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THE ESTABLISHMENT OF 21 NEW NINTH MAGNITUDE IAU STANDARD RADIAL VELOCITY STARS

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THE ESTABLISHMENT OF 21 NEW NINTH MAGNITUDE IAU STANDARD RADIAL VELOCITY STARS

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ABSTRACT

Twenty-four stars of photographic magnitude 8.26 to 9.64 and of spectral types F, G and K, in the declination zone +25° to +30° have been investigated for suitability as an extension of the IAU lists of standard velocity stars. The stars were observed with dispersions of 12, 20 and 15 A/mm at the David Dunlap, Haute Provence and Dominion Astrophysical Observatories respectively, and the spectrograms were measured with systems tested against the IAU system. Three of the 24 stars are believed to have small-range velocity variations. The remaining 21 are presented as new IAU standard velocity stars.

INTRODUCTION

At IAU Symposium no. 30 on "Determination of Radial Velocities and their Application" (Batten and Heard 1967), Fehrenback drew attention to the need for an extension of the lists of IAU standard velocity stars to include stars which are appreciably fainter than those in Table 2 of the Report of Sub-commission 30a in the Transactions of the International Astronomical Union, vol IX, 1955.

In 1967 Heard reported to the IAU Commission 30 meeting in Prague the selection of 24 stars in the declination zone +25° to +30° with spectral types ranging from F7 to K5 and photographic magnitudes 8.26 to 9.64 which had already appeared to have constant velocities (Heard, 1956). He proposed to re-observe these stars at higher dispersion at the David Dunlap Observatory and invited participation by others.

OBSERVATIONS

Observations of the 24 stars were begun at the David Dunlap Observatory in 1968 and continued through 1971. The 12 A/mm dispersion of the Cassegrain grating spectrograph was used with the 188-cm telescope, and the goal was to obtain seven spectrograms of each star.

At l'Observatoire de Haute Provence Fehrenbach also undertook observations of these stars with the 20 A/mm dispersion of the coudé spectrograph of the 152-cm telescope, and in 1970 and 1971 obtained from three to five spectrograms of most of the stars.

Through the kindness of Dr. K.O. Wright and his colleagues, a total of 22 spectrograms of the stars were also obtained at the Dominion Astrophysical Observatory with the 15 A/mm dispersion of the Cassegrain grating spectrograph of the 183-cm telescope.

The results which follow are based on these three sets of observations which include a total of 277 spectrograms of the program stars. In addition, 133 spectrograms of existing IAU standard velocities stars were measured to ensure that the new velocities conform to the IAU system.

After reporting our preliminary results at the meeting of IAU Commission 30 in 1970, we were authorized to present the final results as IAU standards.

MEASUREMENT AND REDUCTION

David Dunlap

The Dunlap plates were measured on a Jenna Abbe comparator, four settings being made on both iron arc comparison lines and star lines in each direction of traverse. The star lines were a selection (usually between 20 and 28 in number) of the wavelengths listed by Gorza and Heard (1971). The reductions were made either by the usual method of tables of standard settings and correction curves or by a computer program which effectively establishes the dispersion curve of each spectrogram. We compared the two methods and found that the difference seldom exceeded 0.1 km/sec.

Although our lists of lines had been, in the first place, selected with care as a result of measurements of IAU standard velocity spectrograms, we feared that the special conditions of observation of the faint program stars (projected slit width 33μ, projected slit length 0.3 mm, long exposures and sometimes large hour angles) might introduce systematic errors. In an effort to determine such errors if they existed, we observed IAU standard velocity stars almost nightly under conditions similar to those for the program stars, attempting to match the quality of the spectrograms. Fifty-six such standard velocity spectrograms were measured and reduced. The results are summarized in Table 1 which lists, for F-, G- and K-type spectra separately, the residuals in the sense IAU-DDO and the average corrections which are applicable to our velocities to bring them to the IAU system. Although the mean errors of these corrections reveal them to be only marginally significant, we did nevertheless apply these small corrections to the Dunlap program star velocities.

A study of the standard velocity results failed to reveal any correlations of residuals with length of exposure, hour angle, plate density or seeing.

