

New β Cephei and SPB Stars Discovered in Hipparcos Photometry

by

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ABSTRACT

We discuss 34 stars for which we detected new frequencies in Hipparcos H_p magnitudes. 13 of these stars are variables discovered in this paper. For 20 stars, we derive $\log T_{\text{eff}}$ and $\log g$ from Strömgren or Geneva photometry.

We classify one new β Cep star, HIP 88352, two new β Cep suspects, HIP 54753 and 88123, four new SPBs, HIP 1030, 39206, 46192 and 111147, and two SPB suspects, HIP 75787 and 98778. We find the last star to be triply-periodic and we show that the frequencies detected in H_p magnitudes are present in the photoelectric observations of Hill *et al.* (1976).

Finally, we discover the hottest variable of the SPB type, namely, HIP 1030.

Key words: Stars: early-type – Stars: oscillations

1. Introduction

Hipparcos photometry yielded 726 new B-type variables listed in the Hipparcos Catalogue (ESA 1997), Waelkens *et al.* (1998) or Koen and Eyer (2002). These lists include some 80 new early-type pulsating stars, *i.e.*, slowly pulsating B stars, SPBs, classified as such in the Hipparcos Catalogue or by Waelkens *et al.* (1998) or β Cep stars classified as such by Waelkens *et al.* (1998) or Aerts (2000).

We performed a search for early-type pulsators in the whole sample of 4725 O and B stars in the Hipparcos Catalogue. For all these stars we computed power spectra in the frequency range from 0 to 22 c/d. We analyzed 322 stars that are classified in the Hipparcos 1-letter classification system to be periodic variables, P, 486 unsolved, U, 113 micro-variable, M, 16 revised in their $V - I$ color, R, 1784 constant, C, and 2004 that are not classified. We rejected from our analysis stars classified as D, *i.e.*, those the variability of which may be induced by duplicity.

On the whole, we confirm the periods detected in H_p magnitudes and listed in the Hipparcos Catalogue and by other authors who analyzed the Hipparcos photometry, *i.e.*, Waelkens *et al.* (1998), Aerts *et al.* (1999), Mathias *et al.* (2001), Koen and Eyer (2002) and Aerts and Kolenberg (2005). The new result of our analysis is

the discovery of 13 variable stars and derivation of new frequencies for 21 known variables. The remaining stars for which we do not derive frequencies we find either to be non-variable or we detect slight variability that cannot be solved from H_p magnitudes.

We describe the method of data analysis, derivation of astrophysical parameters and the procedure of classification to variability types in Section 2. In Section 3, we discuss results obtained for stars classified as β Cep, in Section 4, for SPBs. The remaining stars we discuss briefly in Section 5.

2. Analysis

We computed power spectra in the frequency range from 0 to 22 c/d for each of the 4725 stars. We used the Lomb's method (Lomb 1976) modified by adding a floating mean and weights for each H_p magnitude (see Jerzykiewicz and Pamyatnykh 2000). We assumed that the frequency is indicated by the highest peak in the periodogram. After each run, we prewhitened H_p magnitudes with all frequencies found so far. We continued frequency search until there were no significant peaks in the periodogram of the residuals. We considered a peak to be insignificant when the ratio of the standard deviation of the fitted amplitude to the amplitude itself was lower than 3 or when the phase diagram constructed for the detected frequency showed only noise.

In Table 1 we list HIP numbers of the 34 stars for which we derived new frequencies. In the second column of Table 1 we list spectral types adopted mainly from the Hipparcos Catalogue. The remaining sources of spectral type we list at the bottom of Table 1. In the next two columns we list Hipparcos 1- and 6- letter classification and the GCVS variability types (Samus *et al.* 2004). In the following columns, we list the new frequencies detected in H_p magnitudes, the amplitudes, the number of H_p magnitudes used for analysis and our variability classification.

We derived $\log T_{\text{eff}}$ and $\log g$ from Strömgren or Geneva photometry for 20 of the 34 stars. We plot these stars in the $\log T_{\text{eff}} - \log g$ diagram in Fig. 1. For stars classified in this paper as pulsators, we use dots to denote $\log T_{\text{eff}}$ and $\log g$ values derived from Geneva photometry, and circles for the values derived from Strömgren indices. We label these stars with HIP numbers. The remaining variables we plot with asterisks. For stars for which we have both derivations, we plot the values derived from Strömgren photometry. The exception is HIP 39524 that we suspect to be a Be star. In Fig. 1 we also show evolutionary tracks for 2, 3, 5, 9 and 15 $M_{\odot}$ computed for solar metallicity by Schaller *et al.* (1992). In our computations we used the calibration of Napiwotzki *et al.* (1993) and the UVBYBETA code kindly provided by Dr. Napiwotzki or, for stars that have Geneva photometry, the CALIB code of Kunzli *et al.* (1997). We list the stars and the derived $\log T_{\text{eff}}$ and $\log g$ in Table 2. In the last column of Table 2 we give the source of photometric indices used in our derivation.

