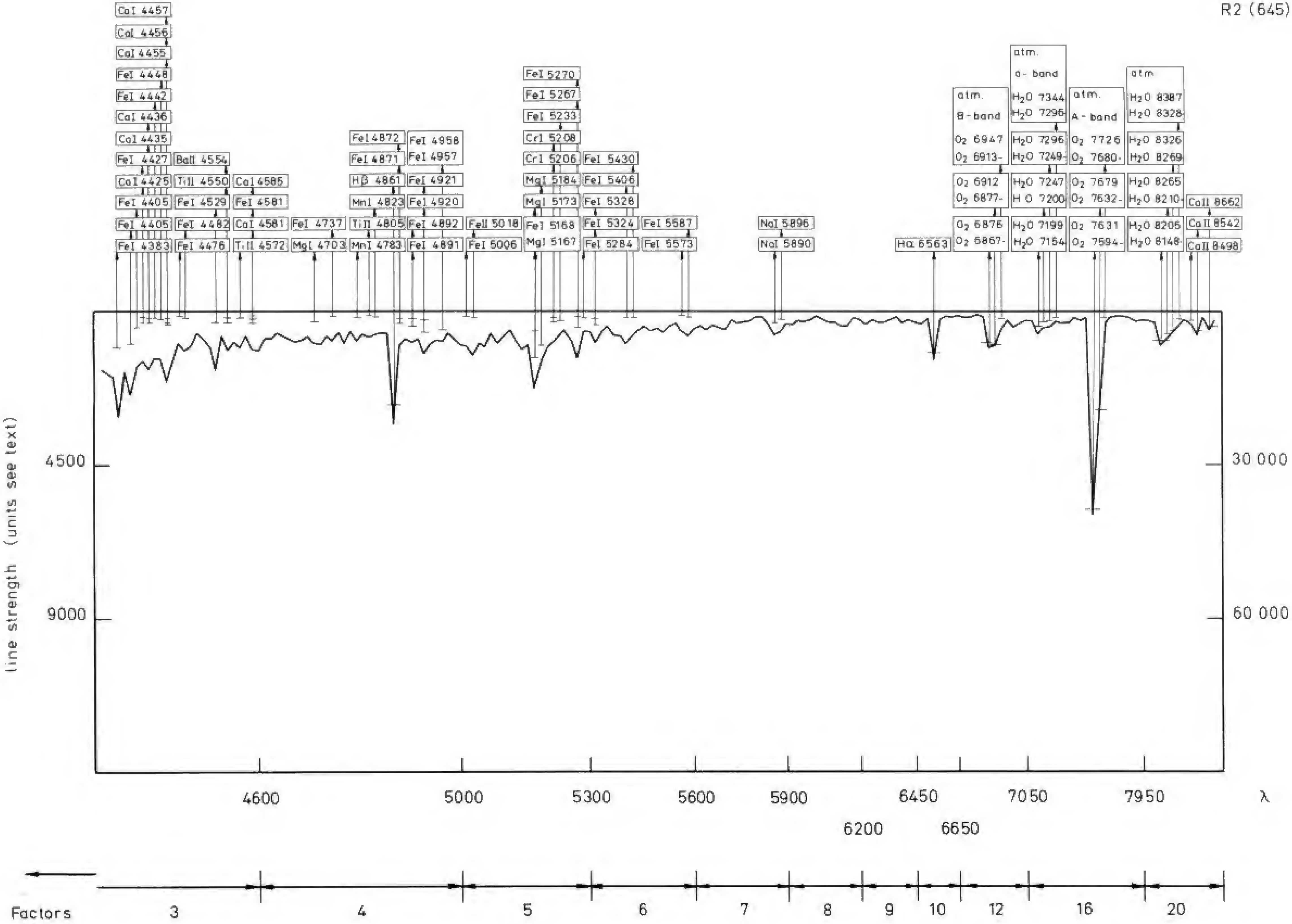
Fe I 4005
H δ 4102
Sr II 4078
Fe I 4072
Fe I 4064
Fe I 4173
Fe I 4144
Fe I 4132
Fe I 4272
Fe I 4260
Cr I 4254
Fe I 4250
Fe I 4234,36
Ca I 4227
CN 4216
Fe I 4207
Fe I 4198,99
Fe I 4191
Fe I 4188
Fe I 4187
H γ 4340
Fe I 4326
Fe I 4308
CH 4311
CH 4302
CH 4302
CH 4292
Cr I 4290
Fe I 4415
Fe I 4405
Fe I 4383
line strength (units see text)
1500
3000
4500
9000
3370
3500
4150
λ
Factors
1
2
3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CaI 4455
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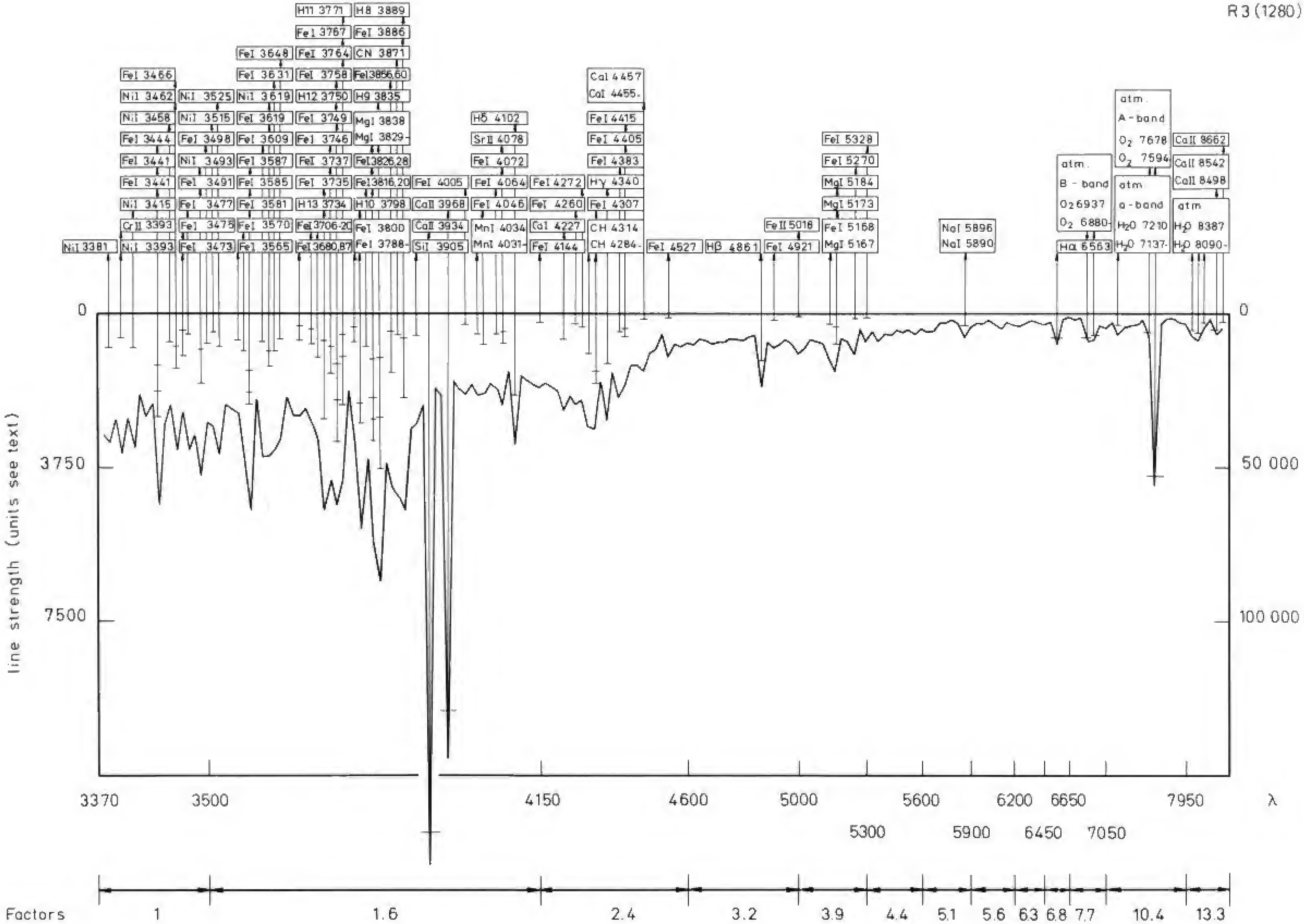
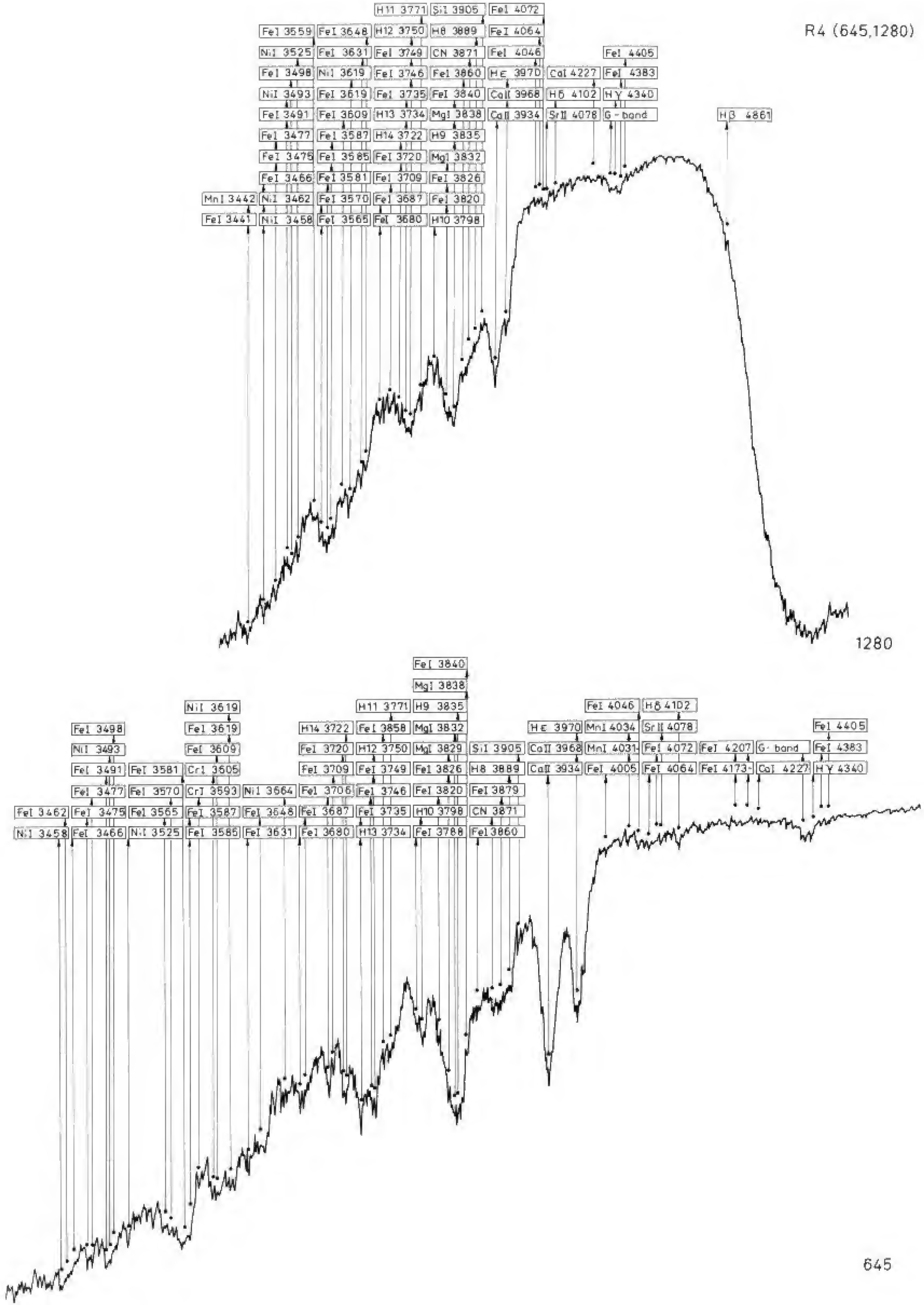
FeI 4383
BaII 4554
TiII 4550
FeI 4529
FeI 4482
FeI 4476
CaI 4585
FeI 4581
CaI 4581
TiII 4572
FeI 4737
MgI 4703
FeI 4872