Dominion Astrophysical

Of the 22 available DAO 15 A/mm spectrograms of the program stars, 11 were taken with the spectrograph fitted with a conventional slit and the remaining 11 with the use of a Richardson image-slicer. Because these plates became available to us before a standard system of selected wavelengths had been made by the DAO astronomers, we used the wavelengths which had been selected for the DDO 12 A/mm spectrograms, and, to determine the systematic corrections which might thus be introduced, we measured six spectrograms of each of F-, G- and K-type standard velocity stars taken with the conventional slit. The results for the 18 spectrograms gave an average residual (IAU-DAO) of -0.8 ± 0.3. This agrees well with the findings of Aikman (1971) who got a residual of about this same amount for DAO standard velocity spectrograms, measuring them in a different manner with a different wavelength selection. The samples used by both us and Aikman were too small to give a significant break-down of the residuals by spectral class. Accordingly, we corrected the measured velocities of all 11 of the conventional-slit spectrograms of program stars by −0.8 km/sec.

Aikman also reported a test of image-slicer standard velocity spectrograms and found no statistically significant mean residual for them. We tested our measures of the image-slicer program star spectrograms by re-computing the velocities according to the wavelengths used by Aikman and found the mean residual to be only 0.1 km/sec. Accordingly, we made no corrections to our measured velocities for these image-slicer spectrograms.

Haute Provence

The methods of measurement and reduction of the Haute Provence 20 A/mm spectrograms have been described by Fehrenbach (1972) who also analysed the results from 59 spectrograms of IAU standard velocity stars. Because he found the residuals, IAU-OHP, to be small and statistically insignificant, we have applied no corrections to the Haute Provence velocities of the program stars.

RESULTS

The results for the 24 program stars are summarized in Table II.

Column 1 gives the designation and (for the three stars not listed in Table III as new standards) the 1950 co-ordinates, the photographic magnitude and the spectral classification, the last two data being quoted from the results of Heard (1956).

Columns 2, 5, 8 give the Julian dates of the observations. Columns 3, 6, 9 give the velocities (corrected to the IAU system as indicated earlier), and columns 4, 7, 10 give the internal mean errors, i.e.

$$\varepsilon_1 = \sqrt{\frac{\Sigma v^2}{n(n-1)}},$$

where n is the number of lines measured and v is the deviation of the velocity of a line from the mean velocity for the plate.

Below the plate velocity entries in columns 2, 5, 8 are given the mean velocities from each observatory followed by the external mean errors, i.e.

$$\varepsilon_2 = \sqrt{\frac{\Sigma V^2}{N(N-1)}},$$

where N is the number of spectrograms and V is the deviation of the velocity of a plate from the mean velocity for the N plates.

Three stars, namely BD + 29° 1553, HD 160952 and HD 204934 show sufficient evidence of small-range variation of velocity to warrant their exclusion from the list recommended as new standards of velocity.

The new list of 21 IAU standard velocity stars is given in Table III.

Finally, we have the following comments on the results which we believe support their validity:

Our observations having been carried out over at least two years and more often three, there seems to be little chance that long-period variations have been missed.

For the determinations at the three observatories considered separately, the average values of the external mean errors per star are DDO ± 0.5, OHP ± 0.5, DAO ± 0.7, whereas the average values of the residuals between observatories are DDO-OHP = −0.2, DDO-DAO = +0.2. These residuals, then, seem not to be statistically significant.

Comparing the average external mean error per star in the list of IAU standard velocity stars fainter than magnitude 4.3 as given in IAU Transactions vol. IX p. 443 (after converting from P.E. to M.E.) with ours, we find that ours is somewhat better (0.34 compared to 0.44) in spite of the fact that the average number of observations per star is greater in the IAU list than in ours.

ACKNOWLEDGEMENTS

We gratefully acknowledge the help of colleagues at the three observatories in the obtaining of the spectrograms, and we thank Mr. Mark McCutcheon and Miss Molly Morrow at the David Dunlap Observatory and Mr. and Mrs. H. Petit at the Haute Provence Observatory for the measuring of most of the plates. One of us (J.F.H.) has received support for the project in the form of a research grant from the National Research Council of Canada.

REFERENCES

Aikman, C.L. 1971, private communication.

Batten, A.H. and Heard, J.F. 1967, *Determination of Radial Velocities and their Applications* (London: Academic Press), p. 70.

Fehrenbach, Ch. 1972, *Astr. and Astrophys.* (in press).

Gorza, W.L. and Heard, J.F. 1971, *David Dunlap Obs. Pub.*, 3, 99.

Heard, J.F. 1956, *David Dunlap Obs. Pub.*, 2, 107.

