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A study of visual double stars with early type primaries. I. Spectroscopic results (*)

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Summary. — Information on spectral classes for 486 stars in 254 visual doublet or multiplet systems with O or B type primaries is presented together with information on various spectral peculiarities found. It is demonstrated that the material contains a substantial fraction of secondaries that are likely to be physical and that several of these may be in their pre-main-sequence phase of stellar evolution or have reached the ZAMS.

Key words : visual double stars — early stellar evolution.

1. **Introduction.** — The present article is the first in a series dealing with visual double and multiple stars with primaries of spectral types O or B. The systems have been studied both spectroscopically and photometrically and special attention has been given to systems where the secondaries are fainter and of later spectral types than the primaries.

The program stars were selected from the Index Catalogue of Visual Double Stars (Jeffers *et al.*, 1963) abbreviated IDS and the updated version on magnetic tape as provided by Dr. Worley at the U.S. Naval Observatory, Washington. Special attention was given to systems for which binary motion or common proper motion have been reported. The selected systems have separations between the individual components ranging as a rule from 2″ to 60″.

One of the goals of this investigation has been to provide information on spectral classes, magnitudes and colours of the components in a large sample of double and multiple systems. From this information, together with information on radial velocities and tangential motions of the individual components we discuss the probability that a given system is physical or optical. Those systems that are likely to be physical are then studied in more detail.

From the Strömgren system of *uvbyβ*-photometry of the primaries, their age is determined through calibrations over stellar model computations. A reasonable assumption is that the components in physical systems are of the same age. Hence, the age and the observed position in the HR-diagram of the secondary components can be compared with predictions from theoretical model computations (evolutionary tracks).

(*) Based on observations collected at the European Southern Observatory.

The selection of objects is such that if a given system is physical then the probability that the fainter secondaries are contracting pre-main-sequence stars or stars on the ZAMS is large. *The main purpose of this investigation has been to isolate a group of very young stars in order to study characteristics of early stellar evolution.* Previous investigations of this type have been concerned about the properties of very young stellar clusters or associations. Such systems have a large spread in age among their members. It was therefore thought that studies of young double stars may open an alternative way when comparing observed and predicted properties of very young stars. In this context the question of interchange between the primaries and the secondaries must be considered. Since the selected systems have rather large separations between their components it could be expected that after the fragmentation of the primordial cloud the evolution of the stars proceeds independently. Hot primaries may, however, influence the atmospheres of cool secondaries through radiation.

Systems with early-type primaries have been subject to several spectroscopic and photometric investigations. Some of these involve systems with secondaries of late spectral type. The most extensive survey of such systems is that by Murphy (1969) who determined spectral types for 20 secondaries of late type. Several of these were noted to be peculiar in the sense that the CaII H and K lines were in emission or that the absorption lines of hydrogen were too strong for the spectral type as determined from metallic lines. These features may indicate that such secondaries have a higher degree of chromospheric activity than is normal. Since this is also a characteristic feature of pre-main-sequence stars there is the indication that if a sufficiently large number of systems of this kind is observed a certain fraction of the secondaries may be in early stages of stellar evolution. In that case one would expect the late-type secondaries to have surface lithium abundances close to the interstellar value. This expectation is based on the fact that recognized pre-main-sequence objects do have large abundances of Li (see e.g. Herbig, 1977). A few secondaries have been observed for Li and we note that for ADS 10993 for which Batten (1966) assigned spectral types A3 (primary) and gG3 (secondary), Wallerstein found a very strong absorption line of Li at λ 6707 Å for the secondary indicative of a high abundance of Li. Furthermore, Catchpole (1971) found a high Li abundance ($[N_{\rm Li}] = +2.8$) for HD 113703B, which is a K0 V star with CaII H and K in emission. If this system with a B5 V primary is physical, then the secondary is above the main sequence. One other secondary, α Leo B also a K0 V star, has been observed for Li by Wallerstein (1966) who found no trace of the Li absorption line.

Of other spectroscopic surveys one can mention those by Bouige (1974), Levato (1975) and Lutz and Lutz (1977) where no special spectral peculiarities were noted. In the photometric survey by Mechler (1976), the secondary of the system HD 46401/386 (both A3 stars) was suspected to be contracting towards the main sequence.

In the present paper we give information on MK spectral classes for the primaries and secondaries in 254 systems. The majority of these systems were observed photometrically and/or spectroscopically by us. In addition we provide information on systems where at least two components in each system have been observed photometrically by others. The photometric properties of the stars are presented in the subsequent article by Lindroos (1983, paper II). Preliminary radial velocities have been measured for several program stars and have been published by Gahm (1982, paper III). This whole material provides the basis for the discussion on the properties of the stars in relation to current ideas of early stellar evolution. This discussion will appear as paper IV where we will give a detailed definition on which secondaries may be regarded as physical and which may not. Some of the results have already been discussed in a thesis by Lindroos (1981).

2. **The spectroscopic observations.** — Most of the observations were carried out with the 1.52 m reflector at ESO, La Silla, Chile. Additional observations were collected at l'Observatoire de Haute Provence (OHP), France. The details of the observations and the instruments used are given in table I. As a rule the secondaries were first observed at Cassegrain focus with an image intensifier attached to a Boller and Chivens spectrograph (BC). Those secondaries that were found to be of late spectral type were then observed at coudé focus if they were sufficiently bright. In addition, the primaries and some relatively bright secondaries were observed at coudé. For a few stars additional spectroscopic information was obtained through observations at the 3.6 m telescope with the Image Dissector Scanner (dispersion being 29 Å/mm-blue) and with the Reticon (dispersion 60 Å/mm-red).

The spectrograms cover the blue spectral region from λ 3700 Å to λ 4900 Å. During the period Dec. 19, 1979 to Jan. 1, 1980 spectrograms covering the red spectral region from λ 6450 Å to λ 7050 Å were obtained. These spectrograms were used to check selected program stars for the presence of Hα emission and for the degree of absorption of Li I at λ 6708 Å. A few red spectrograms were obtained in May 82 with the Reticon (RET).

A few additional spectrograms, not presented in table I, were obtained over the whole period with image tubes of type Varo or Carnegie connected to the Boller and Chivens spectrograph of the 1 m reflector of the Stockholm Observatory, the dispersion being typically 55 Å/mm.

The coudé plates provide a rather homogeneous spectroscopic material. Since baked (B) Kodak IIa-O plates were used at the beginning of this program we have used them throughout the program. The image tube spectrograms, on the other hand, are not so homogeneous due to the fact that different tubes were made available over the period. For the main body of the image tube material, the dispersions used are similar however.

From this material of spectroscopic plates we have determined MK classes for the stars. It it obvious, that since the equipment and dispersions used are different from period to period this is not an easy task. For the coudé material a number of MK standards were observed. For the image tube material a number of fainter stars for which spectral classes seemed to be well established were observed. In addition, some brighter standards were observed at similar dispersions at the Stockholm Observatory. Also, there is a certain overlap between the coudé material and the image tube material.

The MK classes for the program stars were obtained by comparing with spectrograms of standard stars and by using the MK atlases by Morgan *et al.* (1943), Keenan and McNeil (1977), Yamashita *et al.* (1978), Morgan *et al.* (1978) and Fehrenbach (1978).

For many stars which were observed only at low dispersion with image tube it has been difficult to make any precise statements about the luminosity class. Lindroos (1981) concluded that the MK classes derived from the spectroscopic material are in good agreement with those derived from the photometric material.

Most coudé spectrograms were measured for radial velocity using the Grant oscilloscope measuring machine of ESO, the intention being to check whether two components in a given system have the same radial velocity. These measurements are published separately by Gahm (1982).

The results are presented in table II. In this table we give information on those systems for which at least one component has been observed spectroscopically or photometrically by us or for which at least two components have been observed photometrically by others. Only those components for which MK class or photometric magnitudes are available enter the table. In other words, if such information exists only for components A and C and not for B in a given system, then the table includes only A and C.

Column 1 : HD number. For other designations see Lindroos (1983).

Column 2 : Component. Each component of a system has one entry.

Column 3 : Separation in seconds of arc as taken, and in a few cases averaged, from the IDS. The separation is given relative to component A. Separations indicated by an asterisk were measured by us. The symbols following the number are B : the component has been reported to be in binary motion with component A ; SB : the component is a spectroscopic binary ; SD : the component is a spectroscopic double star ; OP : the component has been reported to be optical ; E : the component is an eclipsing binary. In Lindroos' thesis (Lindroos, 1981) it was demonstrated that the majority of the components are optical. These results will be discussed in a subsequent paper of this series ; C : the component has common proper motion with A. A system is considered to have common proper motion if the position angle and separation is constant over more than 50 years according to the IDS or if the system has been noted to have common proper motion or fixed separation by Hoffleit (1964).