FeI 4871
Hβ 4861
MnI 4823
TiII 4805
MnI 4783
FeI 4958
FeI 4957
FeI 4921
FeI 4920
FeI 4892
FeI 4891
FeII 5018
FeI 5006
FeI 5270
FeI 5267
FeI 5233
CrI 5208
CrI 5206
MgI 5184
MgI 5173
FeI 5168
MgI 5167
FeI 5430
FeI 5406
FeI 5328
FeI 5324
FeI 5284
FeI 5587
FeI 5573
NaI 5896
NaI 5890
Hα 6563
atm. B-band
O2 6947
O2 6913-
O2 6912
O2 6877-
O2 6876
O2 6867-
atm. a-band
H2O 7344
H2O 7296
H2O 7296
H2O 7249-
H2O 7247
H O 7200
H2O 7199
H2O 7154
atm. A-band
O2 7726
O2 7680-
O2 7679
O2 7632-
O2 7631
O2 7594-
atm
H2O 8387
H2O 8328-
H2O 8326
H2O 8269
H2O 8265
H2O 8210-
H2O 8205
H2O 8148-
CaII 8662
CaII 8542
CaII 8498
line strength (units see text)
4500
9000
30 000
60 000
4600
5000
5300
5600
5900
6200
6450
6650
7050
7950
λ
Factors
3
4
5
6
7
8
9
10
12
16
20

