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TRUE AND POSSIBLE CONTACT BINARIES IN THE HIPPARCOS CATALOGUE

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Contact binaries are the most frequent type of eclipsing binaries. Nevertheless, many of them escape detection because their inclination angles are small, and the light variations are below the general detection limit of (mainly photographic) searches for variable stars. An unpublished study of the distribution of inclination angles of contact binaries shows that the probability of discovery drops dramatically below 75 degrees, and becomes nearly zero at 60 degrees (Duerbeck 1997). In recent years, low amplitude contact binaries were found in CCD studies of galactic clusters and the bulge (see, e.g., Rucinski & Kaluzny 1994, Rucinski 1997), but no systematic all-sky-survey is available until now.

The photometric survey of the HIPPARCOS satellite has confirmed many variables, and has produced a substantial number of new ones. I have surveyed the list of periodic variables in the Variability Annex of the HIPPARCOS Catalogue (ESA 1997) for known and new contact binaries. Stars classified as "EW" were examined, and a few dubious cases were rejected. Of the 108 remaining contact binaries observed by HIPPARCOS, 34 were discovered or newly classified as contact binaries by the HIPPARCOS team.

Are there more contact binaries in the HIPPARCOS catalogue? The Variability Annex contains a number of low amplitude variables of short period described only by "P" for periodic variable. These objects might be pulsating stars of low amplitude of types RRC, DSCT/DSCTC, or BCEP, or contact binaries seen at small inclination angles. As such they belong to the variable star group ELL – rotating ellipsoidal variables. The definition of type ELL is somewhat ambiguous, since it comprises contact binaries as well as EB and EA binaries with low inclination angles. Most stars classified as ELL (in the Variability Annex and elsewhere) have maxima of unequal height, which shows that binaries with a strong O'Connell effect are preferentially included in the ELL group. Without spectroscopic information, systems with maxima of equal height and displaying sinusoidal light curves might easily be taken for pulsating variables with half the adopted orbital period.

In order to provide a working list of contact binary candidates for spectroscopic verification, I have plotted a period–colour relation for the "true" HIPPARCOS contact binaries; for a discussion of the period–colour relation, see Rucinski (1993). The (B − V) values from the HIPPARCOS catalogue are not corrected for interstellar extinction, which is expected to be small. The systems are shown in Fig. 1 as open circles. All low-amplitude variables of short period with sinusoidal light curves were also entered, in this case, with period values doubled. These data are shown as filled circles.

The "true" contact binaries, together with the majority of low amplitude variables (filled black circles), match the well-known broad band from the "red" short period contact binaries to the "blue" long period binaries. A small subgroup is found at generally short periods and blue colours (grey filled circles): These variables may consist mainly of DSCT and RRC variables, and are designated, in the present context, as "pulsating" stars. The borderline can be assumed as a polygon through the bluest confirmed contact binaries; another possibility is the use of the Blue Short Period Envelope defined by Rucinski (1997), transformed to the (B−V) index (see Rucinski & Duerbeck 1997b). Both methods separate well the blue pulsating stars from the contact binaries. The remaining sample of contact binary candidates will, however, still be contaminated by pulsating stars, since the RRC stars extend to redder colours and longer periods. Space motions, parallaxes, and spectroscopic investigations are needed for a complete separation of the two groups.

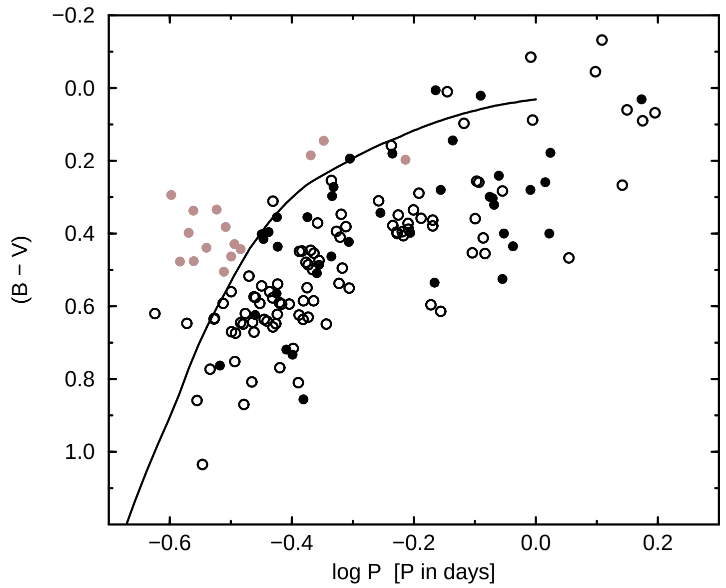

Figure 1. The period–colour diagram of confirmed contact binaries (open circles), suspected contact binaries (filled circles, black) and suspected pulsating variables (filled circles, grey). The latter ones fall outside the band defined by the true contact binaries. The short-period blue envelope of contact binaries (Rucinski 1997) is also shown.

Table 1: List of periodic variables in the Variability Annex of the HIPPARCOS Catalogue, which are either contact binary stars (EW) or pulsating stars.

HIP	GCVS	P (days)	B − V	range ($m_{\rm Hp}$)	spectral type	comment
2005	BQ Phe	0.4370	0.509	10.473−10.594	F3/5 V	EW
2274	CL Cet	0.6216	0.398	9.881− 9.999	F2 V	EW
7682	CE Hyi	0.4408	0.486	8.481− 8.527	F5 V	EW
8821	V778 Cas	0.8808	0.525	8.943− 9.090	F0	EW; vis. bin
11934	WY Hor	0.3989	0.733	9.516− 9.705	G2 IV/V	EW
17042	V579 Per	0.4656	0.272	7.875− 7.942	A0	EW
17826		0.8863	0.400	8.271− 8.315	F0	EW; vis. bin

Table 1 (cont.)