Column 4 : *V* magnitude given with two decimals if derived from photoelectric photometry (Lindroos, 1983) and with one decimal if based on estimates of the magnitude as given in the IDS. When the photometric value includes more than one component, say A and B, this is indicated by an asterisk following the value.

Column 5 : Published MK classes as compiled by Jaschek *et al.* (1964), Kennedy and Buscombe (1974) and Buscombe (1977, 1980, 1981), without parenthesis, or as derived by Levato (1975), indicated by 1 in the accompanying parenthesis, or by Houk and Cowley (1975) and Houk (1978), indicated by 2 in the parenthesis, or by Abt (1981), indicated by 3 in the parenthesis. For one star the MK class was taken from Hube (1970), indicated by 4 in the parenthesis. A few stars for which no MK class exists enter with spectral type according to the HD catalogue, indicated by 5 in the parenthesis. The stars with an H following the MK class are those for which Murphy (1969) found anomalously strong hydrogen lines for the spectral type.

It is to be noted that behind one MK class given without parenthesis there may be several individual classifications.

Column 6 : MK class as derived from the present spectroscopic material. Those stars for which coudé plates were taken are indicated with an asterisk. For many stars several spectrograms were taken and in many cases both image tube and coudé spectrograms are available. If certain spectral peculiarities like emission lines or anomalously broad and shallow absorption lines were noted, the MK class is followed by a PEC and the type of peculiarity is given in column 7. Those stars for which spectrograms covering the red spectral region were taken are indicated by (R).

Column 7 : Notes on individual stars. Here the following symbols have been used :

E (spectral lines) — The lines indicated in the parenthesis are in emission.

ABGD refer to Hydrogen $\alpha\beta\gamma$ and δ. H and K refer to CaII H and K.

RV — Radial velocity determined by Gahm (1982).

RV* — Radial velocity compiled by Abt and Biggs (1972) or by Evans (microfiche version of the table described by Evans, 1967).

RV : E, RV : D — The radial velocity of a secondary component is equal, respectively different, from that of the primary component to within twice the estimated errors of the measurements.

LI : S, LI : W — According to red spectrograms the Li I absorption line at λ 6708 Å is strong, respectively weak or absent. The Li I line is considered to be strong if it is comparable in strength or stronger than CaI absorption line at λ 6572 Å.

DIFF — The metallic lines are unusually broad and shallow indicative of a large value of $v \sin i$.

K — The CaII K absorption line is much too strong for the spectral type as indicated by the hydrogen and/or helium lines.

NEB — Nebular emission lines from hydrogen and [OII] are superimposed on the stellar spectrum.

A number in column 7 refers to the notes following the table.

3. **Discussion.** — In the present study spectroscopic information on 486 stars in 254 systems was obtained. In the following we will consider the spectroscopic results obtained for the 213 secondary components observed by us. Their distribution over spectral type is shown in table III. Most secondaries are of luminosity class IV or V. It is seen from the table that most stars turned out to be of spectral types F and A and that a substantial number of secondaries (63) are of spectral type G or later. Several secondaries show spectral peculiarities. Table IV shows how these peculiarities are distributed over spectral types. In addition to the features given in the table there are 5 early-type secondaries with peculiarities typical for Ap and Am stars. Furthermore, one star has too strong and one star too weak hydrogen lines for the spectral type. Some stars show several of the peculiarities listed in table IV. None of the 4 M type stars shows any peculiarities. In a forthcoming paper we will discuss in more detail which of the secondaries may be physical and which probably are not. The following is a brief review over the spectroscopic results as such.

3.1 — During the selection of program secondaries we had as a rule no information on spectral types or colours for the stars. It is therefore of interest to compare the distribution over spectral types in table III with what can be expected for a « blind » survey of field stars in the same magnitude interval. As an example we have studied the areal distributions derived by Fransworth and McCuskey (1955) in an 11 square degree field in Cassiopeia. The apparent distribution $A(m, S)\,dm$ was derived for two magnitude intervals : 8.25-10.25 and 10.25-12.25. These distributions normalized to the number of A-stars are given in table V. As a comparison the corresponding distribution of secondaries from table III are given.

The number of A-stars relative to the total number of stars is approximately equal in all three cases and as shown by Lindroos (1983), the program stars show a pronounced concentration to the Gould's belt distribution of early-type stars. Therefore, table V indicates that the distribution of program secondaries over spectral type is different than for field stars in areas close to the galactic plane. Concerning the deficiency of B-stars two selection effects may operate. One is that the secondaries were selected in such a way that priority was given to secondaries which were more than 1.5 magnitudes fainter than the B-type primaries. If several systems are physical then a deficiency of B-type secondaries would result. Another effect would come from the fact that B-stars in the field are more concentrated to the galactic plane than the program stars in our sample. A similar effect would be present among the A-stars but to a lesser degree. As mentioned above the number of A-stars relative to the total number of stars are equal for the program stars and the field stars, however. In that case, the excess of F-stars can be taken as an indication that a large fraction of these systems are physical and not just optical components which happen to lie in the line-of-sight. For the later-type stars there is no apparent difference in the relative distributions. However, in the general field the fraction of giants is very large in this group (86 % for the magnitude interval 10.25-12.25). The majority of the program secondaries are of luminosity class V or IV, however.

We conclude that the distribution of secondaries over spectral type and luminosity class indicates that a substantial fraction of the secondaries are physical components.

3.2 — Five early-type (B and A) and eight late-type secondaries have at least one hydrogen line in emission. Of these, 3 late-type stars have only Hα in emission as discovered from the red spectroscopic survey. In addition, one of the stars, which was not observed over the blue spectral region, turned out to be a strong Hα emitter. Clearly, more stars with only Hα in emission could be detected if the red survey were extended to cover the whole material. Based on the blue spectroscopic survey one can state that the fraction of hydrogen line emitters among the secondaries is not strikingly large. As will be evident below, some of the hydrogen emitting stars have also other interesting peculiarities, however. Two stars with pronounced hydrogen line emission, HD 96261 B and HD 104901 B, deserve further studies. The latter has pronounced P Cygni structures in the emission lines.

3.3 — 14 secondaries have the CaII H and K lines in distinct emission superimposed on broad absorption features. Usually the central intensity of the emission is comparable to or larger than the intensity level of the adjacent continuum. All these stars are of spectral types F or later with the noticeable exception of HD 222661 B, an A5 V star. According to Dravins (1981a) no normal A-stars have the CaII lines in emission, while this is a common property among the nebular A$\underline{e}$ and B$\underline{e}$ stars (Herbig, 1960).

1/5th of the late-type secondaries, the majority of luminosity class IV or V, has the CaII H and K in emission. The frequency of CaII emitters is the largest among the K-type secondaries (29 %) but also a large fraction of the G-type secondaries have pronounced H and K emission (16 %). From the compilation of CaII H and K emission intensities in field stars by Glebocki *et al.* (1980) we have selected those with H and K intensities of 4 or 5 on the scale of Wilson and Bappu (1957), 5 indicating the strongest lines where the central intensity is comparable to or larger than the surrounding continuum. These intensities are also representative for all stars indicated with E(H, K) in the present survey. From the above-mentioned selection of field stars we conclude that the fractions of stars with strong H and K in emission is 13 % for the K-type stars and only 8 % for the G-type stars. Similar low frequencies were found by Dravins (1981b). We therefore have an indication that among the secondaries observed, there is an unusually large fraction of stars with substantial CaII H and K emission.

There is evidence that the degree of CaII H and K emission decreases with age (Wilson and Skumanich, 1964 ; Wilson, 1967 ; Skumanich, 1972). Hence, the circumstance that the material of secondaries shows an excess of CaII emitters can be taken as an indication that the material includes several physical components which are very young.

Another possibility is that the material includes a fraction of physical components which are older but have enhanced chromospheric emission due to interaction from the hot primaries. This possibility we regard as less likely. Firstly, Glebocki and Stawikowski (1979) and Middelkoop and Zwaan (1981) found that late-type binary components with periods $\leq$ 100 days show enhanced CaII H and K emission possibly due to tidal interaction and/or larger rotational velocities, while those with large separations do not. The stars in our sample have much larger separations than those considered by these authors. Secondly, the radiation density produced by a B-type primary component at a distance of 1000 a.u. is less than 10^{-9} of the radiation density produced locally in the photosphere of a late-type secondary component at this distance. Hence, we expect that the interaction due to radiation from the primary on the secondary is negligible.

