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An investigation of the micro-variations of highly luminous OBA type stars. I (*)

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Summary. — VBLUW photometry of eight OB type stars of high luminosity ($M_{\rm bol} < -7$) is presented. This is the first paper of a series dealing with the search for possible micro variations in the brightness and colours of highly luminous OBA type stars

This paper discusses the standard deviations, the mean errors and the variations in the photometric parameters relative to the comparison stars. The mean errors of the nightly averages of these relative brightnesses and colours amount to $\leq \pm 0$. All program stars appear to be variable in brightness, ranging from about 0.01 to 0.1 with time-scales of days or weeks. One star HD 37022 (O7.0 V) shows a secular increase in brightness by ~ 0.012 within an interval of ~ 2 yr. The fact that some stars exhibit much larger standard deviations in the colour index *B-U* than one would expect for a constant colour, suggests that temperature and/or density variations occur on or close to the surfaces of these stars in a time scale of days or shorter.

Key words: early type stars — supergiants — variable stars — photometry.

1. Introduction.

In 1980 a survey was started to investigate the photometric stability of OBA type stars of high luminosity (see the Introduction of the paper in the Main Journal, van Genderen 1985, hereafter called Paper II). The luminosity classes of the stars are I and II with a few of class V. The absolute bolometric magnitude $M_{\rm bol} < -7$.

The desired mean error for the nightly averages (abbreviated NA), in the sense program star minus comparison star, was of the order of \pm 0.002 or smaller for the brightness and the colour indices. This put high demands not only on the selection of the comparison stars, but also on the observing technique. Our technique thus differs from that of the Geneva group, which does not use comparison stars for the study of micro variability, but only standard stars (Rufener and Bartholdi, 1982; Burki, 1984 and references therein). The comparison stars should be of luminosity class V to III and of lower absolute magnitudes than those of the program stars. The reason is that according to the results of the large photometric program of e.g. Maeder and Rufener (1972) and Burki (1978), the microvariability strongly decreases with the luminosity.

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Nevertheless several small groups of low luminosity B type stars are now known, showing periodic or quasi-periodic light variations. Their periods are of the order of a day and the amplitudes are in the range $\leq 0^m$.1 (Waelkens and Rufener, 1983). Thus one should always be cautious Spectral types of the comparison stars should preferably be late B or early A and their apparent magnitude ≤ 9 . Furthermore, they should not be located more than a few degrees from the program stars, in order to minimize the differential extinction corrections. Sky background measurements should always be taken at the same position, and standard stars should be measured frequently throughout the night. In our survey most of these requirements could be met.

2. The observations and reductions.

The observations were made with the 90 cm Dutch Light Collector stationed at the ESO, La Silla. This telescope is equipped with the five-colour simultaneous *VBLUW* photometer of Walraven. Descriptions of the photometer and the photometric system are given by Walraven and Walraven (1960), Rijf *et al.* (1969) and Lub and Pel (1977).

A number of OBA type stars of high luminosity were selected of which eight of them will be discussed in the present paper and in Paper II. Nearby comparison stars were also selected; they are listed in table I.

^(*) Observations collected at the ESO, La Silla, Chile.

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As a rule each program star was measured eight times alternated with the comparison star. Sky backgrounds preceded and ended the cycle, with a third one in the middle of the sequence. They were always linearly interpolated in order to correct for a changing sky brightness during moon nights. The sky positions were always the same and usually close to the program stars. That this demand is necessary, considering the highly desired accuracy, is clear from the differences in the photometric data of the comparison star HD 93596, which has been used for two different program stars (table I).

Table I lists the photometric and spectroscopic data of the comparison stars. The VBLUW photometric data are given in log intensity scale. The V and B-V of the Johnson UBV system (with subscript J) are in magnitude scale. V_J is transformed from the equivalent V of the VBLUW system with the aid of a relation given by Pel (1983). (B- $V)_J$ is transformed from the equivalent V-B of the VBLUW system with the aid of a calibration determined by Lub (1982). The standard deviations (s.d.) and the total number (n) of the nightly averages (NA) are also listed in table I and discussed in section 3. The internal s.d. for one NA is defined by :

$$s.d. = \sqrt{\frac{\sum_{i=1}^{n} (m_i - \overline{m})^2}{n-1}}$$

in which $\overline{m} = \sum m_i/n$ is the mean log intensity. The internal mean error (*m.e.*) is thus $s.d./\sqrt{n}$.

Table II lists the NA of the brightness differences in the sense program star minus comparison star for V (called ΔV) and for the colour indices (called $\Delta (V-B)$, $\Delta (B-U)$, $\Delta(U-W)$ and $\Delta(B-L)$. The latter are tabulated only if they clearly show variations. This is adopted to be the case if one or more of the colour curves in the phase diagrams (Paper II), also show a cyclic variation. If no such variation is present, only the averages (relative to the comparison star) are listed in table III, below the colour indices (which are on the natural VBLUW system) together with the s.d. of these relative colour indices. Only HD 62150 (B3/5 Iab) and HD 96248 (B1 Iab) were found to have two colour curves showing clearly a cyclic variation. The colour curves are also represented in table III by an average value and their s.d.'s are bracketed if extrema are obviously present. The column for V lists the average brightness with respect to the standard stars and their s.d.'s.

The average *m.e.* in the NA of the ΔV values appears to amount to ± 0.0004 with a spread of -0.0002 and +0.0003. Thus, the desired accuracy (Sect. 1) of $\leq 0^{\text{m}}.002$

has been reached indeed. The average m.e.'s in the NA of the relative colour indices ($\Delta(V-B)$ etc.) appear to amount to \pm 0.0003 with a spread of - 0.0001 and + 0.0004. The m.e. in $\Delta(V-B)$ is usually smallest and in $\Delta(U-W)$ largest.

The Julian Dates given in three decimals in table II refer to the middle of the measuring sequence. It was not considered necessary to derive a heliocentric correction.

Sometimes the series of observations was repeated once or more times in the same night (marked in table II by an asterisk). In most cases the differences between the averages were of the size of the just quoted *m.e.* An exception for example is HD 96248, which showed at JD 2445011 a total increase in its brightness by 0.0024 during subsequent series.

3. The stability of the comparison stars and the variability of the program stars.

Figure 1 shows the trend of the standard deviations (in log intensity scale) of V and the colour indices of the comparison stars as a function of the visual brightness V_J (in magnitude scale). HD numbers and spectral types are indicated. HD 93596 is plotted twice because it has been used separately for two different program stars, often during the same nights. The double circles will be explained later.