TABLE I

RADIAL VELOCITY RESIDUALS FROM IAU STANDARDS
MEASURED ON DUNLAP SPECTROGRAMS

F-type			G-type			K-type		
HD	Sp.	IAU-DDO km/sec	HD	Sp.	IAU-DDO km/sec	HD	Sp.	IAU-DDO km/sec
22484	F8 V	+0.3	65583	G8 V	−1.6	3712	K0 II-III	+1.1
		+0.9						
			84441	G0 II	+1.5	3765	K2 V	+1.1
36673	F0 Ib	+1.3						
			103095	G8 V	+0.9	9138	K4 III	+1.3
89449	F6 IV	+1.2			−0.9			+0.1
		−2.0						+1.4
		+0.7	109379	G5 III	+0.5			+1.6
		−0.1			−0.4			+1.8
		+0.1						+0.6
			171391	G8 III	−0.5			+0.6
102870	F8 V	+0.2			−1.4			−0.6
136202	F8 IV	+0.3	204867	G0 Ib	+0.3	26162	gK1	+0.7
		+0.3			+0.3			
					+1.5	29139	K5 III	−1.8
187691	F8 V	+0.8			−0.6			+1.3
					−0.6			
222368	F7 V	+0.6			+1.5	35410	K0 III	0.0
					+0.4			0.0
								+1.6
						66141	K2 III	+1.5
								−2.0
								−1.7
								−0.2
								−1.7
								−0.4
						92588	K1 IV	−1.5
						107328	K0 III	−0.8
						186791	K3 II	+1.5
						212943	K0 III	−0.1
								+0.7
13 plates, mean +0.3 ±0.2			15 plates, mean 0.0 ±0.1			28 plates, mean −0.2±0.2		

TABLE II

RADIAL VELOCITY MEASURES OF THE PROGRAM STARS

STAR	DAVID DUNLAP			HAUTE PROVENCE			DOMINION ASTROPHYSICAL		
	J.D. 244. . .	Vel. km/sec	ε_1	J.D. 244. . .	Vel. km/sec	ε_1	J.D. 244. . .	Vel. km/sec	ε_1
HD 4388	0525.7	−30.0	0.6	0856.5	−29.5	0.5			
	0532.6	−28.4	0.5	0858.5	−27.0	0.7			
	0571.6	−32.2	0.6	0862.5	−25.9	0.5			
	0784.2	−27.3	0.6						
	0793.2	−26.2	0.6						
	0834.7	−28.0	0.5						
	0849.8	−28.7	0.4						
		−28.7	±0.7		−27.5	±1.0			
HD 12029	0578.6	+37.1	0.8	0850.5	+37.8	0.5	0480.0	+39.1	0.6
	0804.8	+38.3	0.6	0851.6	+38.1	0.6			
	0806.9	+38.1	0.2	0853.5	+43.7	0.5			
	0834.8	+37.4	0.3	0873.0	+36.8	0.5			
	0875.5	+39.7	0.5	0874.6	+38.1	0.6			
	0923.5	+39.6	0.4						
		+38.5	±0.4		+38.9	±1.2		+39.1	
HD 14969	0621.5	−32.6	0.4	0852.6	−33.0	0.7			
	0849.8	−35.2	0.5	0862.6	−32.6	0.5			
	0895.7	−32.6	0.8	0866.5	−33.2	0.9			
	0951.5	−34.9	0.3	0873.6	−32.5	0.8			
	0953.5	−32.5	0.4						
	0958.5	−34.9	0.5						
		−33.8	±0.6		−32.8	±0.2			
HD 23169	0578.7	+12.9	0.9	0858.6	+14.2	0.5			
	0594.7	+12.6	0.8	0872.6	+14.0	0.5			
	0624.6	+13.2	0.7	0873.5	+14.8	0.3			
	0640.6	+13.5	0.8	0874.5	+13.3	0.5			
	0927.8	+13.0	0.9	0892.6	+12.8	0.4			
	0951.5	+11.9	0.7						
	0953.5	+13.0	0.5						
	0993.5	+14.2	0.6						
		+13.0	±0.3		+13.8	±0.4			
HD 32963	0223.7	−64.0	0.8	0855.6	−60.0	0.6			
	0259.5	−62.2	0.6	0857.6	−64.0	0.6			
	0266.5	−63.4	0.6	0866.5	−64.5	0.4			
	0624.7	−63.7	0.5	0872.6	−63.7	0.4			
	0849.9	−64.2	0.4	0874.6	−62.4	0.6			
	0941.8	−63.4	0.6	1190.6	−60.8	0.4			
	0942.7	−64.1	0.7						
		−63.6	±0.3		−62.6	±0.7			