3.4 — The absorption line of Li I at λ 6707 Å was found to be strong in 11 out of 38 secondaries observed over the red spectral region. As mentioned above the Li line is considered to be strong if it is comparable to or stronger than the CaI line at λ 6572 Å. According to Hultqvist (1976) the ratio of the equivalent widths of the λ 6707 Å and the λ 6572 Å lines directly related to the relative abundance of Li to Ca :

$$\frac{N(\mathrm{Li})}{N(\mathrm{Ca})} = 1.4 \times 10^{-5} \times 10^{0.72\theta}\, W(6707)/W(6572)$$

provided that the lines are weak or desaturated. If the two lines are of equal strength the relative abundance is approximately $N(\mathrm{Li})/N(\mathrm{Ca}) = 10^{-4}$ for F, G and K stars with only a weak dependence on θ ($\theta = 5040/T_{\mathrm{eff}}$). The implication is that those stars marked Li : S in table III may have Li abundances close to the primordial Li abundance provided the abundance of Ca is the same in all stars and equal to the cosmic abundance.

Young stars have large Li abundances (see e.g. Herbig, 1977 ; Zappala, 1972) and stars later than G0 suffer a rapid depletion of surface lithium with time (Skumanich, 1972). The rate of Li depletion increases with decreasing effective temperature. In a sample of 55 field stars of spectral types G2 to G5 studied by Duncan (1981), none have Li abundances corresponding to $N(\mathrm{Li})/N(\mathrm{Ca}) = 10^{-4}$ or larger. In our sample 38 % of the stars later than G2 that were observed over the red spectral region have the Li line in strong absorption (LI : S). Even though the estimates of the corresponding Li abundances made in this context is very crude, we again have an indication that the sample of secondaries observed include a large fraction of young stars for which Li depletion has not yet been effective.

3.5. — Several secondaries show more than one of the spectral peculiarities listed in table IV. Five stars with strong Li absorption also have emission lines. Stars like HD 560 B and HD 113703 with the CaII H and K lines and the Hα line in emission are reminiscent of T Tauri stars with weak emission line spectra. It is tempting to identify these objects with contracting stars that have just passed the T Tauri phase.

3.6. — Five secondaries which were noted by Murphy (1969) to have the hydrogen lines too strong for the spectral type, symbol H in table II, were observed by us. In all cases, except for one, the hydrogen lines were found to be of normal strength for the spectral type. The possible exception is HD 27638 B for which we unfortunately only have one « red » spectrogram.

4. **Conclusions.** — In the present spectroscopic survey of double and multiple stars with hot primaries we have found several indications that a large fraction of the secondary components are physical. Many of these secondaries are of late spectral type and if the components in a given system were formed at the same time the implication is that the secondaries are very young pre-main-sequence objects or stars on ZAMS. A large fraction of the secondaries show spectral peculiarities like emission lines and strong absorption of Li at λ 6707 Å. These features are probably related to the youth of stars. Some stars have spectra reminiscent of T Tauri stars with weak emission lines spectra. In a forthcoming paper (paper IV) the spectroscopic material, as presented here, will be reviewed together with the results from the photometric survey of the stars. In that article we will discuss more in detail which individual systems are likely to be physical and which are not.

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TABLE I. — *Technical data of the observations.*

Observing period	Telescope	Instrument	Dispersion Å/mm	Emulsion
Dec. 25 - Dec. 30, 1974	OHP 1.9	Coudé ITT	20	IIa-O B
Jan. 6 - Jan. 7, 1974	OHP 1.5	Coudé ITT	20	IIa-O B
Aug. 20 - Aug. 21, 1976	ESO 1.5	BC + ITT	86	127-04
Aug. 27 - Sept. 3. 1976	ESO 1.5	Coudé	20	IIa-O B
June 1 - June 4, 1977	ESO 1.5	BC + Carnegie	86	IIa-O B
June 5 - June 10, 1977	ESO 1.5	Coudé	20	IIa-O B
Feb. 22 - Feb. 24, 1978	ESO 1.5	Coudé	20	IIa-O B
Aug. 17 - Aug. 18, 1978	OHP 1.5	PEDISCOU + RCA	95	IIa-O B
Aug. 19 - Aug. 21, 1978	OHP 1.5	Coudé	20	IIa-O B
Jan. 28 - Jan. 31, 1979	ESO 1.5	BC + Carnegie	86	IIIa-J B
Dec. 29 - Jan. 1, 1980	ESO 1.5	BC + Varo (RED)	24	IIa-O B
March 24, 1981	ESO 1.5	Coudé	20	IIa-O B
June 8 - June 9, 1981	ESO 3.6	BC + IDS (BLUE)	29	
May 10 - May 12, 1982	ESO 3.6	BC + RET (RED)	60	
1974 - 1978	Stockholm 1.0	BC + Carnegie	55	IIa-O
		and Varo	28	IIa-D

TABLE III. — *Distribution of spectral types for the secondary components.*

Spectral type	Number
O	0
B	38
A	59
F	63
G	25
K	24
M	4

TABLE IV. — *Distribution of spectral peculiarities over spectral type.*

Spectral Pec.	B	A	F	G	K
E(hydrogen)	2	3	3	3	2
E(H,K)	0	1	2	4	7
Li:S	0	0	2	5	4
DIFF	4	5	5	1	0
K	1	2	0	0	0

TABLE V. — *Normalized distributions over spectral type of field stars and program secondaries.*

Spectral Type	Mag. interval 8.25-10.25	Mag. interval 10.25-12.25	Secondaries
B	1.9	1.5	0.6
A	1.0	1.0	1.0
F	0.4	0.6	1.1
G	0.4	0.6	0.4
K	0.7	0.1	0.4
M	0.06	0.02	0.07

TABLE II. — *Spectral properties of visual double stars.*

HD (1)	COMP (2)	SEP (3)	RELATION	V (4)	MK FROM LITERATURE (5)	OUR MK (6)		NOTES (7)
480	A			7.07	B5 V (2)			
	B	25.0		13.06				
560	A			5.53	B8 V,B9 V,B9 VN (3)	B9 V *		RV*
	B	7.7	B	10.37		G5 V E PEC *	(R)	E(A,H,K),RV:E,LI:S,1
1438	A			6.06	B8 V,B8 V (3)			RV*
	B	6.2	C	10.6		F3 V *		RV:E
3369	A		SB	4.37	B5 V,B6 IV			RV*
	B	35.9	C	8.61	F0 V H,A5 V	A6 V *		RV:E,RV*:E.
	C	55.2		11.4		F3		
4180	A			4.62	B2 V,B2 V E,B3 IV,B5 III			RV*
	B	33.2	C	11.2		F8		
8803	A			6.43	B9.5 V,B9 V	B9 V *		RV*,RV
	B	6.0	B	9.67	A5 V,A8 V,A9 V	F6 V PEC *	(R)	RV:E,RV*:E,DIFF,LI:W
9899	A			6.6		B9 V *		RV
	B	33.6		12.9		F8		
10161	A		SB	6.92	B9 V N,B8 V			RV*
	B	20.3		12.32				
10293	A			6.36	B8 V,B8 III	B7 V PEC *		RV*,RV,K
	B	19.6		8.7		K2 V *		RV:D
16046	A		SB	4.97	B9 V,B9.5 V,A0 IV,A0 III			RV*
	B	10.8	B	7.79	A8 V,A3 V M,A7 V			
17543	A		SB	5.28*	B6 IV,B6 V	B6 IV *		RV*
	B	3.2	C	8.3		A0 V PEC *		RV:D,K,2
	C	25.2	C	10.73		F8 V		
23793	A			5.10	B3 V			RV*
	B	9.0	B	9.41	F5 V H	F3 V PEC *	(R)	RV*:E,DIFF,LI:W
23990	A			6.77	B9 (5)			
	B	30.7		13.21				
24388	A			5.50	B8 V			RV*
	B	8.2	C	10.35		F4 V	(R)	LI:W
25330	A			5.69	B5 V			RV*
	B	12.0	C	11.21		F8 V	(R)	LI:W
27638	A			5.41	B9.5 V,B8 V,B9 VN,B9 V			RV*
	B	19.4	C	8.43	G2 V H	G	(R)	RV*:D?,LI:S,3
28107	A			7.36	B6 V (2)			
29227	A			6.37	B7 III			RV*
	B	17.5	C	10.72				
	C	45.1		13.64				
31065	A			7.79	B9.5/A0 V (2)			
32202	A			7.26		B9 V *		RV
	B	32.8		10.29		A2 V PEC *		RV:E?,DIFF
32964	A		SB	5.11	B9.5 V,B9 V+B9 V HG			RV*
	B	52.8	C	10.84				
33224	A			5.82	B8 V,B9 V	B9 V *		RV*
	B	21.6	C	8.99	K0 III-IV	K0 IV *	(R)	RV:D,LI:W
33802	A		SB?	4.47	B8 V,B9 V	B9 V *		RV*
	B	12.7	C	9.92	G5 V E	G8 V PEC *	(R)	E(A,H,K),LI:S
33949	A			4.37*	B8 III,B8 V,B9 V			RV*
	B	2.6	C	7.8		B9 V *		RV:E?
34503	A		SB?	3.61	B5 III,B8 III			RV*
	D	36.0		10.97				
34527	A		SB?	6.98		B9.5 V *		RV*,RV
	B	20.6	C	8.72		A0.5 V *		RV:D
34798	A			6.38	B3 V,B5 V,B2 IV-V			RV*
34797	B	39.4	C	6.54	B9 IV,B6 V P WL,B8 III,A0 P			RV*:E
35007	A			5.68	B3 V			RV*
	B	32.7		13.05				
	C	37.6		11.88				
35149	A			5.00	B1 V,B1 V N,B1 IV NN			RV*
35148	B	32.1	C	7.26	B3 V (1)	B8 V PEC *		RV:D,DIFF,4
35173	A			7.27	B8 (5)			RV*
35172	B	26.0	C	8.29	A (5)			