Table 1
Hipparcos stars for which we derived new frequencies

HIP	SpT	Hipparcos	GCVS	f	A	N	this paper
1030	B2V			0.36400 0.51661	6.4 3.9	170	SPB
1952 (1)	B9			0.38311	7.2	70	
7088	B5Iab B5s(e) (9)			0.37119	12.7	176	
15600 (2)	B1.5IV	U		0.22230	20.1	101	
16782 (3)	B8V			1.07349	9.2	93	
18424 (4)	B1.5Vne	U	BE	0.58511	19.4	88	
24118 (5)	B2Vne	U, GCAS:	BE	0.50876	30.5	91	
25410	B2Vn	C		1.14789	5.1	70	
25422	B9VSi (10)			1.03515	13.2	76	
26405	B6Ve (11)			1.69758	8.8	120	
26574 (4)	B1Vne	U	BE	0.96940	34.3	95	
33846 (4)	B2Ve (12)	U, SR		0.25365	10.2	173	
37223	B3III	C		3.12254	3.5	134	
38914	B3			0.77570	22.8	80	
39206 (4)	B7III/IV	U		0.82098 0.71279 0.84882	25.8 17.4 13.0	178	SPB
39524	B3III			1.50223	7.8	83	
46192 (4)	B9III	U		0.51197 0.51029	19.2 18.0	181	SPB
46889 (4)	B8III	U		0.18011	12.7	122	
54753	B1:Vn			8.91132	15.5	104	β Cep:
74091	B4/B5III/IV			1.81828	6.3	130	
75787	B9III	C		1.77028	10.0	81	SPB:
76945 (4)	B5V	M		0.94483	6.7	112	
86253 (4)	B2Vne	U, GCAS	BE	0.77399	73.0	62	
88123 (6)	B1.5V:ne (13)	U, GCAS	GCAS	0.23495 3.42870	22.7 12.7	118	β Cep:
88352 (4)	B0III	U		6.53876 6.37776	24.9 23.5	105	β Cep
89121 (4)	B7/B8II	U		0.17342	24.8	70	
92236	B9			0.91618	12.7	81	
95673 (4)	B3Ve	U, GCAS	BE	0.60972 0.62625	19.5 14.1	119	
97948	B8 III			0.07282	15.1	167	
98778 (7)	B5II:n	U, E	E:	0.38343 0.65176 1.17691	30.6 24.3 14.0	149	SPB:
100513 (8)	B9VSi	R		1.03223	16.1	109	
101220 (4)	B9	U, SR		1.03009	12.5	138	
111147 (4)	B9	U		1.21358 1.17748	18.3 10.9	142	SPB
112881 (2)	B1Ia	U		1.03470	19.2	100	

1 – Adelman (1998), 2 – Bidelman (1984), 3 – Winzer (1974), 4 – Hipparcos Catalogue, 5 – Bidelman (1982), 6 – Woodward (1975), 7 – Percy (1970), 8 – Hopmann (1953), 9 – Merrill and Burwell (1933), 10 – Gomez *et al.* (1998), 11 – Bernacca and Ciatti (1972), 12 – Henize (1976), 13 – Garrison *et al.* (1977).

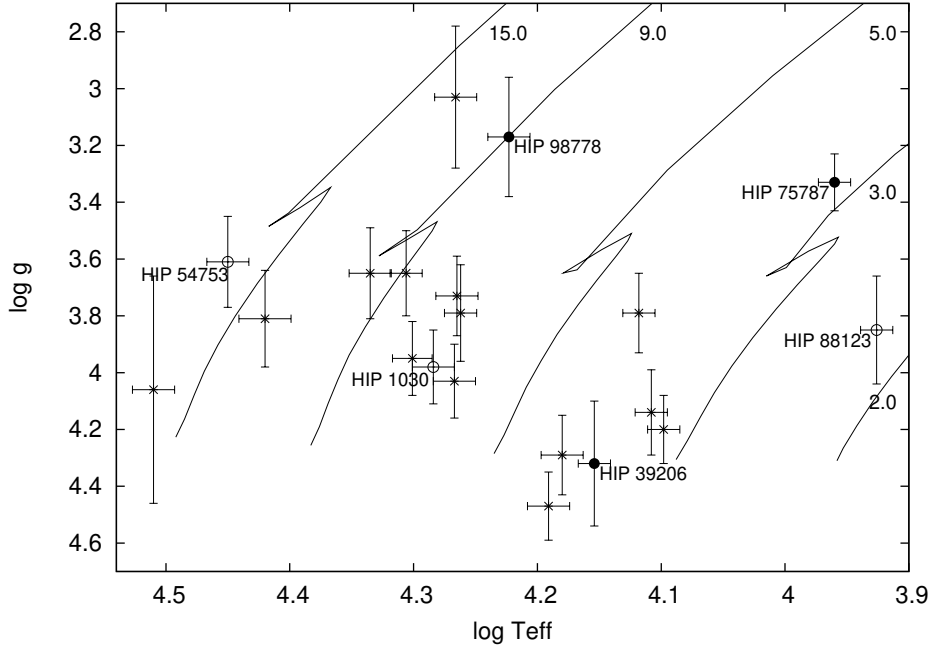


Fig. 1. The $\log T_{\text{eff}} - \log g$ diagram for stars from Table 1. For pulsating stars that are labeled with HIP numbers, we used dots to indicate $\log T_{\text{eff}}$ and $\log g$ values derived from Geneva photometry, and open circles, from the Strömgren photometry. The remaining stars are plotted with asterisks. The $Z = 0.02$ evolutionary tracks for 2, 3, 5, 9 and $15 M_{\odot}$ are adopted from Schaller *et al.* (1992).

For most stars that have both Strömgren and Geneva indices, the $\log T_{\text{eff}}$ and $\log g$ values agree well to within the error bars. For three stars, HIP 7088, HIP 39524 and 54753, $\log g$ derived from Strömgren indices is smaller than the value derived from Geneva photometry. For HIP 54753, $\log g$ derived from Geneva photometry has very large standard deviation equal to 0.7 dex. HIP 7088 is a Be star and we suspect HIP 39524 to be also Be star. We plot the 15 stars that have Strömgren indices in the $c_0 - \beta$ diagram shown in Fig. 2. We give the c_0 and β values of these stars in columns 6 and 7 of Table 2. In Fig. 2 we also plot the β Cep stars listed by Stankov and Handler (2004) and the SPBs that are not classified as Be. The three stars located high above the others with similar c_0 index are known Be stars: HIP 7088, 88123 and 95673. We find also HIP 39524 slightly above the non-Be stars and we suspect that this star shows faint emission in $H\beta$ line.

