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Citation
Hensberge, H., Jongeneelen, A., & Le Poole, R. (1988). Wide binaries in a HIPPARCOS sample centered around B = 0 deg, L = 300 deg. *Astrophysics And Space Science*, *142*, 259-264. Retrieved from https://hdl.handle.net/1887/6542

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Note: To cite this publication please use the final published version (if applicable).

1988Ap&SS.142..259H

WIDE BINARIES IN A HIPPARCOS SAMPLE CENTERED AROUND $b = 0°$, $l = 300°$ *

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Summary. 3′ × 3′ pictures centered on *Hipparcos Input Catalog Objects* (L3–2 INCA) have been produced in Leiden from measuring 87 plates of the Dutch glass copy of the ESO Quick Blue Survey by use of astroscan. We extract from this material our studied sample, consisting of 19825 regions around INCA objects brighter than 11 mag and outside open clusters. It enables to study in a statistical way wide binaries with apparent angular separations between 0.″1 and 1.″5 and with components within 3 mag (in the blue spectral region) of the pointed object. We present in this paper our first results on the observed characteristics of this population.

1. Introduction

In the frame of the commitment of Leiden Observatory to the INCA consortium preparing the HIPPARCOS mission, 87 plates of the Dutch glass copy of the ESO Quick Blue Survey have been measured with the ASTROSCAN microdensitometer, providing information on 3′ × 3′ regions around approximately 22 000 INCA stars. An accurate position and a photographic blue magnitude B have been measured for each INCA star and for stars in their vicinity that could influence significantly the signal received from HIPPARCOS. Explicitly, position and magnitude have been determined for all additional stars within 1.″5 and brighter than $B + 3$; fainter stars have only been measured progressively with decreasing separation to the pointed star.

Although measured originally for the purpose mentioned above, the sample obviously contains valuable information on wide binaries and deserves attention from that point of view. The available sample, after statistical correction for optical companions, gives information on very wide binaries composed of mostly rather young stars of comparable luminosities (mass). The sample is dominated by young stars, and includes several OB associations in the constellation Scorpius. A typical system, with apparent separation of the order of 1′, apparent magnitude 10 and spectral types A0 + A0 would correspond to a system with linear separation of roughly 50 000 AU and escape velocity of 0.4 km s^{-1}. Such systems have a non-negligible probability of disruption over a stellar life-time, so that age/spectral-type dependencies may be expected. Moreover, the sample is suitable to study wide binary characteristics for association members versus field stars, once the HIPPARCOS programme of the SPECTER group in Leiden will have furnished extensive membership data.

In this contribution, a subsample selected to look for the presence of wide double stars is described, some of its apparent characteristics are pointed out and prospects for further research are discussed.

* Presented by H. Hensberge.

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Astrophysics and Space Science **142** (1988) 259–264.