TABLE II *(continued)*.

HD (1)	COMP (2)	SEP (3)	RELATION	V (4)	MK FROM LITERATURE (5)	OUR MK (6)	NOTES (7)
35715	A		SB	4.58*	B1 IV,B1 V,B2 IV		RV*
	C	83.4		13.88			
36013	A			6.89	B1.5 V,B2 V,B3 V N		RV*
	B	25.0		12.49		F	(R) LI:S,5
36151	A			6.69	B5 V		RV*
	B	48.6		10.60			
	X	45*		11.98			
36408	A		SB	6.09	B7 IV + B8 V,B8 III,B7 III		RV*
	B	9.6	C	6.51	B7 IV		
36779	A			6.24	B2 V,B3 V,B2.5 V		RV*
	B	27.5		11.20		K	(R) LI:W,6
36861	A			3.47*	O7.5 (II),O8 III F,O8 II (F)		RV*
36862	B	4.4	C	5.0	B0.5 V,B0 V		RV*:E
36861	C	28.6	C	10.72			
36898	A			7.16	B7 V		RV*
	B	10.0	C	10.09			
36960	A			4.90	B0 V,B0 V P,B1 IB,B0.5 V		RV*
36959	B	35.7	C	5.73	B1 V		RV*:E
38426	A			6.79		B2 V *	
	B	19.4	C	11.58		G8 V	(R) LI:W
38622	A			5.27	B2 V,B2 IV-V		RV*
	B	17.8	C	12.17			
	C	24.9	C	12.01			
38672	A			6.70	B5 (5)		RV*
	B	19.3		12.97			
40494	A			4.36	B3 IV,B2.5 IV		RV*
	B	33.8		12.66			
43112	A			5.94	B1 V,B0.5 V		RV*
	B	21.3		12.70			RV*:D
43286	A			6.99	B5 (5)		RV*
	B	18.3		12.38			
	C	58.8		10.11			
43983	A			7.67	B8 (5)		
	B	21.9	C	11.30			
44458	A			5.55*	B1 V PE,B1 V E		RV*
	C	56.5		11.62			
44944	A			7.84		A5 V *	
	B	20.0		10.38			
44996	A			6.11	B5 V,B IV-V E		RV*
	B	23.2	C	10.50		F0 V	
45995	A			6.11	(B0) III,B2 V NNE,B2.5 V E,B3 IV NNE		RV*
	B	16.3	B	9.16	B8 V E,B9 IV		RV*:E?
46035	A			6.78	B8 (5)		
	B	21.6		10.98			
46064	A			6.16	B2 V,B1.5 V		RV*
	B	36.6		11.08		F5 V	
46547	A		SB?	5.74	B2 IV		RV*
	B	24.9		8.67		A0 V *	
47116	A			7.71	B9 V P SI		
	B	38.5		9.29	F6 V		
47247	A			6.41	B5 V		RV*
	B	9.1	B	9.32		A2 V	
47732	A		E	8.47	B3 V NNK,B2.5 V N,B1.5 IV+B2		
	B	21.4	C	10.91			
	C	25.8		12.46			
47851	A			7.67	B3 III,B3 V		RV*
	B	23.8		10.15*		F	(R) LI:W,7
47887	A			7.19	B2 III,B3 V		RV*
	B	12.8	C	10.23	B9 V		RV*:D
48383	A			6.16	B3 V NNK,B4 V,B4 V (2)		RV*
	B	15.4	C	9.60			
48425	A			7.14	B5 (5)		RV*
	C	34.9		12.83			

TABLE II (continued).

HD (1)	COMP (2)	SEP (3)	RELATION	V (4)	MK FROM LITERATURE (5)	OUR MK (6)		NOTES (7)
48857	A		SB?	7.03	B5 V,B4 V,B4 IV/V (2)			RV*
	B	42.3	C	9.16	B9 V			
48917	A			5.22				RV*
	B	36.3		12.58				
52140	A			6.31	B5 III			RV*
	B	35.		10.10		M5 III	(R)	LI:W
	C	70.		11.37		F6 V	(R)	LI:W
52437	A			6.53*	B4 V NE,B2 IV-V			RV*
	C	128.4		11.07		K	(R)	LI:W,8
53191	A			7.74	A0 V (2)			
	B	17.0		11.75				
53755	A			6.50*	B0 V,B0.5 IV N,B0.5 V			RV*
	B	6.2	C	10.4	F5 III			
54764	A			6.05	B1 II			RV*
	B	31.0		11.67		F3 V		
55856	A			6.38	B2 V			RV*
	B	19.7	C	9.09	G5 IV	G5 III	(R)	RV:D,LI:W
56456	A			4.76	B8/9 V(2)			
	B	18.5		13.04				
56504	A			9.08	B9 (5)			
	B	31.1		9.92	G5 (5)	G	(R)	LI:W,9
58420	A			6.32	B7 III			
	B	25.0		11.78		F5 V		
60102	A			7.54	B9/9.5 V (2)			
	B	16.4		11.86				
60575	A			8.71	B6 V,B3 V (2)			
	B	15.4		10.05		PEC	(R)	E(A),LI:W,10
	C	26.4		12.80		M4		
60624	A			7.59*	B9 (5)			
	B	5.7		12.2		A3 V		
60855	A			5.72*	B2 IV,B2 IV:E?,B2 V E ,B2 V N,B3 V			RV*
	C	19.6	C	9.77	B9.5 V	B9 V		
60863	A			4.65	B7 V			RV*
	B	38.4		9.15				
	C	79		10.45		G	(R)	LI:S,11
61555	A			4.53	B6 V,B5 V			
61556	B	9.9	B	4.78	B7 V,B5 IV			
63065	A			8.38	B9 (5)			
	B	17.5	C	9.30				
	C	26.5		12.43				
63425	A			6.93	B0 V,B0.5 V,B1 IB/II,B1/2 IB/II (2)	B2 II *		RV*,RV
	B	49.6	C	7.65	M1 III	K7 III *	(R)	RV:D,LI:W
63465	A			5.08	B2.5 III,B2 III			RV*
	B	10.9		11.13				
63922	A			4.09	B0 II,B0 II-III,B0.5 III,B0 III			RV*
	B	59.2	C	8.93		B9 V *		RV:D
64755	A			8.67*	B8 (5)			
	B	4.2		12.5		G6 V		
65162	A			8.13*	B8 (5)			
	C	15.7		10.16				
66005	A		SB?	6.35	B2 IV-V			RV*
66006	B	16.4	C,SB?	6.36	B2 IV-V			RV*:E?
66230	A			8.17	B5 (5)			
	B	9.7		12.23		A5		
66539	A			7.67	B2.5 V N			
	B	6.1		11.4		F5 V		
66546	A		SB	6.12	B4 V,B2 IV-V,B4 III,B2 IV,B2 IV (2)			RV*
	B	40.4	C	8.18		B9 III P(SI II) *		RV:D?
66624	A			5.52	B9 P SI,AP SI (2)			RV*
	B	27.0	C	8.31		M6 III *	(R)	RV:D,LI:W
67059	A			7.43*	B3 III/IV (2)			
	B	4.2		11.6		G2 V		

TABLE II (continued).