R 3 (1280)



NiI 3381
FeI 3466
NiI 3462
NiI 3458
FeI 3444
FeI 3441
FeI 3441
NiI 3415
CrII 3393
NiI 3393
NiI 3525
NiI 3515
FeI 3498
NiI 3493
FeI 3491
FeI 3477
FeI 3475
FeI 3473
FeI 3648
FeI 3631
NiI 3619
FeI 3619
FeI 3609
FeI 3587
FeI 3585
FeI 3581
FeI 3570
FeI 3565
H11 3771
FeI 3767
FeI 3764
FeI 3758
H12 3750
FeI 3749
FeI 3746
FeI 3737
FeI 3735
H13 3734
FeI 3706-20
FeI 3680,87
H8 3889
FeI 3886
CN 3871
FeI 3856,60
H9 3835
MgI 3838
MgI 3829
FeI 3826,28
FeI 3816,20
H10 3798
FeI 3800
FeI 3788
FeI 4005
CaII 3968
CaII 3934
SiI 3905
Hδ 4102
SrII 4078
FeI 4072
FeI 4064
FeI 4046
MnI 4034
MnI 4031
FeI 4272
FeI 4260
CaI 4227
FeI 4144
CaI 4457
CaI 4455
FeI 4415
FeI 4405
FeI 4383
Hγ 4340
FeI 4307
CH 4314
CH 4284
FeI 4527
Hβ 4861
FeII 5018
FeI 4921
FeI 5328
FeI 5270
MgI 5184
MgI 5173
FeI 5168
MgI 5167
NaI 5896
NaI 5890
atm.
B - band
O_2 6937
O_2 6880
Hα 6563
atm.
A - band
O_2 7678
O_2 7594
atm.
a - band
H_2O 7210
H_2O 7137
CaII 8662
CaII 8542
CaII 8498
atm
H_2O 8387
H_2O 8090
0
3750
7500
0
50 000
100 000
line strength (units see text)
3370
3500
4150
4600
5000
5600
6200
6650
7950
λ
5300
5900
6450
7050
Factors
1
1.6
2.4
3.2
3.9
4.4
5.1
5.6
6.3
6.8
7.7
10.4
13.3