TABLE II–*continued*

STAR	DAVID DUNLAP			HAUTE PROVENCE			DOMINION ASTROPHYSICAL		
	J.D. 244. . .	Vel. km/sec	ε_1	J.D. 244. . .	Vel. km/sec	ε_1	J.D. 244. . .	Vel. km/sec	ε_1
HD 42397	0259.6	+38.1	0.4	0872.6	+36.5	0.5	1026.7	+35.3	0.6
	0270.7	+36.2	0.5	0873.7	+37.0	0.4			
	0280.6	+40.5	0.6	0892.7	+39.4	0.5			
	0660.6	+36.9	0.7	0893.6	+36.9	0.5			
	1001,5	+37.3	0.8						
	1015.5	+37.6	0.6						
	1020.5	+37.0	0.7						
		+37.7	±0.5		+37.5	±0.7		+35.3	
BD+29°1553	0259.7	−7.8	0.6						
07^{h}31.^{m}4	0657.6	+1.2	0.9						
+28°51′	0665.6	+0.5	0.6						
9.29	0675.6	−2.0	0.7						
GO IV	0681.6	−1.8	0.9						
	0951.8	−5.4	0.6						
		Var.							
HD 65934	0207.8	+34.7	0.3	1051.3	+36.5	1.3			
	0280.7	+35.4	0.3	1052.3	+35.1	0.8			
	0595.8	+34.8	0.4	1053.3	+35.3	0.7			
	0658.6	+33.4	0.7						
	0662.5	+34.3	0.5						
	0927.9	+33.9	0.3						
	0955.7	+36.2	0.3						
		+34.7	±0.4		+35.6	±0.4			
HD 75935	0207.8	−19.8	0.4	1052.3	−19.3	0.8			
	0308.6	−19.8	0.5	1053.4	−20.4	1.0			
	0624.8	−19.1	0.4	1055.3	−18.9	0.5			
	0641.8	−16.9	0.8						
	0700.6	−18.8	1.2						
	1015.6	−17.9	0.9						
	1020.6	−18.2	0.6						
		−18.6	±0.4		−19.5	±0.4			
HD 86801	0269.8	−14.3	0.5	1052.4	−13.0	0.7	0943.0	−12.7	0.6
	0273.8	−15.6	0.7	1052.4	−14.9	0.7	1026.8	−17.1	0.4
	0318.6	−14.5	0.6	1053.4	−15.7	0.9	1035.8	−13.6	0.5
	0665.7	−12.6	0.6				1075.7	−14.8	0.4
	0971.9	−16.8	0.6						
	1015.7	−12.4	0.9						
	1022.7	−15.4	0.8						
		−14.5	±0.7		−14.5	±0.8		−14.5	±1.0

TABLE II–*continued*

STAR	DAVID DUNLAP			HAUTE PROVENCE			DOMINION ASTROPHYSICAL		
	J.D. 244. . .	Vel. km/sec	ε_1	J.D. 244. . .	Vel. km/sec	ε_1	J.D. 244. . .	Vel. km/sec	ε_1
HD 90861	0208.9	+36.2	0.4	1051.4	+37.7	1.3			
	0579.9	+36.4	0.3	1051.4	+36.4	0.8			
	0583.9	+36.7	0.3	1051.4	+36.5	0.8			
	0592.9	+36.3	0.3	1055.4	+34.2	1.0			
	0657.7	+36.9	0.3						
	0694.6	+38.8	0.6						
	0928.0	+33.5	0.5						
		+36.4	±0.6		+36.2	±0.7			
HD 102494	0208.0	−22.3	0.4	1051.4	−21.6	0.8	9902.9*	−24.8	0.6
	0209.0	−22.8	0.3	1051.4	−21.7	1.2	9993.9*	−24.0	0.4
	0257.7	−24.9	0.5	1055.4	−21.6	0.5	0245.0	−21.7	0.5
	0951.9	−24.3	0.6	1101.4	−22.4	0.7	1044.8	−22.9	0.5
	0967.9	−23.4	0.4	1110.4	−23.4	1.0	1063.9	−22.1	0.6
	1024.8	−21.8	1.2				1068.7	−22.5	0.7
	1027.8	−24.1	0.9						
		−23.4	±0.4		−22.1	0.3		−23.0	±0.4
HD 112299	0260.0	+6.8	0.6	1100.4	+3.0	0.6	0724.8	+3.3	0.4
	0266.7	+1.9	0.5	1101.4	+3.1	0.6	1029.9	+3.1	0.5
	0268.8	+5.0	0.6	1134.4	+2.3	0.6			
	0308.7	+3.8	0.4						
	0681.7	+1.4	0.9						
	0713.6	+2.3	1.0						
	0724.6	+1.3	1.0						
	0726.6	+7.0	0.9						
		±3.7	±0.8		+2.8	±0.3		+3.2	±0.2
HD 122693	0268.9	−4.8	0.3	1100.5	−7.3	0.7	9999.8*	−6.6	0.4
	0584.0	−6.5	0.5	1101.5	−5.2	0.5	1068.8	−5.7	0.5
	0606.9	−7.2	1.2	1102.4	−7.0	0.5			
	0657.8	−6.4	0.3	1111.4	−7.3	0.7			
	0710.8	−6.7	0.7						
	0725.8	−5.5	0.4						
	1035.8	−5.5	0.6						
		−6.1	±0.4		−6.7	±0.5		−6.2	±0.5
HD 132737	0270.8	−24.9	0.4	1101.5	−24.0	0.7	0734.7	−22.5	0.7
	0304.0	−24.8	0.5	1111.4	−23.6	0.8	1068.8	−27.4	0.6
	0624.9	−24.4	0.3	1136.4	−24.0	1.0			
	0657.9	−24.9	0.4	1143.4	−23.5	0.8			
	0726.7	−23.8	2.2						
	0727.6	−23.2	0.5						
	0743.7	−22.7	0.4						
		−24.1	±0.3		−23.8	±0.1		−25.0	±1.9