HD (1)	COMP (2)	SEP (3)	RELATION	V (4)	MK FROM LITERATURE (5)	OUR MK (6)	NOTES (7)
67880	A			5.66*	B2.5 V,B2 V		
	B	5.3		12.7		A5 III	
69144	A			5.14	B2.5 IV,B3 III,B3 III (2)	B3 III *	RV*,RV
	B	35.		9.50		K5 V *	(R) RV:D,LI:S
70309	A		SB?	6.45	B3 V,B3 III (2)		RV*
	B	42.5		11.28			
70556	A			5.18*	B2 IV-V		RV*
	B	6.8		12.0		A2 V	
71304	A			8.26	O9 II?,O9 IB (F),O9 (III) (2)		RV*
	B	11.8		11.23			
	C	18.6		11.83			
71510	A			5.19	B2 V,B3 IV (2)	B2 V *	RV*
	B	25.5		9.51		B8 V	
	C	34.9		10.77		G3 V	
71833	A			6.70	B8 III		RV*
	B	18.9		11.77		F2 V	
72798	A		SB?	6.46	B5 III,B3 III (2)		RV*
	B	15.		10.90		A0 V	
74067	A			5.22*	B9 V		RV*
	B	3.9	B	8.5		A2 V	
74115	A			8.21	B9 V (2)		
	B	17.0		13.09		F3 V	
74146	A		SB	5.20	B5 V,B4 IV,B5 IV,B5 IV (2)	B5 V *	RV*
	B	16.6	C	8.66		F0 IV *	RV*:E
74531	A			7.25	B2-3 III,B2 IV,B2 (V) (2)		
	B	13.9		11.63		A7 V	
76323	A			7.36	B5 V (2)	B8 V PEC *	RV,DIFF
	B	17.5		10.21		A1 V	
76566	A			6.28	B3 V,B3 IV,B3 IV (2)		RV*
	B	35.0		12.64			
77002	A			4.92	B2 IV,B3 IV,B2 IV-V,B2 V (2)		RV*
	B	40.4	C	6.83	B9.5 V		
77484	A			8.02*	B9 (5)		
	B	4.4	C	12.0		G5 V	(R) LI:S?
82906	A			7.90	B9 (5)		
	B	49.1	OP?	9.08			
82919	A			7.13	B5 V,B6/7 II/III (2)		RV*
	B	10.8		11.46		A2 V	
83953	A			4.76	B5 V,B6 V E		RV*
	B	54.7		10.94		G8 V *	(R) RV:D,LI:W
83965	A			8.38	B9 (5)		
	B	17.0	OP?	11.87			
86388	A			6.87	B9 V (2)	B9 V? *	RV
	B	9.2		9.98		F5 V *	(R) RV:E,LI:W
86440	A			3.54	B5 I-II,B5 IB,B5 II,B5 IB (2)		RV*
	B	37.2		12.38		K0 III	
86523	A		SB?	6.08	B3 V NN,B3 V,B2 V (2)		RV*
	B	14.1	C	10.51		A1 III	
87901	A			1.35	B7 V,B8 V,B7 V N		RV*
	B	176.9	B	8.08*	K0 V H	K0 V PEC *	(R) E(H,K),LI:W
90972	A		SB	5.58	B9.5 V		RV*
	B	11.0	C	9.65		F9 V PEC *	(R) E(H,K),RV:E?,LI:S
91355	A			5.78	B6 II: (4)		RV*
91356	B	13.5	C,SB?	6.14	B8 II: (4)		RV*:E
91590	A			7.10	AP SI (2)		
	B	28.4	C	9.99		A P(SI II)	12
91645	A			6.90*	B9 (5)		
	B	3.7		10.7		F4 V	
92029	A			7.06	B5 III/IV (2)		
	B	41.9		9.44		A8 III	
93010	A			6.63	B3 III,B5 V,B3 III (2)		RV*
	B	12.4	C	8.19		A0 III *	RV:D

TABLE II *(continued)*.

HD (1)	COMP (2)	SEP (3)	RELATION	V (4)	MK FROM LITERATURE (5)	OUR MK (6)		NOTES (7)
93632	A			8.35	O4 III (F),O5 III (F)	O4 III *		RV
	B	16.8		10.47		B2 V *		NEB
93873	A			7.76	B1 IA-IAB,B0.5 IAB,B1 IA/IAB (2)			
	B	13.8		10.64		A2 III PEC		K,13
94565	A			7.06		B8 I P(SI II) *		RV
	B	25.8	C	8.55		A8 PEC *		RV:D,DIFF,14
94909	A			7.31	B0 I,B0 IB,B0 IA,B0/0.5 IA (2)			RV*
	B	23.6		10.60		G5 V		
95198	A			7.88	B9 P SI			
	B	26.7		11.88				
96261	A		SB?	7.70	B0.5 III,B1 IB,B1 IAB,B1 IB/II (2)			RV*
	B	17.6		9.52		B/A PEC *	(R)	E(A,B,G,D),RV:D,LI:W,15
96264	A			7.60	O8.5 V,O9.5 IV,O9.5 III,O9 V			RV*
	B	24.0	C	10.17		B4 V		
97583	A			5.23	B9 V,B8 V (2)			RV*
	B	19.1		11.11		A0		
99803	A		SB	5.16	B9 V,B9 V (2)	B9 V P(SI II) *		RV*,RV
	B	13.1	C	7.78	A5 V	A3 V *		RV:E
100359	A			6.87	B7 IV (2)	B7 IV *		RV
	B	21.0		10.89		A1 V		
100841	A		SB?	3.15	B9 II:,B9 III,B9 III (2)			RV*
	B	16.3		13.19		B9 V		
101436	A			7.61	O6 V,O6.5 V,O7.5,B5/7 IB/II (2)	B0 V *		RV,RV*
	B	27.8	C	8.37		B0 V *		RV:D
102340	A			7.74*	B5 V,B5 V (2)			
	C	7.9		11.5		A2 V		
104901	A			7.36	B8 IAB-IB,B8 IB-II H,B8/9 IAB/B (2)			
	B	23.0	C	7.57		F0 II PEC *	(R)	E(A,B,G,D),RV,LI:W,16
106983	A			4.05	B3 IV,B3 V,B2.5 V,B2/3 V (2)			RV*
	B	33.8		12.49		G8 III	(R)	LI:W
107348	A		SB	5.22	B8 V N			RV*
	B	8.0	OP	13.6		F6 III		
108610	A			6.94	B3 V,B3 IV/V (2)	B9.5 V *		
	B	21.8		11.89		A5 V		
108767	A		SB?	2.94	B9 V,B9 V N,B9.5 V (3)	B9.5 V *		RV*
	B	24.2	C	8.43	K0 V H	K2 V PEC *	(R)	E(H,K),RV,LI:S
109668	A		SB?	2.69	B2 IV,B2 V,B3 IV,B2 IV/V,B2 IV (2)			RV*
	B	29.6		12.8		B4 V		
109867	A			6.29	B0.5 I K,B0.5 IAB E,B1 IA			RV*
	A				B1 IB,B0.7 IB,B0.5/1 IAB (2)			
	B	17.0		11.47		B7 PEC		17
110956	A			4.62	B3 IV,B3 V,B2/3 V (2)			RV*
	B	52.6	C	8.72	A3 P	B9 V		RV*:D
111123	A		SB?	1.25	B0 III,B0.5 III,B0.5 IV,B1 IV			RV*
	B	44.3		11.4		F8 V		
112092	A			4.00	B3 IV,B3 V,B2 IV/V,B3 IV,B2 IV (2)	B1 V *		RV*
112091	B	34.9	C	5.13	B5 V E,B5 V NE,B4 V,B4 V (1)	B7 V PEC *		E(B),RV*:E,DIFF,18
112244	A		SB?	5.38	O9 IB,O9.5 IA,O8.5 IAB (F),			RV*
	A				O9 IA-IAB (E),O9 IA/IAB (2)			
	B	29.1		11.77		K0 III	(R)	
112413	A		SB	2.89	A P,A0 P III,A0 P SI EU HG			RV*
112412	B	19.6	B	5.60	F0 V	F0 V *		RV*:E,RV
113703	A			4.72	B3 V,B4 IV,B5 IV,B5 V,B4 V (2)			RV*
	B	11.4	C	10.8	K0 V E	K0 V PEC	(R)	E(A,B,H,K),RV*:E,LI:S
113791	A		SB	4.25	B2 IV,B2 V,B1.5 V,B3 V (2)	B2 III *		RV*
	B	25.1	C,SB	9.38	F5 V	F7 V *	(R)	RV*:E,RV
114911	A		SB	4.76	B8 V,B7 V (2)			RV*
	B	60.0	C	7.31		A P(SR II) *		RV:E,19
117460	A			7.48	B2 III,B0/1 (III) (2),B2.5 II	B2 III *		
	B	16.1	C	8.41		B2 PEC *		E(B,G),RV,DIFF,20
118716	A			2.30	B1 IV,B1 V,B1 III			RV*
	B	36.0		13.56		B1 PEC		DIFF,21

TABLE II (continued).