R4 (645,1280)
H11 3771
SiI 3905
FeI 4072
FeI 3559
FeI 3648
H12 3750
H8 3889
FeI 4064
NiI 3525
FeI 3631
FeI 3749
CN 3871
FeI 4046
FeI 4405
FeI 3498
NiI 3619
FeI 3746
FeI 3860
H ε 3970
CaI 4227
FeI 4383
NiI 3493
FeI 3619
FeI 3735
FeI 3840
CaII 3968
H δ 4102
H γ 4340
FeI 3491
FeI 3609
H13 3734
MgI 3838
CaII 3934
SrII 4078
G - band
H β 4861
FeI 3477
FeI 3587
H14 3722
H9 3835
FeI 3475
FeI 3585
FeI 3720
MgI 3832
FeI 3466
FeI 3581
FeI 3709
FeI 3826
MnI 3442
NiI 3462
FeI 3570
FeI 3687
FeI 3820
FeI 3441
NiI 3458
FeI 3565
FeI 3680
H10 3798
1280
FeI 3840
MgI 3838
NiI 3619
H11 3771
H9 3835
FeI 4046
H δ 4102
FeI 3498
FeI 3619
H14 3722
FeI 3858
MgI 3832
H ε 3970
MnI 4034
SrII 4078
FeI 4405
NiI 3493
FeI 3609
FeI 3720
H12 3750
MgI 3829
SiI 3905
CaII 3968
MnI 4031
FeI 4072
FeI 4207
G - band
FeI 4383
FeI 3491
FeI 3581
CrI 3605
FeI 3709
FeI 3749
FeI 3826
H8 3889
CaII 3934
FeI 4005
FeI 4064
FeI 4173
CaI 4227
H γ 4340
FeI 3477
FeI 3570
CrI 3593
NiI 3664
FeI 3706
FeI 3746
FeI 3820
FeI 3879
FeI 3462
FeI 3475
FeI 3565
FeI 3587
FeI 3648
FeI 3687
FeI 3735
H10 3798
CN 3871
NiI 3458
FeI 3466
NiI 3525
FeI 3585
FeI 3631
FeI 3680
H13 3734
FeI 3788
FeI 3860
645