We classified as β Cep all stars with spectral type earlier than B3 and frequencies higher than ≈ 3 c/d. For stars that have mid- or late-B types and periods of the order of a day, we used the detected periods, $v \sin i$ values and the mean radii from Underhill and Doazan (1982) to compute the inclination angles, i , at which the stars should be seen to be rotating variables. We excluded rotation as the reason of the observed variability when the computed $\sin i$ exceeded 1. For stars for which $v \sin i$ was not measured, we computed the equatorial velocity which the star should have to rotate with the detected period and excluded rotational variability

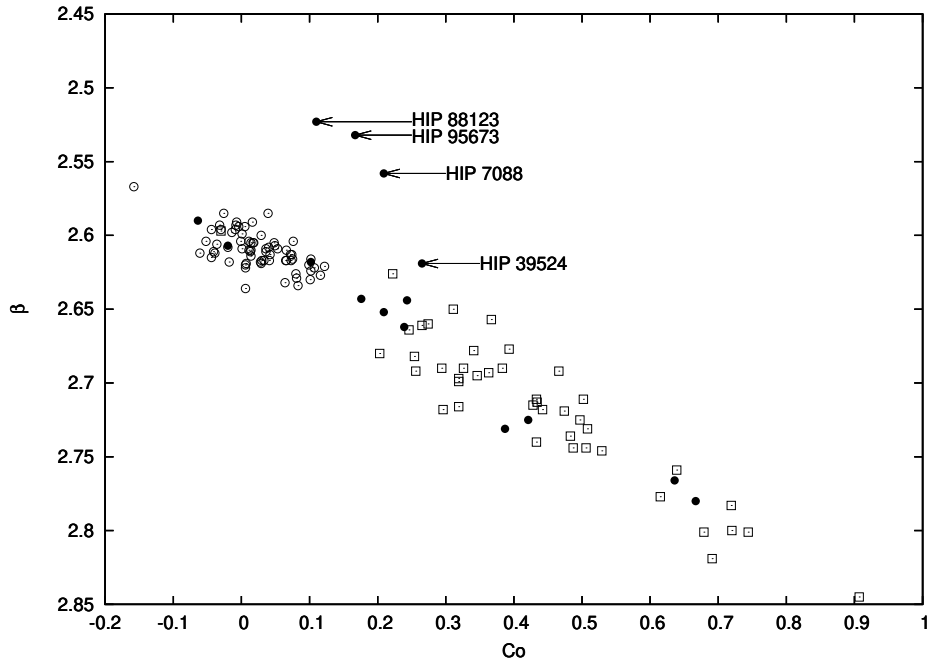


Fig. 2. The c_0 - β diagram for 15 stars from Table 1 that have Strömgren photometry (dots) and for the β Cep (circles) and SPB stars (squares) that are not classified as Be. Stars labeled with HIP numbers are discussed in the text.

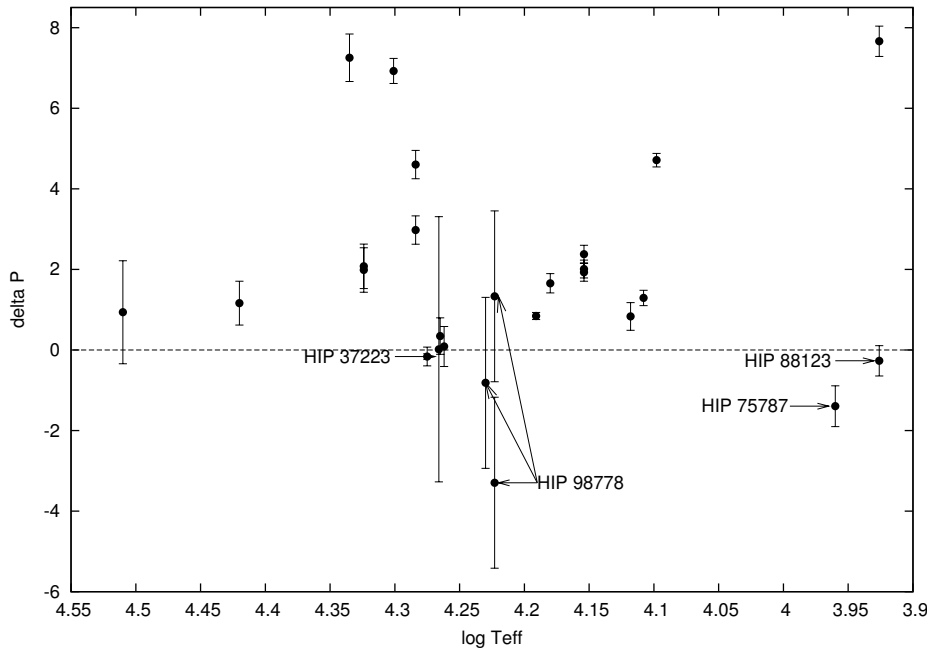


Fig. 3. $\Delta P = P_{\text{orb}} - P_{\text{min}}$ computed for stars from Table 1. Stars with negative ΔP , that cannot be ellipsoidal variables, are labeled with HIP numbers. The values computed for HIP 37223 and for the secondary frequency of HIP 98778 are slightly shifted to higher effective temperatures for the clarity of the diagram.

Table 2

Hipparcos stars discussed in this paper for which we derive $\log T_{\text{eff}}$ and $\log g$ values

HIP	Strömgren phot.		Geneva phot.		c_0	β	ref
	$\log T_{\text{eff}}$	$\log g$	$\log T_{\text{eff}}$	$\log g$			
1030	4.284	3.98	4.277	3.91	0.209	2.652	1,3
1952	4.098	4.20	4.099	4.32	0.667	2.780	2,3
7088	4.154	1.84	4.266	3.03	0.209	2.558	8,3
15600	4.335	3.65			0.102	2.618	2
16782	4.108	4.14	4.105	4.34	0.636	2.766	1,3
25410	4.265	3.73			0.243	2.644	2
25422			4.118	3.79			3
26405	4.191	4.47	4.183	4.40	0.387	2.731	2,3
33846	4.301	3.95	4.284	3.95	0.176	2.643	3,4,5
37223	4.269	4.03	4.256	4.11	0.239	2.662	2,3
38914	4.420	3.81	4.420	3.76	-0.020	2.607	2,3
39206			4.154	4.32			3
39524	4.240	3.16	4.262	3.79	0.365	2.619	2,3
54753	4.450	3.61	4.468	4.15	-0.064	2.590	6,3
75787			3.960	3.33			3
76945	4.180	4.29	4.174	4.32	0.421	2.725	2,3
88123	3.926	3.85			0.110	2.523	7
95673	3.733	3.65	4.324	3.84	0.167	2.532	2,3
98778			4.223	3.17			3
112881			4.510	4.06			3

1 – Crawford and Barnes (1974), 2 – Hauck and Mermilliod (1990),
 3 – Rufener (1988), 4 – Kilkenney (1981), 5 – Kilkenney (1978),
 6 – Kaltcheva (2003), 7 – Sterken *et al.* (1998), 8 – Schmidt (1976).

when the computed equatorial velocity was higher than the break-up velocity listed by Collins (1974).