HD (1)	COMP (2)	SEP (3)	RELATION	V (4)	MK FROM LITERATURE (5)	OUR MK (6)	NOTES (7)
119423	A			7.54*	B3/5 V NE (2),B3 V NE,B4 V NE		
	B	3.6		12.0		B7 V	K
120324	A		SB?	2.94	B2 V E,B2 V PE,B2 V PNE,B2 V NE,		RV*
	A				B3 V,B3 V E,B2 IV-V E,B3 V PNE		
	B	48.0		13.63		F2 V	
120642	A			5.28	B9 V N,B8 V,B8 V (2)	B9.5 V *	RV*
120641	B	18.0	C	7.54	A3 V,F0 V	F0 V PEC *	RV*:E?,RV:D?,DIFF
120955	A		SB	4.78	B5 III,B5 IV,B5 V,B4 IV		RV*,RV
	B	14.9	C	8.41	A3 III,A M	A3 V M *	RV:D?,22
120991	A			6.13	B2 III E,B2 II NE (2)		RV*
	B	21.4	C	11.52		B8 V	
123445	A			6.19	B9 V,B9 V (2)	B9 V *	RV*,RV
	B	28.6		12.52		K2 V	E(H,K)?
123635	A			7.76	B9 II (2)	A0 II *	RV
	B	9.2		11.30		F0 V	
124367	A		SB?	5.07	B3 V E,B3 V NE,B4 V NE,B5 V N,		RV*
	A				B5 V NE (2)		
	B	33.9		12.29		M3 IV	
	C	36.		12.79		F4 V	
124471	A		SB?	5.76	B2 IB,B1.5 III,B2 IB,		RV*
	A				B2 III,B2 III/IV (2)		
	B	23.8		13.48		F5 V	
126981	A			5.52	B6 IV+A1,B8 V,B8 V (2)		RV*
	B	10.5		12.45		G6 V PEC	E(H,K)
127304	A		SB?	6.07	A0 V S,B9 V P SI,A0 V (3)	A0 V	RV*
	B	25.8		11.37	K1 V		
127971	A		SB?	5.89	B6 V,B7 V (2)		RV*
	B	26.9		11.22		K0 V (R)	
128819	A			6.67	B8/9 V (2)		
	B	8.7		12.93		A0 V PEC	E(B,G?)
128919	A			9.16*	B9 IB/II (2)		
	B	5.0		13.2		A1 V	
129791	A			6.94	B9.5 V,A0 V (2)		
	B	35.3		12.93		K5 V PEC (R)	E(A,H,K),LI:S
130081	A			6.83	B8 V (2)	B9 V P(SI II) *	RV
	B	17.7		11.75		F4 V PEC *	RV:E,DIFF
131168	A			6.87	B3 V E,B3 V NE,B2/3 NNE (2)	B2 V PEC *	E(B,G),RV*,DIFF
	B	17.5	C	9.61		G5 IV *	RV:D
	C	17.					
135160	A			5.74*	B1 V,B1 V E,B0.5 V,B1/2 N (2)		RV*
	C	10.8		11.62		A5 V *	RV:D
135240	A		SB?	5.06	O8 N, O8.5,O9 V,		RV*
	A				O8.5 V, O8 V,O7.5 III((F))		
	B	50.		12.87		G5 V	
135591	A		SB?	5.45*	O9 I,O9 IB,O9 II,		RV*
	A				O7 I,O8 V,O7.5 III ((FF))		
	B	5.4		12.0		B9 V	
	C	44.5		11.71		A	
136454	A			9.47*	B9 III (2)		
	B	3.7		13.3		F0	23
137387	A		SB?	5.47	B3 IV,B3 IV E,B5 N E		RV*
	A				B1 PNE,B3 IV NE,B3 IB/III NE (2)		
	B	27.0		11.27		K5 IV (R)	LI:W
138497	A			7.2	B9 IV P(CR,SR,EU) (2)		
	B	2.4		10.7		F4V	
138800	A			5.65	B8 S,B8 IV,B7 III/IV (2)		RV*
	X	34*		12.86		K0 V	
	Y	27*		14.09			
139619	A			8.98	B9/A0 V (2)	B7 V *	RV
	B	8.		12.0			
140022	A			9.06	B8 V (2)	B9 V *	RV
	B	7.7		10.56		A0 V *	RV:E?
141318	A		SB	5.80	B2 III,B2 II,B2 III (2)	B1 III *	RV*
	B	20.4	OP	9.09		K0 V	
	X	50*		11.76			

TABLE II *(continued)*.

HD (1)	COMP (2)	SEP (3)	RELATION (3)	V (4)	MK FROM LITERATURE (5)	OUR MK (6)	NOTES (7)
141468	A			8.60	B8 III (2)	B8 V *	
	B	17.0		10.38		K2 V *	
141569	A			7.13		A0 V *	
	B	7.4		12.7		G0 V PEC	E(B,G,H,K),24
142448	A		SB?	6.05	B6 V		RV*
	B	18.		12.70		G8 V	
142514	A			5.75*	B7 IV,B7 III (2)		RV*
	B	9.7		12.65		F5 V	
143018	A		SB	2.91	B1 V,B2 IV,B1 V+B2 V		RV*
	B	50.4		11.90		F4 V	
143118	A		SB?	3.44	B2 IV-V,B2 V,B3 V,B2.5 IV	B2.5 V	RV*
	B	15.0	B	7.86	A3 V N	A5 V PEC *	RV*:E,RV:D,DIFF,25
143939	A			6.98	B9 P,B9 P SI	B9 III *	RV*
	B	8.6		11.80		K3 V PEC	E(H,K)
144217	A		SB	2.59*	B0.5 IV,B0.5 V,B0 V,B1 V,B1 V (1)		RV*
	A				B1 V (3)		
144218	C	13.6	C	4.93	B2 V,B3 V,B2 IV-V,B 2 V (1),B2 V (3)	B2 V *	RV*:E,RV:D
145483	A			5.67*	B9 V,B9 V N		RV*
	B	4.3	B	7.7	F2 V	F3 V *	RV:E
147049	A			7.70	B1 IA,B1.5 IA,B1 IA/AB (2)		
	B	7.		11.69		A0 V	
148066	A			8.24	B5 III (2)	B6 III *	RV
	B	15.6		10.58		F2 V PEC *	RV:D,DIFF
148688	A			5.29*	B0.5 I,B1 IA,B1 IA+,B1 IA (2)	B0.5 IA *	RV*
	B	8.6		13.06		F5 V	
	C	58.0	C	9.69			
149249	A			7.37*	B2/3 III/IV (2)	B4 III *	RV
	C	22.9		12.92		A5 V	
150742	A			5.64*	B3 V,B2.5 V,B2 IV/V,B3 V (2)		RV*
	B	8.		12.78		A5 V *	
151158	A			8.19*	B2 IB/II (2)	B2 V	
	B	2.8		11.2		B7 V	
152408	A			5.80*	O7 F,O7-8 FP,O8 FP,	O PEC *	RV*,26
	A				O8 I+F P,O8 IF,WN (2)		
	B	5.4		11.8		F4 PEC	E(B,G,H,K)?,27
152723	A			7.24	O6,O6.5,O6 K,O7,O6.5 III (F),		RV*
	A				O6.5 V,O7/8 (2)		
	B	7.2		13.0		A4 V	NEB
	C	7.6		9.7		B5 V *	RV:D
	D	15.7		10.30		B6 V	
152901	A			7.51	B2.5 V N,B2 V		
	B	9.1		12.60		A7 III	
153519	A			8.26*	B6 II/III (2)	B9 V *	RV
153613	A		SB?	5.04	B8 V		RV*
	B	25.5	OP?	12.61		A8 V	
	C	43.0		13.78		F5 V	
	D	48.2		14.35			
155240	A			9.4	B8/9 III (2)		
	B	5.1		11.4		A4 V	
155454	A			6.8	B2 V (2)		
	B	25.1		11.4		F5 V	
156247	A		SB	5.91	B5 V,B5 V NN,B5 V+B5 N		RV*
	B	20.4	C	12.26		G0 V	
156325	A			6.38	B6 IV,B5 V,B5 V NE,B5 V N		RV*
	B	19.5		11.91		F2 V	
157042	A			5.24	B2 III NE,B2 (V) NNE (2)		RV*
	B	42.8		12.08		G5 III-IV	
157246	A		SB?	3.31	B1 III,B1 V,B1 IB,B1 V NE		RV*
	B	17.9	C	10.53		A7 V	
	C	41.6		12.17			
157736	A			7.48*	B9 (5)		
	B	5.5		12.01		A1 V	
157741	A			6.36*	B9.5 IV,B9 V		RV*
	B	3.9	C	10.9		A6 V	