CONCISE LIST OF SPECTRAL CRITERIA FOR DISPERSION 645 Å/mm AT Hγ

O9 - B5

The spectral pattern is dominated by the Balmer series of hydrogen and - to a lesser degree - by lines of neutral helium.

1. BALMER LINES

   H-lines medium strong; slightly *increasing* with *advancing* spectral type, *decreasing* with *increasing* luminosity class (for blends see 3. and 5.).

2. BALMER DISCONTINUITY

   Strong UV continuum in O9 - B2 (in the absence of interstellar reddening); Balmer discontinuity begins to show at B3 in *high* luminosity classes.

3. NEUTRAL HELIUM

   Increasing strength of He I lines (especially of diffuse triplets HeI 4471, HeI 4026, HeI 3820) towards maximum at B2 - B3, fairly rapid *decline* to B5. Noticeable *enhancement* of H16 by HeI 3705 in O9 - B2, especially in *lower* luminosity classes.

4. IONIZED HELIUM

   He II strongly *decreasing* from O9 to B1, absent in later types.

5. IONIZED LIGHT METALS

   SiIV 4089 and SiIV 4116 + HeI 4121 (slightly blended with Hδ) present in O9 - B2; *increasingly* stronger in *higher* luminosity classes.
   CIII,OII,NIII 4650 noticeable in O9 - B0.5, marginal in B1 - B3, absent in later types.

B5 - A0

The spectral pattern is dominated by the Balmer series of hydrogen and the Balmer discontinuity.

1. BALMER LINES

   Noticeably *increasing* strength and *width* of Balmer lines with *advancing* type; *decreasing* strength and width with *increasing* luminosity class.
   Faster *decline* of higher members of Balmer series with *advancing* spectral type and *decreasing* luminosity class.

2. BALMER DISCONTINUITY

   Noticeable Balmer discontinuity, *increasing* with *advancing* spectral type; located at *longer* wavelengths, showing more *gradual* decline in *lower* classes; looks more *abrupt* in *higher* luminosity classes.

3. NEUTRAL HELIUM

   Disappearance of He I at B7 in luminosity class V, at B9 in class Ia. In later types He I replaced by metallic absorptions MnI 4031-4034, FeI 4385, MgII 4481.

4. IONIZED CALCIUM H AND K

   Weak stellar Ca II (K) at about B8 where it is difficult to separate from interstellar Ca II ; in earlier types distinguished through broad blend with HeI 3926, in later types stronger than interstellar lines. CaII (H) blended with Hε .

5. IONIZED METALS

   Metallic lines (especially of Fe II , Ti II , Si II) weakly present in late B-type stars of class V; noticeably *stronger* in *higher* luminosity classes.

A0 - F0

The spectral pattern is dominated by the Balmer series of hydrogen, the Balmer discontinuity and the Ca II (K) line; in higher luminosity classes by increasingly stronger lines of ionized metals.

1. BALMER LINES

   Slight *decrease* of H-line strengths between A0 and F0.

2. BALMER DISCONTINUITY

   Strong Balmer discontinuity occurs at *longer* wavelengths in *lower* luminosity classes; looks more *abrupt* in *higher* luminosity classes.

3. IONIZED CALCIUM H AND K

   Increasing strength of CaII (K) with *advancing* spectral type. CaII (H) blended with H_ϵ with *noticeable* contribution to total absorption in *later* spectral types and *higher* luminosity classes.
   Strength of CaII (K) = CaII (H) + $H\epsilon$ at A8 in class Ia, at F6 in class V.

4. G - BAND

   Fairly strong G-band at about F0 and later in luminosity class V, at A5 and later in class Ia.

5. METALS

   Strength of metallic lines *slowly* increasing with *advancing* spectral type in *lower* luminosity classes. MgI 3829-3838 contribution to H9 increasingly stronger in *later* spectral types and *higher* luminosity classes. Lines and blends of ionized metals *strong* in *high* luminosity classes, especially FeII 4173-4179 and TiII 3758,3761.