For all stars that have periods of the order of a day, we checked the possibility that they are ellipsoidal variables. We used the detected frequencies and the $\log T_{\text{eff}}$ and $\log g$ values given in Table 2 to see whether these stars can be binaries with orbital period, P_{orb} , equal to twice the photometric one. For stars that have $\log T_{\text{eff}}$ and $\log g$ derived from both Strömgren and Geneva photometry, we used the values derived from the Strömgren indices. The exceptions are Be stars HIP 7088, 39524 and 95673 for which we used Geneva photometry. In our computations, we applied the method described in detail in Molenda-Żakowicz and Połubek (2004), *i.e.*, we computed the minimal orbital period, P_{min} the star can have being a binary with primary component that has the $\log T_{\text{eff}}$ and $\log g$ that we derived from photometry. We rejected the possibility of being an Ell for these stars for which $\Delta P = P_{\text{orb}} - P_{\text{min}}$ was negative. In Fig. 3 we show ΔP computed for stars from Table 2.

3. New β Cep Stars

Below, we discuss the new β Cep star and the β Cep suspects classified in this paper. We show periodograms and phase diagrams for these stars in Fig. 4. For HIP 88123, the three points deviating from the mean curves of phase diagrams were rejected when computing periodograms.

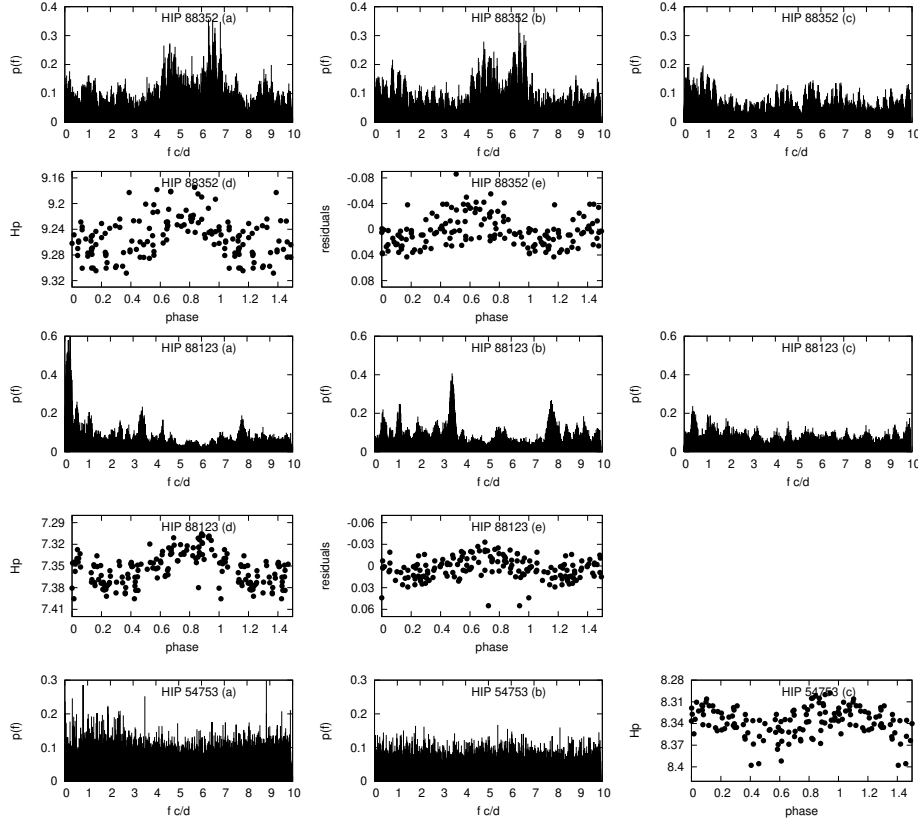


Fig. 4. The β Cep star, HIP 88352, and β Cep suspects, HIP 88123 and 54753, discovered in Hipparcos photometry. HIP 88352 (a) periodogram of H_p magnitudes; the highest peak indicates the frequency f_1 ; HIP 88352 (b) periodogram of H_p magnitudes prewhitened with frequency f_1 ; the highest peak indicates the frequency f_2 ; HIP 88352 (c) periodogram of H_p magnitudes prewhitened with all detected frequencies; HIP 88352 (d) H_p magnitudes phased with the frequency f_1 ; HIP 88352 (e) residuals phased with the frequency f_2 . HIP 88123 (a)–(e) and HIP 54753 (a)–(c), analogously.

HIP 88352 (HD 164340, NSV 24078) is a poorly studied star discovered to be variable by Hipparcos. In H_p magnitudes of this star we find two close frequencies, 6.53876 and 6.37776 c/d, that are so high that can be explained only as due to pulsations. We classify this star as β Cep.