It appears from figure 1 that especially the s.d. for V are sensitive to the brightness: they range from \pm 0.0040 for $V_{\rm J} \sim 9^{\rm m}$ to \pm 0.0025 for $V_{\rm J} \sim 5^{\rm m}$. This variation is only partly governed by the photon statistic, therefore the stars are still too bright, so the fluctuations in the extinction and the atmospheric scintillation are the main cause. The s.d. for the colour indices are twice as small. Within certain limits this diagram indicates how stable the comparison stars are. Thus, strictly speaking, we are not sure that the comparison stars are constant in V within a limit somewhat smaller than 0.0025-0.0040 (or equivalently 0\mathbb{m}:006-0\mathbb{m}:010). However, it can be shown that the scatter around the mean light curves, exhibited by most of the program stars is largely intrinsic (see Paper II). Thus it is unlikely that the comparison stars are variable with a range that large.

Figures 2 and 3 show the NA of ΔV of two program stars HD 76556 (O5.5 VNF) and HDE 305523 (O9 II), respectively, as a function of the date. Smooth curves have been sketched through the NA to indicate the timescales and amplitudes of the fluctuations. The derived maximum m.e. of the NA (0.0007, Sect. 2) has been indicated by bars at the left top. The variations are clearly at least four times larger, namely \pm 0.0030. Since the program stars, because of their much higher luminosity, are supposed to be the ones which are variable they must be the main cause of the variations.

Figure 4 shows the NA of ΔV of the program star HD 93205 (O3 V). It should be noted that the same comparison star as for HDE 305523 has been used in figure 3. Most of the NA of both program stars have thus been obtained in the same nights (March 1982 and February 1983). A close inspection of the fluctuations in these nights in common, shows that no correlation exists.

The s.d. of the scatter of V of the program stars (V is directly obtained from a comparison with the standard stars, thus similar to the comparison stars), were also determined.

For four of the program stars, HD 57061 (O9 I), HD 62150 (B3/5 Iab), HD 96248 (B1 Iab) and HD 105056 (O9.7 IaeN), the light variations are so large that they are definitely real: they range from 0.0200 up to 0.0500 (Paper II). A fifth star HD 37022 (O7.0 V), shows an s.d. only slightly larger than the expected average s.d. (Sect. 2), because it does show a slow secular increase in brightness during ~ 2 yr of observing by ~ 0.0050 in V and a secular change in the colours by ~ 0.0010 (Fig. 5). Thus a discussion of the s.d. of these five stars has little sense.

Three stars remain, which were already discussed before, namely HD 76556 (O5.5 VNF), HD 93205 (O3 V) and HDE 305523 (O9 II). Since their maximum fluctuations in ΔV are small (namely \pm 0.0030 for the first and third star and \pm 0.0045 for the second one), it is of interest to plot the s.d. of the scatter in the V values, directly obtained from a comparison with the standard stars, in figure 1 also. They are represented by double circles. A line connects them with their respective comparison stars. HD numbers are indicated.

It is evident that in view of its visual brightness V_J , HD 93205 shows a larger s.d. than we expect from a non-variable star (as the plotted comparison stars are supposed to be). The s.d.'s of HD 76556 and HDE 305523 do not differ much from those of the comparison stars. This must be considered as accidental in view of the spread in the s.d.'s of the comparison stars. Besides, their amplitudes of variation are small, indeed, but real (Paper II).

It is not the purpose of this paper to discuss the real variations of the program stars into detail. Nevertheless it is important to discuss here the scatter in the average *NA* of the *relative* colour indices. This is particularly true if the colour curves do not show clear extrema, which is the case for most of the colour curves.

Table III lists the average relative colour indices for all colour curves and their s.d's. It is obvious that mutually large differences exist between these s.d's, despite the small m.e. in the individual NA, which for most of them is only ± 0.0003 with a maximum range to a larger m.e. of at most + 0.0007 (Sect. 2).

It is also obvious from table III that HD 37022 (V) is a star of which the s.d.'s are of the above mentioned value, although we had expected them to be smaller since the star is very bright. However, this can be explained by its slow secular variation (Fig. 5). HD 105056 (Ia) and HD 57061 (I) for example, show s.d.'s much larger than these values, especially in $\Delta(B-U)$. It is also important to note that the s.d.'s in $\Delta(B-U)$ are often of the same size as those for $\Delta(U-W)$, despite the fact that the W passband has the lowest intensity. Since the U band lies in the Balmer continuum at the short wavelength side of the Balmer-jump, these large s.d.'s suggest temperature and/or density variations on or close to the stellar photosphere on a time scale of days.

It is possible to check mathematically whether the s.d.'s in the \overline{NA} (that is the average of all NA) are caused by systematic effects (variability of a star), or whether it is compatible with the m.e. in the individual NA. Let the weights of the individual NA be:

$$W_i = \frac{1}{\mu_i^2}$$

in which μ_i is the *m.e.* of the NA of the colour indices designated by X_i . Then the value for \overline{NA} (listed in table III) is:

$$\overline{X} = \frac{\sum_{i} W_{i} X_{i}}{\sum_{i} W_{i}}$$

in which the weight of $\overline{X} = \sum_{i} W_{i}$.

If the deviations of X_i from \overline{X} are:

$$\Delta_i = X_i - \overline{X}$$

then the m.e. of the unit weight is:

$$\mu_{w=1} = \sqrt{\frac{\sum_{i} W_{i} \Delta_{i}^{2}}{n-1}}$$

which should be equal to 1 if no systematic effects are present; in other words if the star is constant in the colour index X. Consequently, the s.d. of $\overline{N}A$ can only be attributed to the m.e. of all individual NA. If $\mu_{w=1} > 1$, in particular if it is $\gg 1$, the colour index is variable. This appeared to be often the case and is confirmed in Paper II, where even with no cyclic variation, relatively large daily fluctuations are present. These fluctuations are obviously real in view of the fact that mutual correlations exist.

4. Conclusions.

We have shown that the nightly averages (NA) of brightnesses and colour indices relative to the comparison stars have mean errors of the order of $\leq \pm 0.0007$ or equivalently $\leq \pm 0.0002$.

The size of the visual brightness variations can be summarized as follows:

- four program stars show, on time scales of days or weeks, intrinsic variations ranging from 0.0200 up to 0.0500 which can be easily seen by eye inspection. These stars are: HD 57061 (O9 I), HD 62150 (B3/5 Iab), HD 96248 (B1 Iab) and HD 105056 (O9.7 IaeN).
- three stars HD 76556 (O5.5 VNF), HD 93205 (O3 V) and HD 305523 (O9 II) presumably show intrinsic variations between 0.0050 and 0.0070, on time scales of days or shorter;
- one star, HD 37022 (O7.0 V), presumably shows no intrinsic variations on such a short timescale, but rather a secular increase in the visual brightness by ~ 0.0050 within ~ 2 yr (the comparison star is constant, it is a standard star of the VBLUW system and has been used for many years).