F0 - G0

The spectral pattern is dominated by the Ca II (H) and (K) lines, the Balmer lines of hydrogen or blends of hydrogen lines with metallic lines, and the G-band.

1. BALMER LINES

   H-line pattern in the UV replaced by metallic line pattern between F0 and G0; *decreasing* strength of unblended H-lines with *advancing* spectral type.

2. BALMER DISCONTINUITY

   Balmer discontinuity noticed on well-exposed spectra of early F-type stars.

3. IONIZED CALCIUM H AND K

   Increasing strength of Ca II lines with *advancing* spectral type.
   Ca II lines very *broad* in supergiants later than type F6.

4. G - BAND

   G-band *increasingly* stronger with *advancing* spectral type; strength comparable to $H\gamma$ in F6 - F7 of luminosity class V, F2 - F8 in class Ia.

5. METALS

   Lines of neutral metals *increasingly* stronger with *advancing* spectral type, noticeably in the UV around FeI 3581, FeI 3609-3648, FeI 3735 and MgI 3829-38. At G0 sudden appearance of broad absorption band shortward of CaII (K) in *high* luminosity classes, largely due to CN band absorption - abundance effects possible.
   Increasingly stronger blends of neutral metallic lines redward of CaII (H) in *high* luminosity classes, enhanced absorption at G0 partly due to CN band contribution - abundance effects possible.
   Green blends, around λ 5000 and near MgI 5167 - 5184 clearly visible in *later* spectral types and *higher* luminosity classes.

G0 - K0

The spectral pattern is dominated by the Ca II (H) and (K) lines; in the BLUE part of the spectrum by the G-band and a strong and broad metallic blend shortward of Hδ - in higher luminosity classes also by strong absorptions in the region λ 4118-4216; in the ULTRAVIOLET by three strong metallic blend regions.

1. BALMER LINES

H-lines *decreasing* with *advancing* spectral type; disappearance around K0.

2. IONIZED CALCIUM H AND K

Ca II lines *increasingly* stronger and broader with *advancing* spectral type and *increasing* luminosity class. CaII (K) stronger and broader than CaII (H) in all types of *lower* luminosity classes.

3. G - BAND

G-band strong in all types - very much stronger than Hγ ; appears generally *increased* in *high* luminosity classes.

4. METALS

BLUE

Broad absorptions between λ 4118 and 4216, *marginal* in luminosity class V, *increasingly* stronger with *increasing* luminosity class and *advancing* spectral type, partly due to CN contribution - subject to abundance effects.
Neighbouring CaI 4227 weakly present.
Blend MnI, FeI, SrII 4031-4078 *increasingly* stronger with *advancing* spectral type; dominating feature in the blue spectral region of stars later than G5 and luminosity classes V and IV.

UV

ABSORPTION REGION I : Broad blend shortward of CaII (K) *increasingly* stronger with *advancing* spectral type and *increasing* luminosity class, largely due to CN contribution - subject to abundance effects. Prominent blend around MgI 3829-3838 strongly *increasing* towards *later* types. The two features attain equal strength in high luminosity classes.
ABSORPTION REGION II : Absorption around and including FeI 3735 *increasingly* stronger with *advancing* spectral type.
ABSORPTION REGION III: Blend around FeI 3581 and blend FeI 3609-3648 *increasingly* stronger with *advancing* spectral type.

K0 - M2

The spectral pattern is dominated by the Ca II (H) and (K) lines, Ca I 4227, the G-band, and strong and broad metallic blends; in M-type stars by TiO bands.

1. IONIZED CALCIUM H AND K

Extremely strong and broad H and K lines + contributing neighbours.

2. NEUTRAL CALCIUM 4227

Rapid *increase* of CaI 4227 with *advancing* spectral type, especially in class V. Dominating feature in M0 V - M2 V, where it is stronger than the G-band.

3. G - BAND

Strong in all types; strength equal to CaI 4227 around K5 in luminosity class V, *stronger* than CaI 4227 in all types of highest luminosity classes.

4. METALS

In latest types strong blends of metallic lines in all spectral regions.

5. TITANIUM OXIDE BANDS

TiO bands appear longward of λ 4100 around M0 and *increase* towards *later* types.

7046

ÜMMLER


Seitter / Bonner Spektral-Atlas I
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Seitter / Bonner Spectral Atlas II
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