HIP 88123 (HD 163868, V 3984 Sgr) is a rapid rotator ($v \sin i = 297$ km/s, Yudin 2001). The star was discovered to be variable by Woodward (1975) who concluded that the period, if it exists, is longer than 20 days but may be accompanied by a variability on the time-scale of hours. Sterken *et al.* (1998) performed a period

search in the range of 0–0.2 c/d in the *uvby* data collected at ESO and detected a period equal to 830 days. These authors conclude that HIP 88123 may be an interacting binary with $P_{\text{orb}} \approx 850$ d and that it shows additional, possibly pulsational, variability. We find this star to be double-periodic with frequencies equal to 0.23490 and 3.42864 c/d. The first frequency can result either from orbital motion or rotational modulation providing that we see the star at the inclination angle $i \simeq 15^\circ$. The secondary frequency is too short to result from rotation or ellipticity. Since HIP 88123 is a Be star, it is not clear whether the secondary frequency is due to pulsations or Be activity. Also our derivation of ΔP should be treated with caution because it is based on $\log g$ derived from the β index that may be affected by emission. We classify this star as a β Cep suspect.

HIP 54753 (HD 97533) is a Car OB2 association member (Kaltcheva 1998). We discover this star to be variable with one frequency, 8.91132 c/d. However, Handler (private communication) finds this star to be non-variable in his amplitude spectra. We conclude that the variability of this star should be confirmed in additional observations and classify HIP 54753 as another β Cep suspect.

4. New SPB Stars

Below, we discuss the new SPBs and SPB suspects classified in this paper. We show periodograms and phase diagrams for these stars in Figs. 5 and 6.

HIP 1030 (HD 829) is a slowly rotating star ($v \sin i = 11$ km/s, Lyubimkov *et al.* 2004). We discover HIP 1030 to be a new variable with two frequencies equal to 0.36400 and 0.51661 c/d. We classify this star as SPB. Having $\log T_{\text{eff}}$ equal to 4.277, HIP 1030 (B2V) still falls into the SPB instability domain (Pamyatnykh 1999) and it becomes the hottest known variable of this type.

HIP 39206 (HD 66183, NSV 17708) is a variable discovered by Hipparcos. We find the star to be triply-periodic, with frequencies equal to 0.82098, 0.71279 and 0.84882 c/d and we classify it as SPB.

HIP 46192 (HD 81543, NSV 18197) is another variable discovered by Hipparcos. Koen and Eyer (2002) analyzed *H_p* magnitudes of this star and found it to be mono-periodic, with frequency equal to 0.51022 c/d. We find this star to be double-periodic with frequencies equal to 0.51197 and 0.51029 c/d and classify it as SPB.

HIP 75787 (HD 137542) is a poorly studied star discovered to be variable in this paper. In the $\log T_{\text{eff}} - \log g$ diagram it falls above TAMS. Our computations show that HIP 75787 cannot be a rotational or ellipsoidal variable and that the observed variability has to be due to pulsations. However, the theoretical pulsational models (Dziembowski *et al.* 1993) do not predict pulsations in this region of $\log T_{\text{eff}} - \log g$ diagram. Since our method of computing ΔP is very sensitive to the adopted $\log g$, we conclude that the final variability classification of this star requires more observational data. We classify HIP 75787 as a SPB suspect.

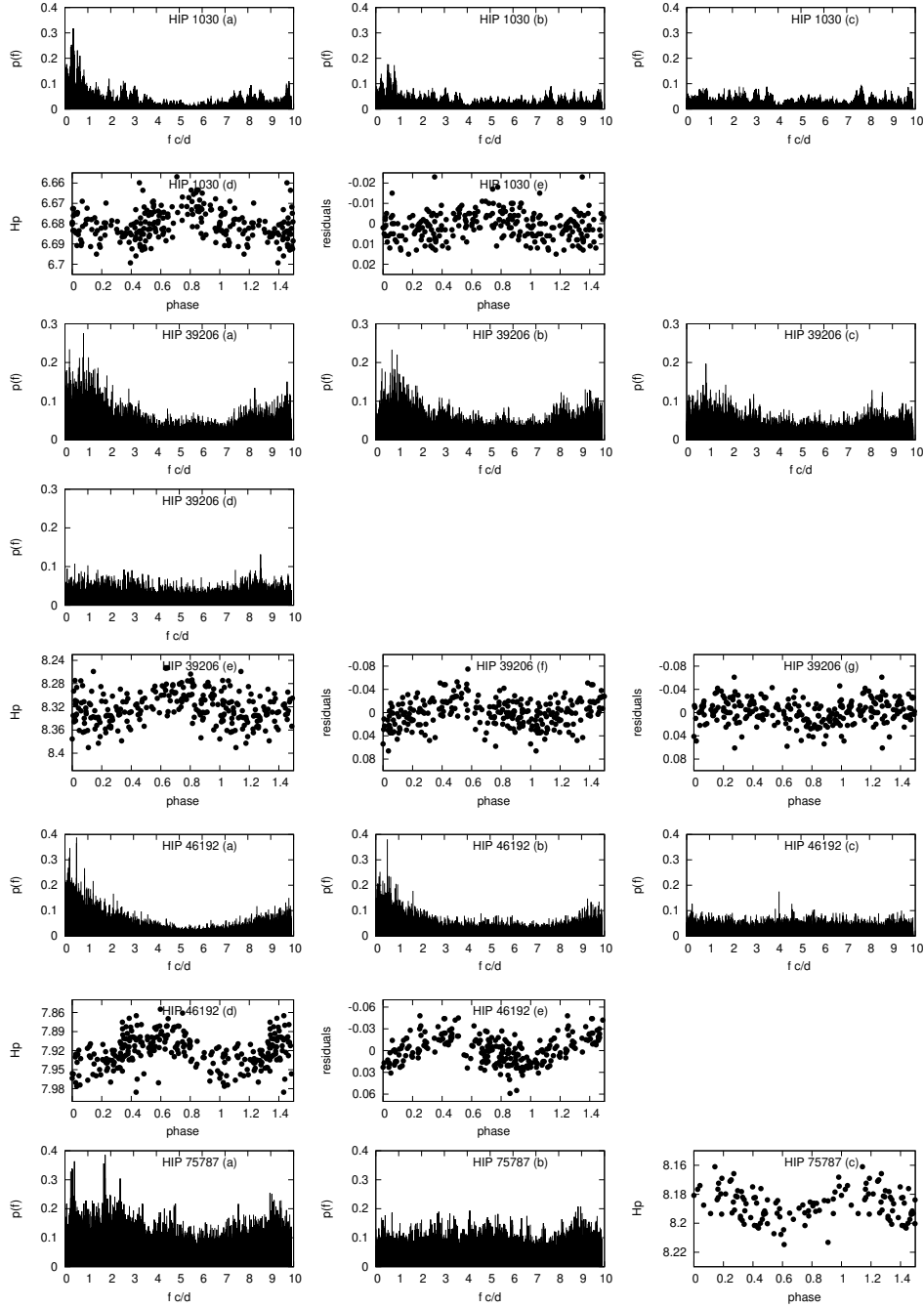


Fig. 5. The same as in Fig. 4 but for HIP 1030, 39206, 46192 and 75787.