The variations of the colour indices can be summarized as follows: for some stars (such as HD 57061 (O9 I), HD 62150 (B3/5 Iab), HD 96248 (B1 Iab) and HD 105056 (O9.7 IaeN)), the colour indices clearly vary, since the s.d.'s of the average colour indices (thus of \overline{NA}) are larger by a factor 2 to 4 than the s.d.'s of the individual NA. Especially (B-U) shows this effect, suggesting that the Balmer continuum and/or the size of the Balmer-jump varies by temperature and/or density variations near the surfaces of these stars on time scales of days or shorter.

The secular colour variations of HD 37022 are ~ 0.0010 in V-B (bluer), B-U (redder) and B-L (redder). U-W is approximately constant. Consequently, the brightnesses in the ultraviolet passbands L, \hat{U} and W increase slower than that in B and are roughly equal to that in V.

It is of interest to mention here some results of the last Geneva catalogue according to Rufener (priv. comm.). The s.d.'s for six stars of our sample confirm that they are variable. HD 76556 was not registered as such for the time being and HDE 305523 was not measured.

All these variations will be discussed and investigated in more detail in Paper II.

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Table I. — Photometric and spectroscopic data of the comparison stars. (The indicated errors are standard deviations).

HD	Sp	n	V	V-B B-U (log intensity)		U-W	B-L	V _J (mag)	(B-V) _J	comparison sta of HD/HDE	
36512	BOV 1	35	0.9083 + 26	-0.0933 + 12	-0.0887 + 14	-0.0470 + 18	-0.0496 + 11	4.627 + 7	-0.265 ± 3	37022	
58612	B9(III)	¹ 20	0.4383 + 21	-0.0374 + 10	0.2381 + 16	0.0627 + 16	0.0505 + 17	5.797 + 5	-0.110 ± 3	57061	
67162	A0IV/V ⁴	45	-0.5430 + 32	_0.0056 + 11	0.3001 + 13	0.0641	0.1261 + 16	8.246 + 8	-0.010 + 3	62150	
75212	в8/9V ³	24	-0.6071 ± 35	-0.0232 + 17	0.2741	0.0576 + 18	0.0899 + 13	8.409 + 9	-0.080 + 4	76556	
93596	в5III ²	21	-0.7585 ± 47	-0.0239 ± 16	0.1933 ± 14	0.0350 ± 17	0.0576 ± 13	8.788 ± 12	-0.082 ± 4	93205	
		22	-0.7561 ± 45	-0.0231 + 18	0.1904 + 11	0.0376 + 16	0.0562 + 11	8.782 + 11	-0.080 + 5	305523	
97223	в3v ²	16	-0.7388 + 32	0.0346 + 22	0.1775 + 18	0.0588 + 16	0.0515 + 13	8.733 + 8	0.060 + 6	96248	
102207	Alv ²	18	-0.9381 ± 42	0.0767 ± 16	0.4759 ± 11	0.1423 ± 21	0.1995 ± 10	9.225 ± 10	0.165 ± 4	105056	

Spectral type according to the HD catalogue, luminosity class according to our photometry Spectral type and luminosity class according to Houk and Cowley (1975)
Spectral type and luminosity class according to Houk (1978)
Spectral type and luminosity class according to Houk (1982)

Table III. — Photometric and spectroscopic data on the program stars. Second row of the V column gives the standard deviation. Second row of the colour indices gives the colour indices relative to the comparison star with the standard deviation (see Sect. 2).

HD/HDE	Sp	Cluster	v	V-B Δ(V-B) (log int	B-U Δ(B-U) ensity)	Δ(W-M)	B-L Δ(B-L)	V _J (π	(B-V) _J nag)	HR No/Name
37022	06ep ⁵ 07.0V ⁴	OriOB1	0.7199 ± 27	-0.022 0.0716 + 5	-0.046 0.0431 + 6	-0.024 0.0234	-0.021 0.0288 + 6	5.09	-0.09	1895/41 p ¹ Ori
57061	g+09.5 ³	NGC2362	0.9923 ± 82	-0.052 -0.0143	-0.076 -0.3145	± 4 -0.029 -0.0918	-0.041 -0.0910	4.42	-0.16	2782/30 τCMa
62150	B3/5Iab ⁶	NGC2439	-0.3280 ± 94	± 9 0.201 0.1958	± 12 0.179 -0.1209	± 8 0.147 0.0827	± 11 0.077 0.0486	7.69	0.45	
76556	06 ¹ 05.5VN(f) ⁴	VelaOB1	-0.5321 ± 34	(± 10) 0.179 0.2023	(± 28) 0.056 -0.2176	± 18 0.086 0.0280	± 13 0.050 -0.0396	8.20	0.38	
93205	d03 ³ 03V ⁴	Tr. 16	-0.3477 ± 50	± 4 0.036 0.0596	± 8 -0.042 -0.2356	± 10 0.001 -0.0338	± 9 -0.012 -0.0693	7.76	0.05	
96248	Bllab ²	CarOB2	0.1210 ± 92	± 4 0.104 0.0698 + 12	± 9 0.033 -0.1447 (+ 20)	± 9 0.058 -0.0011 + 11	± 7 0.016 -0.0347	6.58	0.22	
105056	09/B0Ia ² 09.7IaeN ⁴		-0.2028 ± 116	0.037 -0.0398	-0.032 -0.5080	0.011 -0.1312 + 19	(± 9) -0.009 -0.2088 + 8	7.39	0.05	
305523	09114	Coll. 228	-0.6512 ± 42	± 12 0.074 0.0971 ± 5	± 17 -0.004 -0.1946 ± 9	0.018 -0.0191 ± 9	0.007 -0.0488 ± 8	8.51	0.14	

Houk (1978)

Houk (1978)
HOuk and Cowley (1975)
IUE Low Dispersion Spectra (1984)
Cruz-Gonzalez et al. (1974)
Kennedy and Buscombe (1974)
Houk (1982)

Table II. — The nightly averages (NA) of the program stars relative to the comparison stars ($\Delta D = J.D. - 2440000$).