*J.D. 243 . . .

TABLE II—*continued*

STAR	DAVID DUNLAP			HAUTE PROVENCE			DOMINION ASTROPHYSICAL		
	J.D. 244. . .	Vel. km/sec	ε_1	J.D. 244. . .	Vel. km/sec	ε_1	J.D. 244. . .	Vel. km/sec	ε_1
HD 140913	0308.9	−21.2	0.6	1110.5	−18.0	0.4	9999.8*	−22.3	0.7
	0681.8	−19.1	0.7	1111.4	−18.1	0.4			
	0724.8	−22.6	0.8	1134.4	−21.5	0.7			
	0734.7	−20.1	0.6	1141.4	−20.8	0.7			
	0746.6	−21.1	0.6	1142.4	−21.9	0.8			
	0750.6	−20.8	0.4						
	1022.9	−22.8	0.7						
		−21.1	±0.5		−20.1	±0.8		−22.3	
HD 149803	0303.9	−7.0	0.6	1147.4	−9.2	0.7	0734.9	−6.1	0.9
	0367.8	−7.0	0.6	1148.4	−8.0	0.5			
	0734.8	−9.7	0.6	1149.4	−8.9	0.6			
	0735.7	−8.0	0.6						
	0745.7	−8.3	0.7						
	0760.6	−4.6	0.4						
	1015.9	−6.9	0.6						
		−7.4	±0.6		−8.7	0.4		−6.1	
HD 160952	0368.7	+20.9	0.5	1110.5	+22.5	0.9	9999.9*	+22.4	0.4
17^h39^m7	0444.7	+29.1	0.6	1111.5	+23.2	0.9			
+29°37′	0453.6	+29.2	0.7	1134.5	+24.8	0.7			
9.04	0455.6	+28.7	0.3	1136.4	+24.2	0.9			
G8 III	0736.7	+24.6	0.4						
	0759.6	+23.5	0.5						
		Var.							
HD 171232	0116.6	−35.2	0.3	0855.4	−36.9	0.5			
	0410.7	−36.5	0.6	0865.3	−37.8	0.4			
	0413.8	−38.2	0.4	0866.4	−36.7	0.6			
	0727.7	−33.6	0.3	1111.5	−36.0	0.9			
	0735.8	−38.9	0.6	1136.4	−32.4	0.9			
	0746.8	−34.2	0.6						
	0751.7	−35.1	0.5						
	0758.7	−35.6	0.4						
		−35.9	±0.7		−36.0	±0.9			
BD+28°3402	0504.5	−37.7	0.7						
	0525.5	−37.1	0.6						
	0759.7	−36.6	0.5						
	0760.7	−33.8	0.9						
	0793.7	−37.1	0.7						
	0800.6	−36.2	0.4						
	0804.7	−37.5	0.6						
		−36.6	±0.5						

*J.D. 243 . . .