TABLE II *(continued)*.

HD (1)	COMP (2)	SEP (3)	RELATION	V (4)	MK FROM LITERATURE (5)	OUR MK (6)		NOTES (7)
158094	A			3.75	B8 V			RV*
	B	47.4		10.98		K0 III	(R)	LI:W
158427	A		SB	2.95	B2.5 V,B3 V,B3 V E,			RV*
	A				B3 V N,B2 V NE,B2.5 V NE			
	B	55.6		10.99		K0 IV		
159091	A			7.61		B9 III *		RV
	B	9.2		13.32		F4 V		
159176	A		SB	5.72*	O7,O5 E,O7 V+O7 V			RV*
	B	5.4	C	10.5		B9 V		
	C	13.3		10.91		B8 V		
	X	25*		10.76				
159574	A			7.78	B9 IB (2)	B8 IB *		
	B	12.7		11.03		B7 V *		
160281	A			8.31		B5 V *		
	B	5.6		10.61		A0 V *		RV
160957	A			8.6	B9 (5)			
	B	4.7		12.5		F3 V		
160974	A			8.73*	B1 II			
	B	4.7		13.0		F2 PEC		E(B,G,D)?,27
161004	A			8.74		B8 V *		
	B	7.7	OP?	10.88		G8 IV PEC *		DIFF
162082	A			8.16		B7 V *		
	B	10.7		11.05		F2 V		
	D	27.2		12.12		A4 V		
163181	A		SB	6.63	O5,B0 I+O8,BN0.5 IA E VAR,			RV*
	A				B1 IAB E,BN1 IA PE VAR			
	B	13.5		13.51		F7 V		
164492	A		SB?	7.59	O7,O8,O7.5 III,O7 I			RV*
	B	6.0	C	10.7	A2 IA	A2 IA *		NEB
	C	10.8	C,SB?	8.67	B0 II	B6 V *		RV*:E,RV:D,NEB
	E	16.5		12.6		F3 V *		NEB
165493	A			6.14*	B7/8 II (2)	B8 III *		RV*
	B	3.9		9.7		B9 V		
165530	A			6.62		B7 V *		
	B	13.3		8.92		B9 III P(SI II) *		
166182	A		SB?	4.34	B2 III,B2 V,B2 IV			RV*
	B	23.4	C	12.78		A6 V		
166563	A			6.75	A0 V (3)			
	B	17.4	OP?	12.64		F3 V		
166566	A			7.93*	B1 II,B0.5 III E			RV*
	B	3.6		11.8		F2 V		
166937	A		SB	3.85	B8 IA,B8 IA P,B8 IA E,			RV*
	A				B8 IA E P,B8.5 IA,B9 IA,B6 IB			
	B	16.9	C	10.48		B9 III		
	D	48.5	C	9.69	B3 (5)			
	E	50.0	C	9.25	B2 V			
167263	A		SD	5.96*	O9 II,O9 III,O9.5 II-III((N)),O9 IV (3)			RV*
	B	6.0	C	13.24		A3 V		
167771	A		SB?	6.53	O8,O8 K,O7 IF,O8 IF,O7 III (N)(F)			RV*
	B	8.4		12.55		A3 V		
169337	A		SD	7.47*		B8 V + G8 PEC *		
	B	4.9		12.41		A7 V		
170385	A			7.90*	B3 V,B5 III/V (2)			RV*
	B	4.2		12.2		A8 V		
170580	A			6.68	B2 V			RV*
	B	20.1	C	11.30		A7 V PEC *		RV:E,DIFF
	C	66.9		12.79		F5 V		
	D	85.2		12.9		F8 V		
170740	A			5.76	B2 V,B2 V+DB9,B2 IV-V			RV*
	B	12.3	C	9.29	B9 V,A1 V	A0 V *		RV:E,RV*:E
171247	A			6.43	B8 III P SI(SR)			RV*
	B	38.7	C	10.44				
173360	A			6.93	B9 V N (2)			
	B	25.6		12.32		F3 V		
	C	32.0		12.08				

TABLE II *(continued)*.

HD (1)	COMP (2)	SEP (3)	RELATION	V (4)	MK FROM LITERATURE (5)	OUR MK (6)	NOTES (7)
174152	A		SB?	6.69	B5 III,B6 V,B6 III,B5/7 III (2)		RV*
	B	10.1	C	9.40	B9 V	B9 III	
174585	A			5.90	B2 V,B3 IV		RV*
	C	58.7	C	12.6		G0 V	
174638	A1			3.41	B7 V,B8 II-III P E		RV*
	A2		A1SB		A8 P,A8-9 V		RV*
174639	B	45.7	C	8.6	B6 V	B8 V	
174638	E	66.9	C	9.9		B9 V	
	F	85.8	C	9.9		B9 V	
175876	A		SB?	6.93	O6,O7,O6.5 III (N)(F)		RV*
	B	17.0		12.27		G6 III	
176873	A			6.82		B9 V *	RV
	B	14.7	OP?	10.76		A2 V	
	C	20.3		13.1		F6 V	
177817	A			6.10	B8 IV,B7 IV		RV*
	B	6.4	B	8.78		A0 V *	
177880	A			6.84	B5 V,B5 V (3)	B6 V *	RV
	B	13.9	C	9.70	A0 V	B9 V *	RV:E
179316	A			8.58		B3 V	
	B	50.4		10.20		F6 IV	
179761	A			5.15	B8 P,B7 III,B8 II-III (HG)		RV*
	B	36.2		13.18			
180183	A			6.82	B3 IV,B3 V N,B2 V (2)		RV*
	B	19.4		11.45		K0 V (R)	LI:W
180555	A			5.68	B9 V,B9.5 V,A0 IV	B9.5 V *	RV*,RV
	B	8.2	C	9.29	F8 V	G0 IV *	RV:E
181454	A			3.96	B8 V,B9 V,B9 V (1)		RV*
	B	28.3	C	7.21	A5 V,A3 V,A5 V (1)		
181558	A			6.27	B5 V,B7 III		RV*
	B	46.9		13.00		K2 IV *	RV:D
182110	A			7.06*	B9 (5)		
	B	5.3		13.81			
185507	A		SB	5.25	B3 V,B3 V+B3 V		RV*
	A				B2.5 V P,B2.5 V+B3 V N		
	B	47.8		12.46		K0 V PEC	E(H,K)
185514	A			7.59		B9 V *	RV
	B	11.4	C	12.33		B7 V	
193924	A		SB	1.94	B3 IV,B2.5 V,B2 IV	B3 V *	RV*,RV
	B	145.4		9.23			
	C	140		11.06			
	X	65*		13.50		F5 V	
194262	A			7.23		B8 V *	RV
	B	8.9		12.99		F8 V	
195556	A			4.94	B2 V,B2.5 IV		RV*
	B	17.8	C	13.0		A5 V	
199218	A			6.70	B8 V NN	B9 V PEC *	RV*,RV,DIFF
201819	A			6.53	B1 V P,B0.5 IV N		RV*
	B	21.8		12.3		B8 V	
211924	A			5.37*	B5 III,B5 V,B5 IV		RV*
	B	6.2	C	10.7		A7 V	
	C	12.4	OP?	11.32		F6 IV	
212581	A			4.51	B8 V,B8 V N,B9/A0 V (2)		RV*
	B	6.9	C	8.62		F5 III	
222661	A		SB	4.49*	B9 V,B9.5 V		RV*
	B	5.7	C	10.5		A5 V PEC *	E(H,K),DIFF
224098	A			6.6	B7 V	B8 V *	RV*,RV
	B	45.1		12.1		F0 V	

Notes to table II.