HD 37022	HD 7	6556	HD 105	5056
ΔD ΔV	ΔD	۸۷	ΔD	۸۷
4545.8611911	4659.788	.0773	5365.844	.7174
4546.8611919	4665.698	.#735	5366.851	.7316
4561.8191916	4667.785	.ø755	5369.833	.74.85
4565.7431912	4668.758	.8746	5378.837	.7378
4566.7361918	4678.748	.8726	5372.8#5 5374.84#	.7338
4568.76#1916 4569.7361915	4978.882	.0742	5374.848	.7241
4668.5491896	4974.833	.0750	5377.8ø9	.7385
4676.5421884	4975.758	.0731	5378.819	.7421
4677.5971987	4978.799	.ø75ø	5379.826	.7348
4678.5281898	5#31.58#	.0750	5380.813	.7267
4679.5211896 4688.5211888	5Ø31.76Ø 5Ø32.625	.0760 .0734	5381.823 5383.819	.7534
4681.5141899	5#32.625	.0782	5384.813	.728#
4682.5211896	5#34.635	.Ø773	5385.823	.7485
4683.54919#1	5#36.67#	.Ø731	5386.813	.7234
4952.6281873	5ø37.677	.Ø736	5387.819	.7174
4954.7881872	5#38.66#	.0750	5388.813	.7428
4959.7921876 4975.5661873	5Ø43.583* 5Ø43.719*	.Ø758* .Ø786*	HDE 3055	23
4976.5881879	5366.89#	.0778	ΔD	Δν
4977.5731881	5378.748	.Ø728	5.031.792	.1076
5311.7811866	5375.7#8	.8748	5#32.667*	.1#55*
5331.6151864	5376.7#8	.0765	5#32.813*	.1854*
5333.6071857 5370.6041863	538Ø.7Ø1 5381.7Ø8	.Ø721 .Ø724	5Ø33.823 5Ø34.681	.1854
537Ø.6Ø41863 5381.5831863	5381.788	.8764	5034.881	.1846
5382.5831883	5383.7#5	.0734	5ø37.771	.1#31
5383.58#1866	5384.785	.8746	5366.83#	.1855
5384.5831868	5385.715	.Ø765	5369.8#9	.1030
5385.5831857	5386.781	.Ø771	5370.823	.1849
5386.59#186# 5387.5831861	5387.7#8 5388.7#5	.Ø776 .Ø784	5372.771 5374.819	.1051
5389.5831857		3205	5376.774	.1ø33
5390.5731869	}		5378.799	.1871
HD 57061	ΔD	ΔV	5379.8#6	.1847
ΔD ΔV	5Ø12.771* 5Ø12.795*	.4181*	5380.785	.1ø35
4567.833 .56#1	5812.795*	.4898*	5381.764 5382.83Ø	.1049
4654.733 .5489	5812.838*	.4098*	5383.802	.1861
		.4152*	5384.792	.1857
4655.611 .5592	5013.708*	.4152-		
4657.674 .5586	5Ø13.729*	.4147*	5385.806	.1052
4657.674 .5586 4676.688 .5482	5Ø13.729* 5Ø14.7Ø8	.4147* .4Ø87	5385.8Ø6 5386.795	.1052
4657.674 .5586	5813.729* 5814.788 5815.886	.4147* .4887 .4113	5385.806 5386.795 5387.802	.1852 .1837 .1854
4657.674 .5586 4676.6#8 .5482 4677.74# .5483	5Ø13.729* 5Ø14.7Ø8	.4147* .4Ø87	5385.806 5386.795 5387.802 5388.792	.1852 .1837 .1854 .1843
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483	5813.729* 5814.788 5815.886 5816.722 5828.726 5831.656	.4147* .4887 .4113 .4887 .4187 .4125	5385.806 5386.795 5387.802	.1852 .1837 .1854
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483 5333.792 .5587	5813.729* 5814.788 5815.886 5816.722 5828.726 5831.656 5832.687	.4147* .4887 .4113 .4887 .4187 .4125	5385.806 5386.795 5387.802 5388.792 5423.719	.1852 .1837 .1854 .1843 .1836
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483 5333.792 .5587 5366.712 .5618	5013.729* 5014.708 5015.806 5016.722 5020.726 5031.656 5032.607 5033.719	.4147* .4887 .4113 .4887 .4187 .4187 .4125 .4873 .4184	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483 5333.792 .5587	5813.729* 5814.788 5815.886 5816.722 5828.726 5831.656 5832.687 5833.719 5834.771	.4147* .4887 .4113 .4887 .4187 .4125 .4873 .4184 .4187	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597 5449.632	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836 .1877
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483 5333.792 .5587 5366.712 .5618 5367.788 .5473	5813.729* 5814.788 5815.886 5816.722 5828.726 5831.656 5832.687 5833.719 5834.771 5835.882	.4147* .4887 .4113 .4887 .4187 .4125 .4873 .4184 .4187 .4096	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836
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4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483 5333.792 .5587 5366.712 .5618 5367.788 .5473 5378.694 .5537 5376.667 .5472 5388.649 .5589 5381.632 .5465	5813.729* 5814.788 5815.885 5816.722 5828.726 5831.656 5832.687 5833.719 5834.771 5835.882 5836.646 5837.823 5838.819	.4147* .4887 .4113 .4887 .4125 .4873 .4184 .4187 .4096 .4182 .4134	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597 5449.632	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836 .1877
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4952.734 .5528 4952.736 .5483 5333.792 .5587 5366.712 .5618 5367.788 .5473 5378.694 .5537 5376.667 .5472 5388.649 .5585 5382.667 .5885 5382.667 .5886	5813.729* 5814.788 5815.886 5815.886 5816.722 5828.726 5833.656 5832.687 5833.719 5834.771 5835.882 5836.646 5837.823 5838.819 5366.813	.4147* .4887 .4113 .4887 .4125 .4873 .4184 .4187 .4186 .4896 .4182 .4134 .4868	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597 5449.632	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836 .1877
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4958.774 .5528 3533.792 .5587 5366.712 .5618 5367.788 .5473 5378.694 .5537 5376.667 .5472 5388.649 .5589 5381.632 .5465 5383.668 .5411	5813.729* 5814.788 5815.886 5816.722 5828.726 5831.656 5832.687 5833.719 5834.771 5835.882 5836.646 5837.823 5838.819 5366.764	.4147* .4887 .4113 .4887 .4125 .4873 .4184 .4187 .4896 .4182 .4134 .4868 .4869	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597 5449.632	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836 .1877
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483 5333.792 .5587 5366.712 .5618 5367.788 .5473 5378.694 .5537 5376.667 .5472 5388.649 .5589 5381.632 .5465 5382.667 .5588 5383.668 .5411	5813.729* 5814.788 5815.886 5815.886 5816.722 5828.726 5833.656 5832.687 5833.719 5834.771 5835.882 5836.646 5837.823 5838.819 5366.813	.4147* .4887 .4113 .4887 .4125 .4873 .4184 .4187 .4186 .4896 .4182 .4134 .4868	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597 5449.632	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836 .1877
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483 5333.792 .5587 5366.712 .5618 5367.788 .5473 5378.694 .5537 5376.667 .5472 5388.649 .5589 5381.632 .5465 5382.667 .5588 5383.687 .5588	5813.729* 5814.788 5815.886 5816.722 5828.726 5831.656 5832.687 5833.719 5834.771 5835.882 5836.646 5897.823 5838.819 5366.813 5367.764	.4147* .4887 .4113 .4887 .4125 .4873 .4184 .4187 .4896 .4182 .4134 .4868 .4869 .4186	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597 5449.632	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836 .1877