HIP	GCVS	P (days)	$B-V$	range ($m_{\rm Hp}$)	spectral type	comment
18151	CY Cam	1.0520	0.400	8.432– 8.518	B1 III, B8	EW (early type)
18474	V1131 Tau	0.3080	0.505	8.826– 8.897	F0	puls
22326	HV Eri	0.4218	0.355	8.368– 8.463	A5	EW or puls; vis. bin
22454	V1359 Ori	0.3643	0.396	8.524– 8.569	F0	EW or puls
28440	AN Men	0.4620	0.463	9.358– 9.539	F5 V	EW
28778		0.8400	0.299	7.653– 7.689	A9 V	EW
29186	V1383 Ori	0.7302	0.144	8.767– 8.872	A3 V	EW; vis. bin
29589	PV Gem	0.3762	0.355	7.580– 7.635	F0	EW or puls; vis. bin
34401	V752 Mon	0.4629	0.297	6.979– 7.006	F0	EW; vis. bin
37197	V345 Gem	0.2748	0.476	7.819– 7.883	F0	puls; vis. bin
43071	OQ Vel	0.5813	0.180	7.736– 7.774	A5 V, A3 IV	EW; vis. bin
44800	DO Cha	0.6814	0.535	7.739– 7.777	F7 V	EW
45693	GG UMa	0.2697	0.398	8.662– 8.720	F5	puls
46223		0.9794	0.280	7.067– 7.098	A3	EW
50775	V344 Vel	0.2995	0.334	7.968– 8.005	F0 IV	puls
51361	GS UMa	0.3280	0.443	8.751– 8.800	F8	puls
51677	ET Leo	0.3465	0.624	9.594– 9.721	G5	EW
52624	V353 Vel	0.4953	0.194	7.688– 7.728	A3 IV/V	EW
53708	V527 Car	0.4273	0.185	9.039– 9.090	A3m, A7-9	puls or EW; vis. bin
54165	HH UMa	0.3755	0.565	10.584–10.798	F8	EW
62919	DT Cru	0.9168	0.435	10.022–10.210	B3	EW (early type)
63076		0.8490	0.303	5.283– 5.324	A5n	EW
69300		0.8688	0.241	7.795– 7.869	A4 V	EW
73047	TU UMi	0.3771	0.436	8.837– 8.893	F2	EW or puls
75203	FI Boo	0.3900	0.719	9.596– 9.702	G5	EW
81650		0.8532	0.321	6.370– 6.388	A9 V	EW
82883	V925 Her	0.2610	0.477	10.125–10.233	F5 V	puls
82967	V2357 Oph	0.4156	0.856	10.671–10.787		EW
83370	V929 Her	0.2884	0.439	8.061– 8.110	A5	puls
86294	V1084 Sco	0.3033	0.763	9.067– 9.198	G6 V	EW
86487	V2382 Oph	1.0558	0.178	7.260– 7.292	B3 Vne	EW
87541	GW Dra	0.2524	0.294	9.320– 9.382	F2	puls
92699	V1003 Her	0.4933	0.423	9.810– 9.904	A7	EW
92776	V4408 Sgr	1.4894	0.031	8.291– 8.377	B7 III	EW (early type)
97600	V1464 Aql	0.6978	0.280	8.685– 8.754	A2	EW
99037	IN Dra	0.2743	0.337	8.053– 8.090	F0	puls
99365	BD Cap	0.3204	0.429	7.514– 7.573	A9 III	puls
100187	DE Oct	0.5556	0.343	9.193– 9.266	A9 IV	EW; vis. bin
101862	V2129 Cyg	0.3098	0.382	8.369– 8.449	F8	puls
103803	V388 Pav	0.3165	0.463	8.813– 8.880	F5 II	puls
105249	AW Mic	0.6113	0.197	9.110– 9.198	A0 III:W	see text
108741	BX Ind	0.3552	0.402	7.937– 8.029	F2 V	EW or puls
109191	V445 Cep	0.4487	0.145	6.875– 6.903	A0	puls or EW
110622	V407 Lac	0.8113	0.021	8.309– 8.386	A0	EW
114189	V342 Peg	1.0358	0.259	6.005– 6.063	A5 V	EW; P=0.7853?
115262	V459 Cep	0.3576	0.415	7.723– 7.754	F2	EW or puls
117111	V395 And	0.6847	0.006	7.570– 7.607	A0	EW; vis. bin

A period–colour–luminosity calibration of contact binaries, based on HIPPARCOS data, is given by Rucinski and Duerbeck (1997a,b). An analysis of space motions is in progress. The present list (Table 1) gives preliminary classifications – EW, pulsating, or unclear cases "EW or puls" and "puls or EW". Spectroscopic investigations are needed to verify the true nature of the listed stars.

It is encouraging to see that most objects with spectroscopically assigned high luminosity classes fall indeed into the blue region of the pulsating stars, a notable exception being HIP 105249 (AW Mic). Its HIPPARCOS parallax yields $M_{\rm Hp} = +1.2^{+0.85}_{-1.45}$, which is compatible with either a contact binary or an RR Lyrae star. This star is, however, known as a field Horizontal Branch star and a suspected RR Lyrae variable (cf. Kodaira and Philip 1984). Another case is HIP 92776 (V4408 Sgr), which has the spectral type B7 III and may be an early type contact binary.

The inclination angles of most contact binary candidates will be small and difficult to determine, thus, spectroscopic studies will only be of limited use, spectroscopic verifications will, however, yield the necessary data for the determination of the space density of contact binaries in the solar neighborhood.

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