TABLE II–*continued*

STAR	DAVID DUNLAP			HAUTE PROVENCE			DOMINION ASTROPHYSICAL		
	J.D. 244. . .	Vel. km/sec	ε_1	J.D. 244. . .	Vel. km/sec	ε_1	J.D. 244. . .	Vel. km/sec	ε_1
HD 194071	0418.7	−9.5	0.5	0857.4	−9.1	0.4			
	0425.7	−9.8	0.4	0861.4	−9.6	0.6			
	0751.8	−9.8	0.3	0865.4	−9.9	0.3			
	0758.8	−9.6	0.5	1136.5	−10.6	0.9			
	0773.7	−8.9	0.3	1138.6	−11.0	0.8			
	0774.7	−10.2	0.4						
	0834.6	−9.3	0.5						
		−9.6	±0.2		−10.0	0.3			
HD 204934	0546.5	−3.3	0.4	0873.3	−11.7	0.4			
$21^h29^m.0$	0547.5	−6.3	0.7	1134.5	−6.6	1.1			
$+28^o09'$	0806.7	+0.4	0.3	1191.3	−4.7	0.8			
K1 III	0861.7	−11.5	0.9						
		Var.			Var.				
HD 213947	0116.7	+16.7	0.3	0852.5	+18.2	0.7	0479.9	+16.3	0.9
	0504.6	+17.3	0.6	0856.4	+15.8	0.5			
	0525.6	+15.7	0.6	0864.4	+16.4	0.6			
	0759.8	+16.1	0.5	0893.3	+17.3	0.6			
	0774.8	+16.8	0.6	1134.6	+18.7	1.5			
	0762.7	+14.6	0.6	1136.6	+17.4	1.3			
		+16.2	±0.4		+17.3	±0.4		+16.3	
HD 223094	0116.8	+19.5	0.4	0864.4	+20.0	0.6			
	0504.7	+19.7	0.7	0864.5	+19.8	0.9			
	0525.7	+19.6	0.2	0866.4	+21.0	0.6			
	0532.6	+19.1	0.4	0867.4	+18.9	0.7			
	0576.5	+16.8	1.2	0874.4	+20.0	0.6			
	0784.8	+21.9	0.3	1134.6	+18.8	1.1			
	0806.8	+19.9	0.5						
		+19.5	±0.6		+19.8	±0.3			

TABLE III

21 NEW IAU STANDARD VELOCITY STARS

HD or BD	α(1950) h m	δ(1950) ° ′	Ptg. Mag.	Sp.	Vel. km/sec	M.E.	No. of Obs.
4388	00 43.8	+30 41	8.80	K3 III	−28.3	0.6	10
12029	01 55.8	+29 08	8.96	K2 III	+38.6	0.5	12
14969	02 22.6	+29 39	8.96	K3 III	−33.4	0.3	10
23169	03 40.9	+25 34	9.39	G2 V	+13.3	0.2	13
32963	05 04.8	+26 16	8.36	G2 V	−63.1	0.4	13
42397	06 08.5	+25 01	8.68	G0 IV	+37.4	0.4	12
65934	07 59.1	+26 47	8.87	G8 III	+35.0	0.3	10
75935	08 50.9	+27 06	9.35	G8 V	−18.9	0.3	10
86801	09 58.7	+28 48	9.48	G0 V	−14.5	0.4	14
90861	10 27.1	+28 50	8.36	K2 III	+36.3	0.4	11
102494	11 45.3	+27 37	8.26	G8 IV	−22.9	0.3	18
112299	12 53.0	+26 01	9.19	F8 V	+ 3.4	0.5	13
122693	14 00.5	+24 48	8.74	F8 V	− 6.3	0.2	13
132737	14 57.7	+27 21	9.03	K0 III	−24.1	0.3	13
140913	15 43.1	+28 37	8.81	G0 V	−20.8	0.4	13
149803	16 33.9	+29 51	8.90	F7 V	− 7.6	0.4	11
171232	18 30.6	+25 27	8.66	G8 III	−35.9	0.5	13
28° 3402	19 33.0	+28 59	9.55	F7 V	−36.6	0.5	7
194071	20 20.5	+28 05	9.06	G8 III	− 9.8	0.1	12
213947	22 32.3	+26 20	8.93	K4 III	+16.7	0.3	13
223094	23 43.9	+28 26	8.97	K5 III	+19.6	0.3	13

David Dunlap Observatory,
Richmond Hill, Ontario,
October, 1972.