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483 5333.792 .5587 5366.712 .5618 5367.788 .5473 5378.694 .5593 5386.694 .5593 5386.695 .5471 5388.695 .5491 5388.697 .5588 5383.668 .5411 5384.656 .5628 5385.678 .5535 5386.633 .5613 5387.663 .5627	5813.729* 5814.788 5815.886 5816.722 5828.726 5831.656 5831.656 5832.687 5833.719 5834.771 5835.882 5836.646 5837.823 5838.819 5366.813 5367.764 5378.886	.4147* .4887 .4113 .4887 .4125 .4873 .4125 .4873 .4184 .4187 .4182 .4134 .4868 .4168 .4168 .4869 .4186 .4869 .4186	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597 5449.632	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836 .1877
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483 5333.792 .5587 5366.712 .5618 5367.788 .5473 5376.667 .5472 5388.649 .5537 5376.667 .5472 5388.649 .5589 5381.632 .5465 5383.668 .5411 5384.656 .5628 5383.668 .5411 5384.656 .5628 5385.678 .5528 5386.663 .5613	5813.729* 5814.788 5815.886 5815.886 5816.722 5828.726 5831.656 5831.656 5832.687 5833.719 5834.771 5835.882 5836.646 5837.823 5836.819 5366.813 5367.764 5378.886 5372.758 5374.778 5367.757	.4147* .4887 .4113 .4887 .4125 .4873 .4184 .4187 .44896 .4182 .4134 .4868 .4869 .4186 .4869 .4186 .48897 .4125	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597 5449.632	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836 .1877
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483 5333.792 .5587 5366.712 .5618 5367.788 .5473 5378.694 .5593 5386.694 .5593 5386.695 .5471 5388.695 .5491 5388.697 .5588 5383.668 .5411 5384.656 .5628 5385.678 .5535 5386.633 .5613 5387.663 .5627	5813.729* 5814.788 5815.886 5815.886 5816.722 5828.726 5831.656 5832.687 5833.719 5834.771 5835.882 5836.646 5837.823 5838.819 5366.813 5367.764 5374.778 5376.757 5388.736	.4147* .4887 .4187 .4187 .4187 .4187 .4187 .4896 .4184 .4184 .4868 .4869 .4186 .4889 .4186 .4889 .4125 .4888 .41127 .4892	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597 5449.632	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836 .1877
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483 5333.792 .5587 5366.712 .5618 5367.788 .5473 5378.694 .5593 5386.694 .5593 5386.695 .5471 5388.695 .5491 5388.697 .5588 5383.668 .5411 5384.656 .5628 5385.678 .5535 5386.633 .5613 5387.663 .5627	5813.729* 5814.788 5815.886 5816.722 5828.726 5831.656 5832.687 5833.719 5834.771 5835.882 5838.819 5366.813 5367.764 5378.886 5372.758 5374.778 5376.757 5388.736	.4147* .4813 .4887 .4167 .4167 .4164 .4167 .4164 .4169 .4169 .4166 .4869 .4166 .4869 .4186 .4868 .4118 .4127 .4868 .4118 .4127 .4892 .4118	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597 5449.632	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836 .1877
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483 5333.792 .5587 5366.712 .5618 5367.788 .5473 5378.694 .5593 5386.694 .5593 5386.695 .5471 5388.695 .5491 5388.697 .5588 5383.668 .5411 5384.656 .5628 5385.678 .5535 5386.633 .5613 5387.663 .5627	5813.729* 5814.788 5815.886 5815.886 5816.722 5828.726 5831.656 5831.656 5832.687 5833.719 5836.646 5837.829 5836.819 5366.813 5367.764 5378.886 5372.758 5374.778 5388.736 5381.743 5382.889 5383.774	.4147* .4887 .4113 .4887 .4167 .4167 .4164 .4187 .4184 .4187 .4896 .4186 .4868 .4186 .4868 .4186 .4868 .4186 .4893	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597 5449.632	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836 .1877
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483 5333.792 .5587 5366.712 .5618 5367.788 .5473 5378.694 .5593 5386.694 .5593 5386.695 .5471 5388.695 .5491 5388.697 .5588 5383.668 .5411 5384.656 .5628 5385.678 .5535 5386.633 .5613 5387.663 .5627	5813.729* 5814.788 5815.886 5816.722 5828.726 5831.656 5832.687 5833.719 5834.771 5835.882 5838.819 5366.813 5367.764 5378.886 5372.758 5374.778 5376.757 5388.736	.4147* .4813 .4887 .4167 .4167 .4164 .4167 .4164 .4169 .4169 .4166 .4869 .4166 .4869 .4186 .4868 .4118 .4127 .4868 .4118 .4127 .4892 .4118	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597 5449.632	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836 .1877
4657.674 .5586 4676.688 .5482 4677.748 .5483 4682.691 .5688 4958.774 .5528 4952.736 .5483 5333.792 .5587 5366.712 .5618 5367.788 .5473 5378.694 .5593 5386.694 .5593 5386.695 .5471 5388.695 .5491 5388.697 .5415 5388.698 .5411 5384.656 .5628 5385.678 .5535 5386.663 .5613 5386.633 .5613	5813.729* 5814.788 5815.886 5815.886 5816.722 5828.726 5831.656 5831.656 5832.687 5833.719 5834.771 5835.882 5836.646 5837.823 5836.819 5366.813 5367.764 5378.886 5372.758 5374.778 5381.743 5382.774 5384.743	.4147* .4887 .4187 .4187 .4187 .4127 .4873 .4184 .4184 .4182 .4184 .4868 .4869 .4186 .4869 .4186 .4897 .4125 .4891 .4115 .4892 .4118 .4127 .4893 .41147 .4184 .4119	5385.886 5386.795 5387.882 5388.792 5423.719 5424.698 5426.663 5429.597 5449.632	.1852 .1837 .1854 .1843 .1836 .1858 .1817 .1836 .1877
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AD AV A(V-B) A(B-U) A(U-W) A(B-L) 4654.792 .2336 .1974 -1.1254 .87988466 .4655.736 .2361 .1968 -1.1254 .88168488 .4656.733 .8718 .87211485 .8816 .8557.736 .2282 .19791249 .88288475 .4657.758 .2292 .19791249 .88288475 .4656.757 .2217 .19711174 .88988423 .4666.733 .8718 .87211485 .8886 .8662.757 .2177 .19711174 .88988423 .4668.757 .2177 .19711174 .88988423 .4668.757 .2278 .19711224 .88358489 .8453 .87221443 .88858 4952.7575 .2278 .19711224 .88358489 .8453 .87221448 .88858 4952.7575 .2278 .19711224 .88358489 .8453 .87221448 .88858 4955.882 .2113 .19561237 .88988 4958 .859 .8667 .144588238 4955.882 .2113 .19561227 .88318499 .5811.733* .8659 .8669 .1451 .88198 4959.813 .2263 .19611227 .88318499 .5811.838 .2263 .19611227 .88318498 .5811.838 .8667 .86681451 .88198 4972.764 .2193 .19491197 .8813 .88928 5813.723 .8552 .8659 .8688 .1437 .8889 .8 4972.638 .2181 .19561221 .89278499 .5811.638 .2181 .19561221 .8927 .8949 .5813.723 .8552 .8659 .1423 .8889 .8949 .4977.688 .2181 .19581266 .88488444 .8912 .8949 .8949 .5815.635* .2126 .1964 .1144 .89128492 .5815.635* .2126 .1964 .1144 .89128493 .5815.635* .2126 .1964 .1144 .89128493 .5815.635* .2126 .1964 .1144 .89128493 .5833.627 .8658 .8788 .1442 .88868 5833.6869 .2273 .1917 .1954 .1162 .88938495 .5833.627 .8658 .8788 .1429 .8889 .8859 .8878 .1422 .8889 .8859 .8878 .1422 .8889 .8859 .8878 .1422 .8889 .8859 .8878 .1422 .8889 .8859 .8878 .1422 .8889 .8859 .8878 .1422 .8889 .8859 .8898 .8899 .8899 .1423 .8899 .8899 .8899 .8899 .8899 .8899 .8899 .8899 .8899 .8899 .8899 .8899 .8899 .8899 .8899 .8899 .8899 .8899 .8999	ſ		HD 621	50			T		HD 962	48		