HIP 98778 (HD 190467, V1362 Cyg) is a moderately rotating ($v \sin i = 72$ km/s, Głęboki and Stawikowski 2000) Be star (Merrill and Burwell 1949). The star is another one that had apparently evolved beyond TAMS. HIP 98778 was reported by

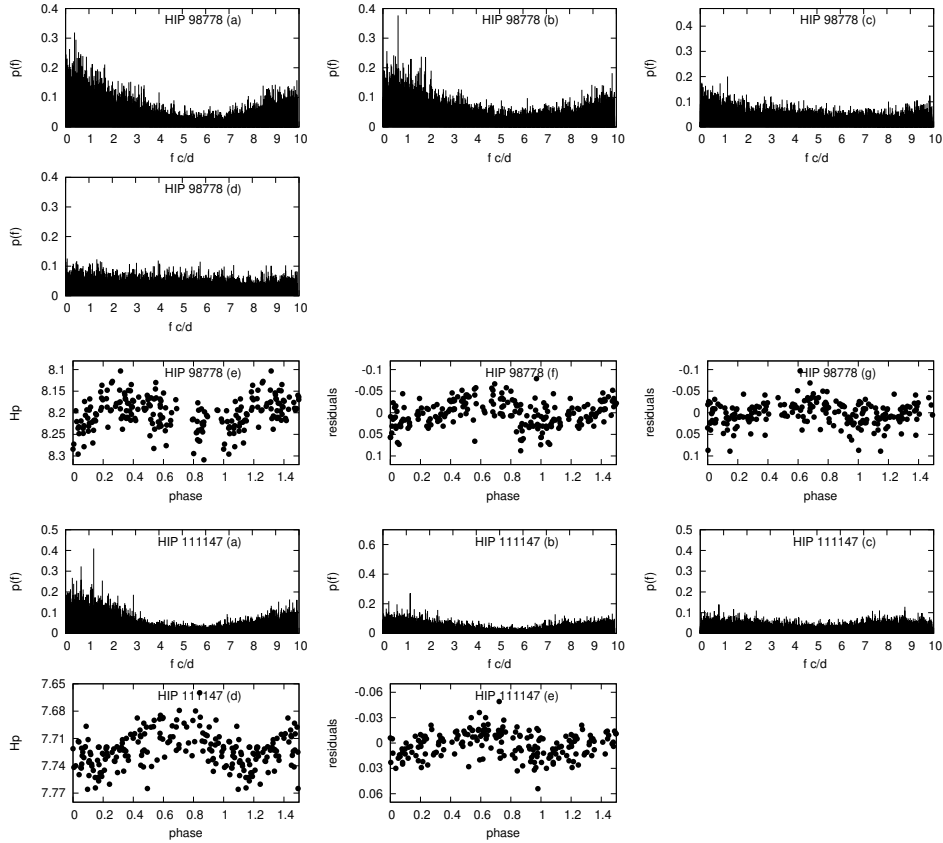


Fig. 6. The same as in Fig. 4 but for HIP 98778 and 111147.

Hill *et al.* (1976) to be a spectroscopic binary having the orbital period of around 57 days. Its photometric variability was discovered by Percy (1970) who suggested that HIP 98778 may be an eclipsing or ellipsoidal variable with orbital period of about a week. Analyzing the photoelectric data of Hill *et al.* (1976), Percy (1984) detected a period of 3.75 days ($f \simeq 0.26$ c/d).

In the H_p magnitudes of HIP 98778 we find three frequencies, 0.38343, 0.65176 and 1.17691 c/d. None confirms the frequency detected by Percy (1984). We re-analyzed the observations of Hill *et al.* (1976) and found that (1) the Hill *et al.* (1976) observations phased with the period detected by Percy (1984) show only noise, (2) the frequency detected by Percy (1984) is probably due to HD 191201, an eclipsing binary having frequency equal to 0.2571 c/d (Samus *et al.* 2004), used by Hill *et al.* (1976) as a comparison star and (3) after rejecting five outlying observations of Hill *et al.* (1976), the periodogram shows high maxima at 0.3598, 0.6403 and 1.1590 c/d, close to the three frequencies that we discovered in H_p magnitudes. In this way we show that frequencies that we discover in H_p magnitudes are not transient events but they are present in the light-curve of the star for at least twenty years.