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1988Ap&SS.142..259H

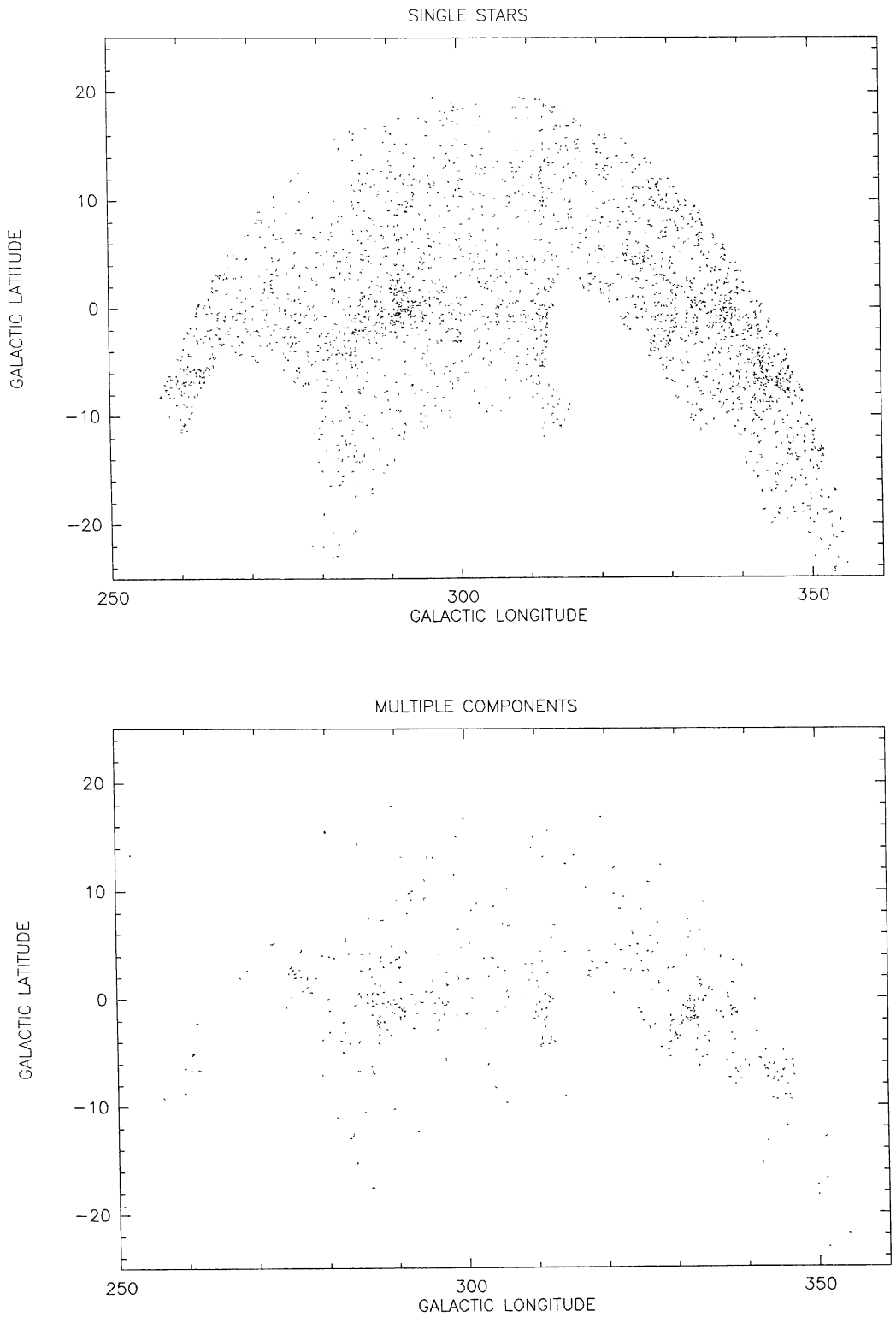

Fig. 1. Selected sample of INCA stars in galactic coordinates.