4654.792 .2336 .19741254 .87988466	ΔD	ΔV	Δ(V-B)	Δ(B-U)	Δ(U-W)	Δ(B-L)	ΔD	ΔV	Δ(V-B)	Δ(B-U)	Δ(U-W)	Δ(B-I
4655.736 .2361 .19681254 .88168488 4655.736 .2282 .19781248 .88288475 4658.654 .8734 .8739 .14658866861 .675.666 .1822 .19561897 .89748475 4658.654 .8734 .8739 .8722 .1445 .88888 4659.654 .8722 .1443 .88888 4659.654 .8722 .1443 .88888 4659.6778 .8493 .8722 .1448 .88858 4554.712 .2144 .19661221 .87828489 .8588 .8722 .1313 .19651227 .88368588 .8588 .2213 .19651227 .88388 4595 .823 .257 .19651227 .88388 4595 .823 .257 .19651226 .88298499 .4956.781 .2215 .19481214 .88388 4595 .823 .257 .19661221 .8831 .8498 .8471 .8498 .2181 .19661221 .88218499 .8927 .8499 .4972.764 .2193 .19491197 .88138492 .8912 .4974.758 .2197 .19571222 .88478944 .4974.658 .2181 .19561226 .88348492 .8913 .2161 .19561226 .88348492 .8915.6358 .2126 .19561288 .88348492 .8915.6358 .2126 .19561288 .88348492 .8915.6358 .2126 .19561184 .88128493 .8915.6358 .2126 .19561184 .88128493 .8915.6358 .2126 .19561184 .88128493 .8915.6358 .2126 .19561184 .88128493 .8915.6358 .2126 .19561185 .88318493 .8915.6358 .2126 .19561184 .88128493 .8916.6358 .2874 .1974 .1285 .88318479 .8915.6358 .2874 .1974 .1285 .88318479 .8915.6358 .2874 .1974 .1285 .88318499 .8915.6538 .2874 .1974 .1285 .88318499 .8915.6538 .2874 .1998 .1184 .88158499 .8933.688 .2874 .19461198 .88238499 .8933.688 .2874 .19461198 .88238499 .8933.688 .2874 .19461198 .88238499 .8933.688 .2189 .19521127 .881188528499 .8933.688 .2215 .19561128 .88278481 .3344 .8657 .1487 .88898 5831.636 .2217 .1952 .1228 .88268499 .8923 .8989 .87821449 .88278481 .3834 .8657 .1488 .88858 5831.638 .2218 .1954 .1128 .88158581 .8831 .8841 .8895 .8861 .2191 .1947 .1118 .88388499 .88238481 .3834 .8625 .8869 .8827 .8881 .3886 .2889 .2899 .1952 .1128 .8827 .8881 .3886 .2889 .2899 .87821448 .8827 .8881 .3886 .2899 .87821448 .8827 .8881 .3886 .2189 .1944 .1119 .88318493 .3862 .3862 .2864 .2866 .2189 .194							465E 7E@	0765				
4657.768 .2282 .1978 -1248 .89288475 4656.646 .1882 .1967 -1897 .8974 .8975 4676.646 .1882 .1967 -1897 .8974 .8975 4682.757 .2177 .1971 -1174 .8998 .8429 4954.712 .2144 .1966 -1221 .89358489 4954.712 .2144 .1966 -1221 .89358489 4955.822 .213 .1965 -1227 .89385588 4959.823 .2255 .1969 -1228 .89298499 4968.781 .2215 .1949 -1214 .8935 .8499 4968.781 .2215 .1949 -1214 .8935 .8499 4969.813 .2253 .1961 -1227 .8931 -8499 4971.888 .2181 .1965 -1221 .8927 -8499 4971.888 .2181 .1965 -1222 .8847 .8499 4972.764 .2193 .1949 -1197 .8813 -8492 4974.758 .2197 .1957 -1222 .8847 .8494 4974.686 .2181 .1966 .1227 .8834 .8492 4978.639 .2175 .1958 .1196 .8848 .8824 .8492 4978.639 .2175 .1958 .1196 .8848 .8825 .8839 .8822 .8658 .1447 .8886 .885 .8816.638 .822 .8218 .1965 .1283 .8825 .8834 .8492 5815.638* .2127 .1968 .1194 .8812 .8493 5815.658* .2127 .1968 .1194 .8812 .8493 5815.658* .2127 .1968 .1194 .8827 .8494 5815.678* .2118 .1965 .1228 .8827 .8489 5815.678* .2118 .1965 .1283 .8825 .8833 .838 .838 .838 .8785 .1429 .8886 .8882 .8884 .8897 .8989 .8822 .8868 .8784 .1142 .8886 .8882 .8881 .8887 .8989 .8882 .8882 .8884	li .						I.					
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4974.758	4971.800	.2181	.1966	1221	.#827	Ø499	5Ø13.729					
4977.688 . 288 . 1958 - 1286 . 8834 - 8492 4978.639 . 2175 . 19581196 . 88488484 5815.653* . 2127 . 1968119488138484 5815.653* . 2127 . 1968119488138484 5815.653*2127 . 1968119488378486 5815.678* . 2118 . 1965128388258483 5815.748*2126 . 1968128388258483 5815.748*2126 . 1968128388258483 5833.65888448697139988828 5815.748*2126 . 1968128388218479 5816.78	4972.764	.2193	.1949	1197	.081-3	Ø492	5814.726	.86#5	.ø689	1423	8889	ø336
\$898.639 .2175 .19581196 .88488484 .8927 .8935 .8658 .8658 .87841464 .88818 .8585 .8958 .8952 .8958 .8952 .8958 .8	4974.758	.2197	.1957	1222	.8847	8494	5ø15.736	.8428				
\$\frac{5815.635*}{5815.635*}\$.2126	4977.688	.2181	.1958	1206	.#834	8492	5ø16.757					
S815.635* .2126 .19641194 .88128493 .8831 .8658 .87841464 .88818551 .653* .2127 .19681194 .88378486 .8515.653* .2118 .19651283 .88258483 .88258483 .88258483 .88258483 .88218825 .8831.635 .8434 .86671399 .88828835 .83558483 .8322 .8825 .88318479 .885184879 .885184879 .885184879 .885184879 .885184879 .88518489 .88538488 .8784142288168851 .8861 .88681 .8784142288168851 .88681 .8784142288168851 .88681 .8784142288168851 .88681 .8784142388278851 .88681 .8784143488278851 .88681 .8784143488278851 .88681 .8784143488278851 .88681 .8784143488278851 .88681 .8784143488278851 .88681 .8784143488278851 .88681 .88681 .8784143488278851 .88681 .88681 .87841454 .8888488884 .88881 .8	4978.639	.2175	.1958	1196	.8848	8484	5020.701	.8721	.ø691	1478	0005	ø358
\$\frac{5815.678^*}{5815.722^*}\$.2128 \ .19741285 \ .88428489 \ \ \frac{5815.722^*}{5815.722^*}\$.2128 \ .19741285 \ .88428489 \ \ \frac{5815.722^*}{5815.722^*}\$.2128 \ .19741285 \ .88428489 \ \ \frac{5815.722^*}{5815.748^*}\$.2126 \ .19681227 \ .88398495 \ \ \frac{5833.625^*}{5833.625^*}\$.8538 \ .8785142288168 \ \ \frac{5833.625^*}{5833.625^*}\$.8598 \ .8785142288168 \ \ \frac{5833.625^*}{5833.688}\$.2848 \ .19521197 \ .88318499 \ \ \frac{5834.687}{5836.681}\$.2813 \ .19521127 \ .88548499 \ \ \frac{5836.681}{5833.686}\$.2877 \ .8654 \ .86671434 \ .8827 \ .8 \ \ \frac{583}{5836.681}\$.2813 \ .195211287 \ .88648499 \ \ \frac{5833.625}{5838.628}\$.2874 \ .1946 \ .1198 \ .8815 \8581 \ \ \frac{5841}{5833.626}\$.2874 \ .1946 \ .1198 \ .8827 \ .8827 \ .8481 \ \ \frac{5843.531^*}{5836.681}\$.2155 \ .1954 \1223 \ .8827 \ .8841 \ .8497 \ \ \frac{5366.712}{5366.792}\$.2213 \ .1942 \1178 \ .8815 \8476 \ \ \frac{5366.72}{5366.681}\$.2217 \ .1952 \ -1287 \ .8821 \8474 \ \ \frac{5366.681}{5382.688}\$.2193 \ .1952 \ -1287 \ .8821 \8474 \ \ \frac{5386.681}{5382.688}\$.2193 \ .1952 \ -1287 \ .8821 \8474 \ \ \frac{5386.681}{5382.688}\$.2193 \ .1944 \1181 \ .8818 \8483 \ \ \frac{5386.681}{5382.688}\$.2193 \ .1952 \ -1287 \ .8821 \ .8474 \ \ \frac{5386.681}{5382.688}\$.2193 \ .1944 \1181 \ .8823 \8472 \ \ \frac{5386.681}{5382.688}\$.2193 \ .1947 \1181 \ .8823 \ .8842 \ \ \frac{5386.681}{5382.688}\$.2193 \ .1947 \1181 \ .8823 \ .8842 \ \ \frac{5386.681}{5382.688}\$.2193 \ .1947 \1181 \ .8823 \ .8484 \ \ \frac{5386.681}{5382.688}\$.2194 \ .1947 \1181 \ .8823 \ .8484 \ \ \frac{5386.681}{5382.681}\$.2191 \ .1947 \1181 \ .8823 \ .8847 \ \ \frac{5386.681}{5382.681}\$.2191 \ .1947 \1181 \ .8823 \ .8484 \ \ \frac{5386.681}{5382.681}\$.2191 \ .1947 \1181 \ .8823 \ .8484 \ \frac{5386.681}{5382.681}\$.2191 \ .1947 \1181 \ .8823 \ .8484 \ \frac{5386.681}{5382.681}\$.2191 \ .1947 \1181 \ .8823 \ .848	5Ø15.635*	.2126	.1964	1184	.8812	0493	5022.851	.865#	.8784	1464	.0001	0362
\$815.722* .2128 .1974 -1285 .88428489 \$5815.748* .2126 .19881285 .88318479 \$5815.748* .2126 .19881285 .88318479 \$5815.748* .2126 .19881285 .88318479 \$583.588 .2848 .19521197 .88318499 \$583.588 .2848 .19521197 .88318499 \$583.687 .1971 .19551287 .88548499 \$583.687 .1971 .19551287 .88548499 \$583.687 .1971 .19551287 .88548499 \$583.687 .2843 .19631184 .88158581 \$583.687 .2843 .19631184 .88158581 \$583.687 .2843 .19631184 .88158581 \$583.687 .2843 .19541288 .88278481 \$5843.531* .2159 .19541228 .88278481 \$5843.531* .2159 .19541228 .88278481 \$531.785 .2155 .19551232 .88418497 \$5365.712 .2213 .19421178 .88158476 \$5365.712 .2213 .19521287 .88168583 \$538.688 .2273 .19531286 .88168583 \$538.688 .2215 .19581184 .88188481 \$538.681 .2217 .19521287 .88218474 \$538.681 .217 .19521287 .88218481 \$538.681 .218 .1943 .194681188338474 \$538.681 .219 .1954 .1128 .88238484 \$538.681 .219 .1954 .1181 .88388474 \$538.681 .219 .1954 .1181 .88388474 \$538.681 .219 .1947 .1181 .88388474 \$538.681 .219 .1947 .1181 .88388474 \$538.681 .219 .1947 .1181 .88388472 \$538.683 .216 .219 .1947 .1181 .88388472 \$538.685 .216 .1943 .1194 .88118486		.2127			.#837	8486	5ø31.635	.8434	.ø697	1399	.8882	ø332
\$5815.722* 2128 1974 - 11285 .88428489 \$833.625* .8598 .8785142288168 \$5815.748** .2126 .19681285 .8831 .8479 \$5833.6161 .2874 .19781212 .88398495 \$833.847* .8681 .8784145288368485 .8687 .8784145288368495 \$833.858 .2848 .19521197 .88318499 .8735556 .8717 .86931466888948 .8536.687 .2813 .19651287 .88648499 .8782148888898 .8536.687 .2813 .19651194 .88158581 .8498 .8543.631* .2159 .19541128 .88278481 .8838 .8488 .8489 .8782148888858 .8484 .8489 .8483 .8484 .8481 .8	5Ø15.67Ø*	.2118	.1965	12Ø3	.#825	0483	5#32.688	.8529	.0700	1429	0018	0337
\$816.618	5015.722*	.2128	.1974	12ø5	.8842	8489	5ø33.625*	.8598				
5833.588		.2126			.#831	8479	5#33.847*	.86Ø1	.8784	1452	0036	ø349
5834.687 .1971 .1954 -1162 .88198495		. 2.874	.1978	1212	.Ø839	8495	5ø34.757	.8654	.Ø687	1434	0027	8347
5836.681 .2813 .19651287 .88548499 5837.635 .2843 .19631184 .88158581 5838.628 .2874 .19461198 .88238481 5843.531* .2159 .19541228 .88278481 5843.646* .2154 .19561232 .88278481 5314.785 .2165 .19551232 .88418497 5365.712 .2213 .19421178 .88158476 5367.698 .2193 .19441199 .88418481 5378.719 .2275 .19681287 .88218474 5386.681 .2273 .19531287 .88168583 5381.688 .2215 .19581286 .88168583 5381.688 .2189 .19521228 .88178481 5382.688 .2189 .19521228 .88118483 5384.677 .2218 .19341181 .88188474 5385.681 .211 .19431283 .88288479 5385.681 .2143 .19461211 .88238474 5385.681 .219 .1951184 .88188483 5384.687 .219 .19521281 .88118483 5384.687 .219 .19431283 .88238474 5385.681 .219 .19431283 .88238474 5385.681 .219 .19471181 .88338474 5385.681 .219 .19471181 .88338472 5387.688 .219 .1953192 .88318474 5386.681 .219 .19471181 .88348474 5386.681 .219 .19471181 .88348474 5386.681 .219 .19471181 .88348474 5386.681 .219 .19471181 .88348474 5386.681 .219 .19471181 .88348474 5387.688 .219 .1953192 .88318474 5387.688 .219 .1953192 .88318474 5387.688 .219 .1953192 .88318474 5386.681 .219 .19471181 .88348461 5426.635 .216 .19431243 .88298581							5035.656	.8717	.#693	1466	8884	ø349
5837.635							5ø37.722	.8691	.#695	1451	0009	ø357
5838.628							5038.802	.8689	.8782	148Ø	0005	ø352
5843.531* .2159 .19541228 .88278481 5843.646* .2154 .19561232 .88278481 5314.785 .2155 .19551232 .88218497 5365.712 .2213 .19421178 .88158476 5367.698 .2193 .19441199 .88418481 5378.719 .2275 .19681287 .88218474 5376.688 .2273 .19531287 .88228484 5388.674 .2235 .19391286 .88168583 5381.688 .2215 .19581184 .88188481 5382.688 .2189 .19521228 .88268479 5382.688 .2189 .19521228 .88118483 5384.677 .2218 .19341181 .88388474 5385.681 .2217 .19521281 .88118483 5384.677 .2218 .1934181 .88388474 5385.681 .2143 .19461211 .88238474 5385.681 .2143 .19461211 .88238472 5387.688 .2149 .19531192 .88318474 5386.681 .2191 .19471181 .88348486 5386.681 .2191 .19471181 .88348486 5386.681 .2191 .19471181 .88348474 5386.681 .2191 .19471181 .88348474 5386.681 .2191 .19471181 .88348474 5386.681 .2191 .19471181 .88348474 5386.681 .2191 .19471181 .88348474 5386.681 .2191 .19471181 .88348461 5426.635 .2176 .19681246 .88268492 5427.562 .2182 .19541123 .88298581 5428.656 .2292 .19541187 .88888447 5428.656 .2292 .19541187 .88888447 5428.656 .2292 .19541187 .88888447 5428.656 .2292 .19541187 .88888447 5428.656 .2292 .19541187 .88888447 5428.656 .2292 .19541187 .88888447 5428.656 .2292 .19541187 .88888447 5428.656 .2292 .19541187 .88888447 5428.656 .2292 .19541187 .88888447 5428.656 .2292 .19541187 .88888447 5428.656 .2292 .19541187 .88888447 5428.656 .2292 .19541187 .88888447												
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5446.684 .2263 .19681238 .88168496												
	5446.684	.2263	.1968	1238	.0816 -	.8496						
5449.58# .2156 .19681269 .#814#494	5449.588	.2156										
5458.573 .2221 .19581225 .88268476	5450.573	.2221	.1958	1225	.ø826 -	.0476						
5451.556 .2278 .19681252 .88838494	5451.556	.2278	.196ø	1252	. #8#3 -	.8494						