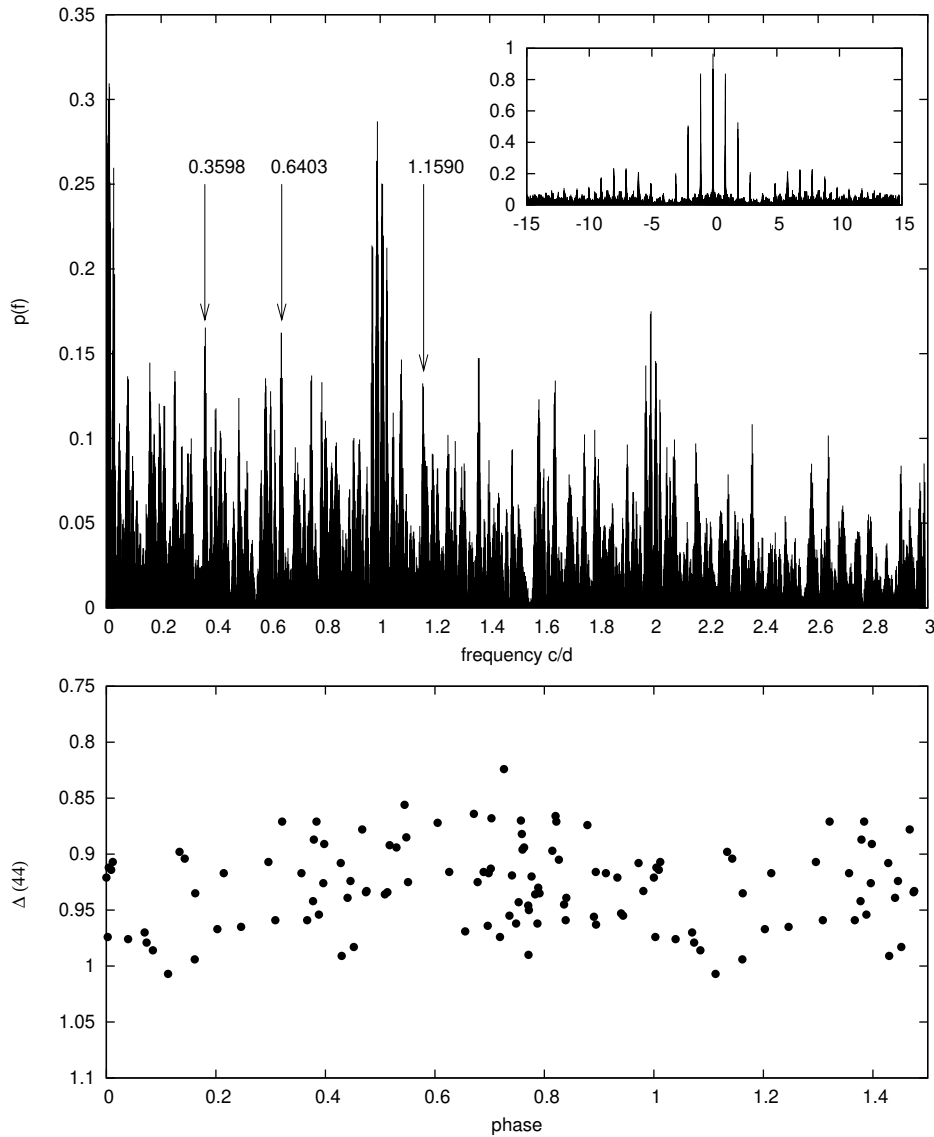


Fig. 7. *Top*: Periodogram of Hill *et al.* (1976) $\Delta(44)$ observations of HIP 98778. The labeled maxima occur close to the frequencies detected in *Hp* magnitudes. *Inset*: Spectral window computed in the frequency range from -15 to 15 c/d. *Bottom*: Phase diagram of $\Delta(44)$ magnitudes phased with the frequency 0.38434 c/d detected in *Hp* magnitudes.

In Fig. 7 we show the $0\text{--}3$ c/d part of the periodogram of $\Delta(44)$ magnitudes given by Hill *et al.* (1976). We chose this set because it has the highest quality of the three sets published by Hill *et al.* (1976). In the inset we show the spectral window of the observations computed in the frequency range from -15 to $+15$ c/d. The peak around 0.26 c/d detected by Percy (1984) is still visible in the periodogram but with much less power than in the original dataset. At the bottom of Fig. 7 we show phase diagram of $\Delta(44)$ magnitudes phased with the frequency $f_1 = 0.38434$ c/d

detected in H_p magnitudes. The $\Delta(44)$ magnitudes phased with any of the two other frequencies show only noise. This is a result of a limited precision of Hill *et al.* (1976) observations which “do not allow to detect variability with amplitude lower than about 20 mmag” (Hill *et al.* 1976).

Since it cannot be excluded that the frequency f_1 may result from ellipticity and the other two - from Be activity of the star, we classify HIP 98778 as an SPB suspect and we conclude that pulsations of this star should be confirmed by further observations.

HIP 111147 (HD 213531, NSV 25920) is the last pulsator classified in this paper. It was discovered to be variable by Hipparcos and found to be mono-periodic (frequency 1.21350 c/d) by Koen and Eyer (2002). We find this star to be double-periodic with frequencies equal to 1.21358 and 1.17748 c/d and classify it as SPB.

5. Other Variables

Most of the remaining 25 stars are mono-periodic variables with periods of the order of a day. We do not reject the possibility that some of them are SPBs but we suspect that variability of the majority of these stars results from Be activity, rotational modulation, ellipticity or α Cyg-type pulsations. Indeed, nine of these stars, namely, HIP 7088, 18424, 24118, 26405, 26574, 33846, 39524, 86253 and 95673, are known to be Be stars or show indications of Be activity. Two stars, HIP 25422 and 100513, are classified as chemically peculiar and may be SX Ari type variables. HIP 37223 may be an ellipsoidal variable because its H_p magnitudes phased with half the detected frequency (not shown in a separate figure) show minima of slightly different depth. Finally, there are two supergiants, HIP 7088 and 112881, that may be variables of α Cyg type. Information available for these stars do not allow to assign to them any variability types with sufficient degree of certainty.

6. Summary

We have discussed 34 stars, 13 of which are variables discovered in this paper. One star we classify as β Cep variable, two, as β Cep suspects (β Cep:), four, as SPBs and two, as SPB suspects, (SPB:). We have discovered the hottest SPB, HIP 1030, and two suspected SPBs, HIP 75787 and 98778, that seem to have evolved beyond TAMS to the region where SPB pulsations are not predicted by theoretical models (Dziembowski *et al.* 1993). We emphasize that additional observations are needed to confirm astrophysical parameters derived for these two stars.