1. HD 560 B : The Hα line is partly filled in by emission. The radial velocity of the absorption lines of Hα and Hδ was measured to − 26.9 ± 2.2 km/s while the metallic lines yield + 10.2 ± 5.0 km/s. The narrow emission peaks of CaII and K center at + 13.7 km/s.
2. HD 17543 B : The absorption lines of CaII H and K are in strong absorption corresponding to spectral type A5.
3. HD 27638 B : According to Murphy (1969) this star is a G2 type star with anomalously strong hydrogen lines for this spectral type. Our spectrogram covering only the red spectral region indicates a spectrum not earlier than G2 but with in that case unusually strong Hα absorption. Unfortunately, we have not obtained a « blue » spectrogram to confirm this peculiarity.
4. HD 35148 : The hydrogen lines are extremely diffuse and shallow. Lines of He not visible, possibly due to large rotational motion.
5. HD 36013 B : For this star we lack a spectrogram covering the blue spectral region. The « red » spectrogram indicates a spectral type around F3.
6. HD 36779 B : The « red » spectrogram indicates a spectral type around K0.
7. HD 47851 B : The « red » spectrogram indicates a spectral type around F2.
8. HD 52437 C : The « red » spectrogram indicates a spectral type around K3.
9. HD 56504 B : The « red » spectrogram indicates a spectral type around G7.
10. HD 60575 B : The « red » spectrogram shows Hα in strong emission with central reversal on a featureless continuum.
11. HD 60863 C : The « red » spectrogram indicates a spectral type around G5.
12. HD 91590 B : The hydrogen lines are narrow and the strength of the CaII H and K lines corresponds to a spectral type F0.
13. HD 93873 B : The CaII H and K lines are strong corresponding to spectral type A5.
14. HD 94565 B : No metal lines are seen in the spectrum possibly due to very large rotational motion.
15. HD 96261 B : The hydrogen lines are in very broad emission with central reversals.
16. HD 104901 B : Hα is in strong emission with central reversal. The Hα, Hβ, and Hδ lines show distinct P Cygni profiles with a sharp edge between the emission and absorption components. The peak of the emission components is red-shifted by 90 km/s relative to the stellar radial velocity as determined from the metallic lines.
17. HD 109867 B : The hydrogen lines are weak for the spectral type based on the appearance of the He lines.
18. HD 112091 B : Hβ has a weak emission component with central reversal superimposed on broad and shallow absorption.
19. HD 114911 B : The strength of the metal lines correspond to spectral type A5, while the hydrogen and helium lines correspond to B8. No CaII H and K absorption.
20. HD 117460 B : Hβ and Hγ are filled in by emission.
21. HD 118716 B : Difficult to classify due to extremely diffuse and shallow absorption lines with the exception for the hydrogen lines which are weak but relatively narrow.
22. HD 120955 B : The hydrogen lines are violet displaced relative to the metallic lines by 45 km/s.
23. HD 136454 B : The spectrogram is contaminated by light from the primary.
24. HD 141569 B : Hβ and Hα seem to be filled in by emission, while Hδ is in fairly strong absorption.
25. HD 143118 B : The strength of the hydrogen lines corresponds to spectral type A3.
26. HD 152408 A : Several broad emission lines present. The object seems to be related to the Wolf-Rayer stars.
27. HD 152408 B and HD 160974 B : There is the possibility that the indication of emission lines on the only spectrogram obtained for this star is due to contamination of light from the primary.

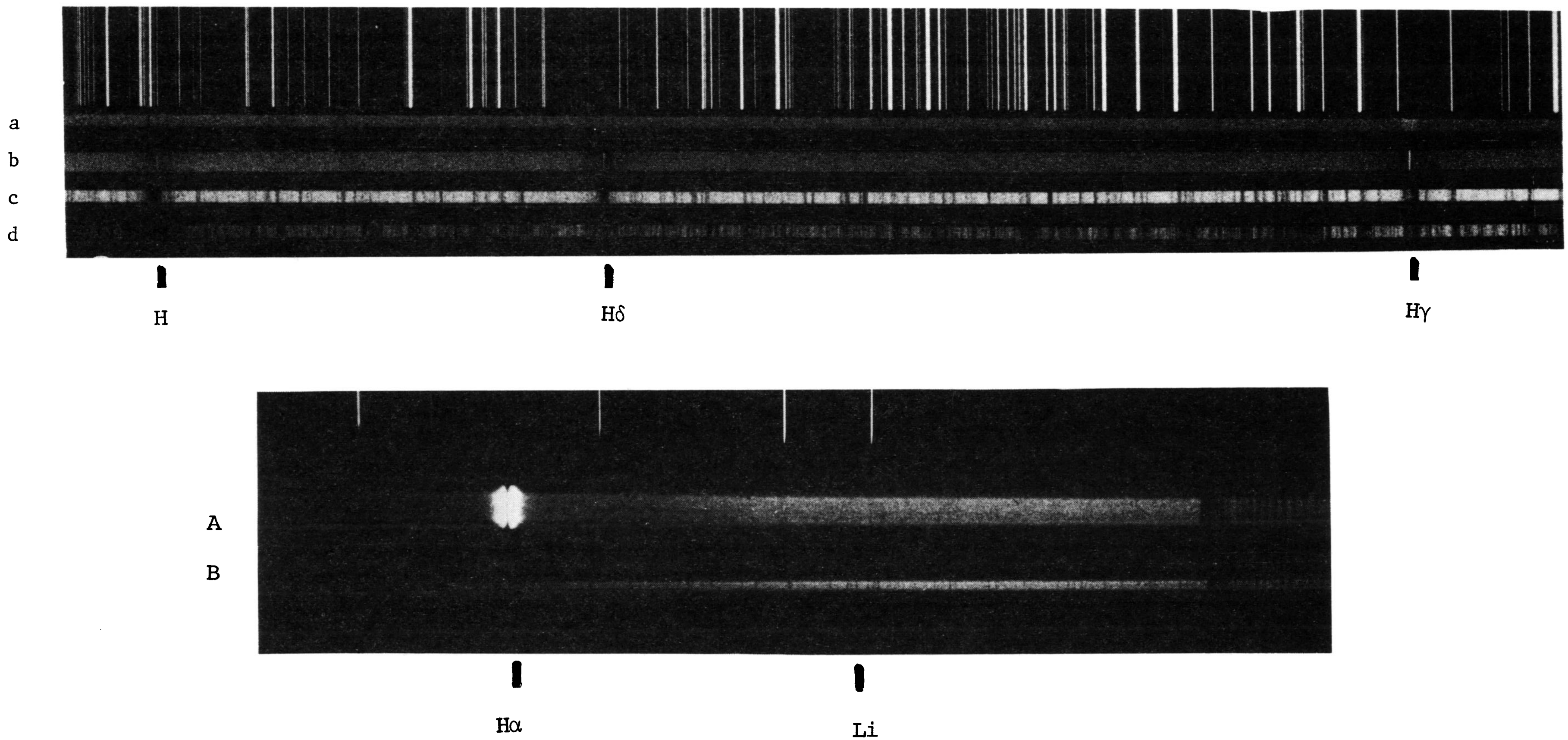

FIGURE 1. — Exemples of coudé spectrograms covering the blue spectral region (a-d) and Varo-tube spectrograms covering the red spectral region (below). (a) HD 96261 B - Broad hydrogen line emission is seen on a continuous spectrum ; (b) HD 164492 C - Narrow nebular emission lines are seen superimposed on a B6 V spectrum ; (c) HD 104901 B - Distinct P Cygni structures are seen in the hydrogen lines of this peculiar star ; (d) HD 105767 B - The H line is seen in narrow emission on this K star ; A : HD 104901 B - The Hα line in magnificent emission (see above) ; B : HD 108767 B - This star has the Li line at λ 6707 Å in strong absorption (see above).