MICRO-VARIATIONS OF OBA TYPE STARS

FIGURE 1. — The standard deviations (s.d.) in log intensity scale of the nightly averages (NA) of the comparison stars as a function of their brightnesses V_J (in magnitudes). HD numbers and spectral types are indicated. Also the standard deviations of three program stars are plotted (double circles, V only). They are connected with their respective comparison stars by a line.

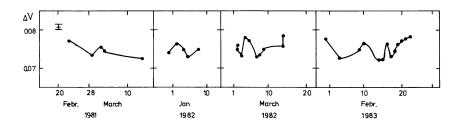


FIGURE 2. — The $NA \Delta V$ (in log intensity scale) of the program star HD 76556 (O5.5 VNF) as a function of the date. The error bar at the left top indicates the maximum mean error (m.e.) of ± 0.0007 in the NA.

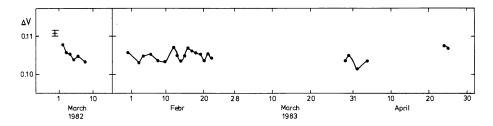


FIGURE 3. — Similar to figure 2, but now for the program star HDE 305523 (O9 II).

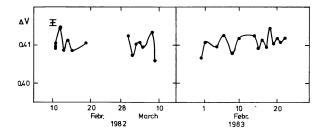


FIGURE 4. — Similar to figure 2, but now for the program star HD 93205 (O3 V).

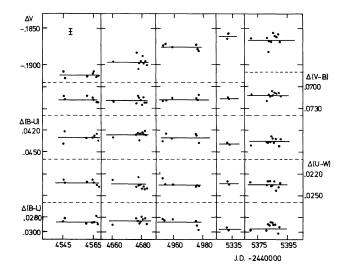


FIGURE 5. — The $NA \Delta V$, $\Delta (V-B)$ etc. (in log intensity scale) of the program star HD 37022 (O7.0 V) as a function of the Julian Date. For each time interval the average level has been indicated by a short line. The error bar in the top left hand corner indicates an average m.e. of \pm 0.0004 in the NA.