For HIP 98778, we show that the three frequencies that we detect in H_p magnitudes are present in the photoelectric observations of Hill *et al.* (1976).

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REFERENCES

- Adelman, S.J. 1998, *Astron. Astrophys. Suppl. Ser.*, **132**, 93.
Aerts, C. 2000, *Astron. Astrophys.*, **361**, 245.
Aerts, C., *et al.* 1999, *Astron. Astrophys.*, **343**, 872.
Aerts, C., and Kolenberg, K. 2005, *Astron. Astrophys.*, **431**, 615.
Bernacca, P.L., and Ciatti, F. 1972, *Astron. Astrophys.*, **19**, 482.
Bidelman, W.P. 1982, *IBVS*, 2112.
Bidelman, W.P. 1984, *IBVS*, 2514.
Collins, G.W., II 1974, *Astrophys. J.*, **191**, 157.
Crawford, D.L., and Barnes, J.V. 1974, *Astron. J.*, **79**, 687.
Dziembowski, W.A., Moskalik, P., and Pamyatnykh, A.A. 1993, *MNRAS*, **265**, 588.
ESA 1997, The Hipparcos and Tycho Catalogues, ESA SP-1200, Nordwijk, ESA.
Feast, M.W., Stoy, R.H., Thackeray, A.D., and Wesselink, A.J. 1961, *MNRAS*, **122**, 239.
Garrison, R.F., Hiltner, W.A., and Schild, R.E. 1977, *Astrophys. J. Suppl. Ser.*, **35**, 111.
Głębocki, R., and Stawikowski, A. 2000, *Acta Astron.*, **50**, 509.
Gomez, A.E., Luri, X., Grenier, S., Figueras, F., North, P., Royer, F., Torra, J., and Mennessier, M.O. 1998, *Astron. Astrophys.*, **336**, 953.
Hauck, B., and Mermilliod, M. 1990, *Astron. Astrophys. Suppl. Ser.*, **86**, 107.
Henize, K.G. 1976, *Astrophys. J. Suppl. Ser.*, **30**, 491.
Hill, G., Hilditch, R.W., and Pfannenschmidt, F.L. 1976, *Publ. Dominion Astrophys. Obs. Victoria*, **15**, 1.
Hopmann, J. 1953, *Sitz. Akad. Wien. Abt. 2a*, **162**, No 1–4.
Houk, N. 1978, *Michigan Catalogue of HD stars*, Vol. **2**.
Houk, N. 1982, *Michigan Catalogue of HD stars*, Vol. **3**.
Jerzykiewicz, M., and Pamyatnykh, A.A. 2000, *P.A.S.P.*, **112**, 1341.
Kaltcheva, N.T. 1998, *Astron. Astrophys. Suppl. Ser.*, **128**, 309.
Kaltcheva, N.T. 2003, *Astron. Astrophys.*, **410**, 523.
Kilkenny, D. 1978, *MNRAS*, **182**, 629.
Kilkenny, D. 1981, *MNRAS*, **194**, 927.
Koen, C., and Eyer, L. 2002, *MNRAS*, **331**, 45.
Kunzli, M., North, P., Kurucz, R.L., and Nicolet, B. 1997, *Astron. Astrophys. Suppl. Ser.*, **122**, 51.
Lesh, J.R. 1968, *Astrophys. J. Suppl. Ser.*, **17**, 371.
Lomb, N.R. 1976, *Astrophys. and Sp. Science*, **39**, 447.
Lyubimkov, L.S., Rachkovskaya, T.M., Rostopchin, S.I., and Lambert, D.L. 2002, *MNRAS*, **333**, 9.
Lyubimkov, L.S., Rostopchin, S.I., and Lambert, D.L. 2004, *MNRAS*, **351**, 745.
Mathias, P., Aerts, C., Briquet, M., De Cat, P., Cuypers, J., Van Winckel, H., and Le Contel, J.M. 2001, *Astron. Astrophys.*, **379**, 905.
Mendoza, V., and Eugenio, E. 1958, *Astrophys. J.*, **128**, 207.
Merrill, P.W., and Burwell, C.G. 1933, *Astrophys. J.*, **78**, 87.
Merrill, P.W., and Burwell, C.G. 1949, *Astrophys. J.*, **110**, 387.
Molenda-Żakowicz, J., and Połubek, G. 2004, *Acta Astron.*, **54**, 281.
Morris, S.L. 1985, *Astrophys. J.*, **295**, 143.
Napiwotzki, B., Schönberner, D., and Wense, V. 1993, *Astron. Astrophys.*, **268**, 653.
Pamyatnykh, A.A. 1999, *Acta Astron.*, **49**, 119.
Percy, J.R. 1970, *Astron. J.*, **75**, 8181.
Percy, J.R. 1984, *J. of the Roy. Astron. Soc. of Canada*, **78**, 241.

- Rufener, F. 1988, "Catalogue of Stars Observed in the Geneva Photometric System" 4-th edition, Geneva Observatory.
- Samus, N.N., *et al.* 2004, "General Catalog of Variable Stars".
- Schaller, G., Schaerer, D., Meynet, G., and Maeder, A. 1992, *Astron. Astrophys. Suppl. Ser.*, **96**, 269.
- Schmidt, E.G. 1976, *P.A.S.P.*, **88**, 63.
- Stankov, A., and Handler, G. 2004, *Astron. Astrophys. Suppl. Ser.*, **158**, 193.
- Sterken, C., Veen, P., and Burnet, M. 1998, *Astron. Astrophys.*, **332**, 605.
- Underhill, A., and Doazan, V. 1982, "B Stars with and without Emission Lines", Eds. Underhill, A., Doazan, V., NASA.
- Waelkens, C., Aerts, C., Kestens, E., Grenon, M., and Eyer, L. 1998, *Astron. Astrophys.*, **300**, 215.
- Winzer, J.E. 1974, *Astron. J.*, **79**, 45.
- Woodward, E. 1975, *IBVS*, 993.
- Yudin, R.V. 2001, *Astron. Astrophys.*, **368**, 912.