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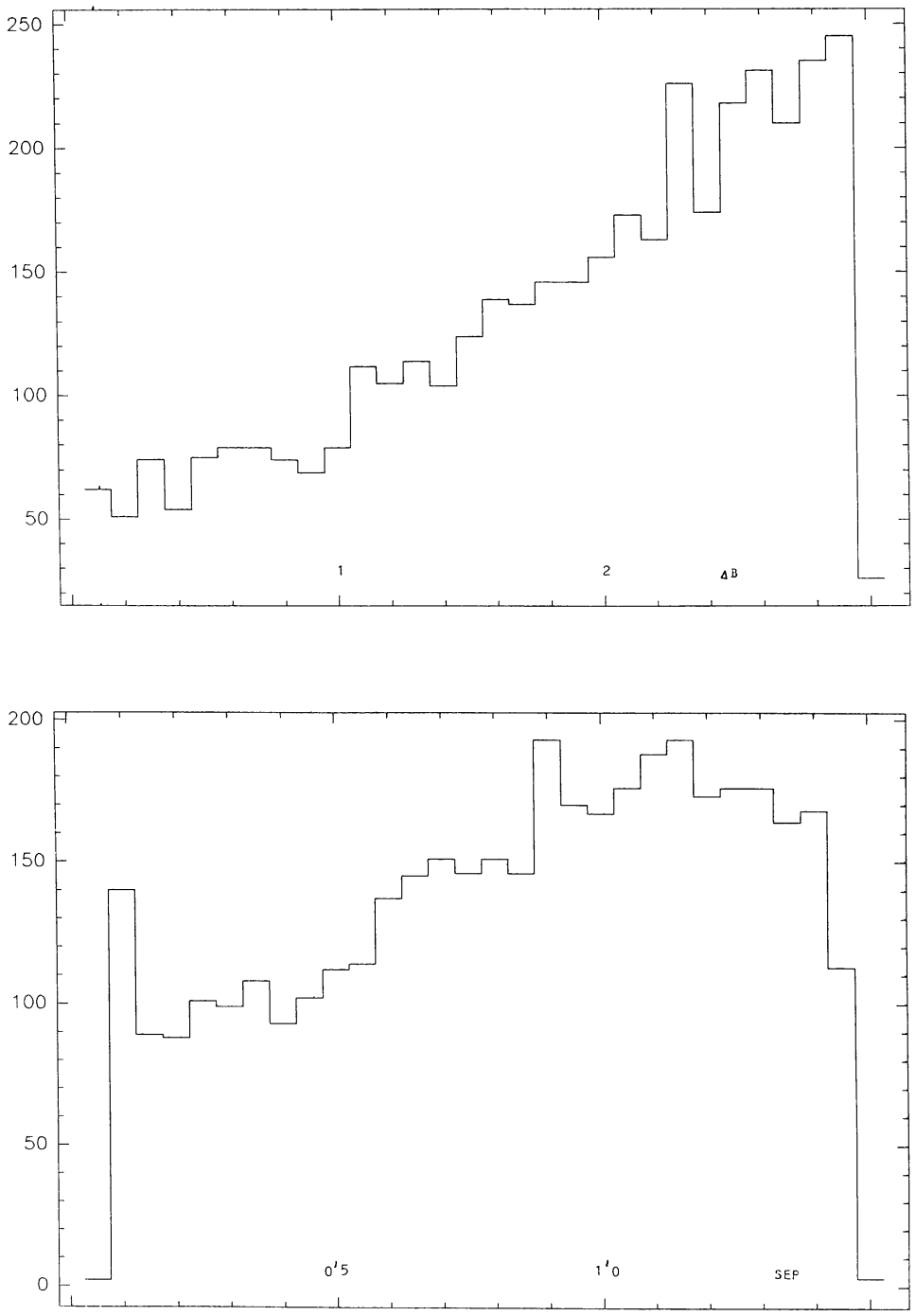

Fig. 2. Frequency (ordinate) per magnitude contrast ΔB bin (above) and per apparent separation bin (below). Apparently our sample is incomplete in the separation range 1.″1 to 1.″5, mainly because faint companions (ΔB near 3) at relative large distance of faint INCA stars (B fainter than 10) have not always been recognized.

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2. Description of the Selected Sample

The original sample has been corrected for redundancies (overlap of plates, overlap of $3' \times 3'$ regions) and has been limited to INCA stars brighter than $B = 11$, and to additional stars within magnitude $B + 3$ with respect to the INCA object and within the apparent separation range 0.'1 to 1.'5. Furthermore, stars in the direction of open clusters have been deleted. The sample then contains 19825 INCA stars and 4752 additional stars, the latter being distributed over 3891 regions around INCA objects. Notice that stars within 0.'1 of each other have always been counted as one object in our subsample, as well for INCA as for additional stars. Half of these INCA stars have spectral types A2 or earlier, 25% belong to types G0 and later. Half of the stars have magnitudes in the range 9.0 to 10.4, only 12% are fainter. Their spatial distribution is given in Figure 1. Figure 2 shows the distribution of the apparent separations and the magnitude differences in the sample.

3. Preliminary Discussion

From this selected sample, subsamples have been drawn with limiting conditions with respect to galactic position, spectral type of INCA star, magnitude of INCA star, magnitude contrast ΔB, apparent separation, etc. A straightforward computation using average stellar count rates for low galactic latitudes b shows that the expectation value for additional stars up to $B + 3$ in a 1.'5 radius around a 11 mag INCA star is already near to unity. Hence, fainter stars contribute at large separations mainly optical companions. About 3 out of 4 listed additional stars in our sample are expected to be optical companions.

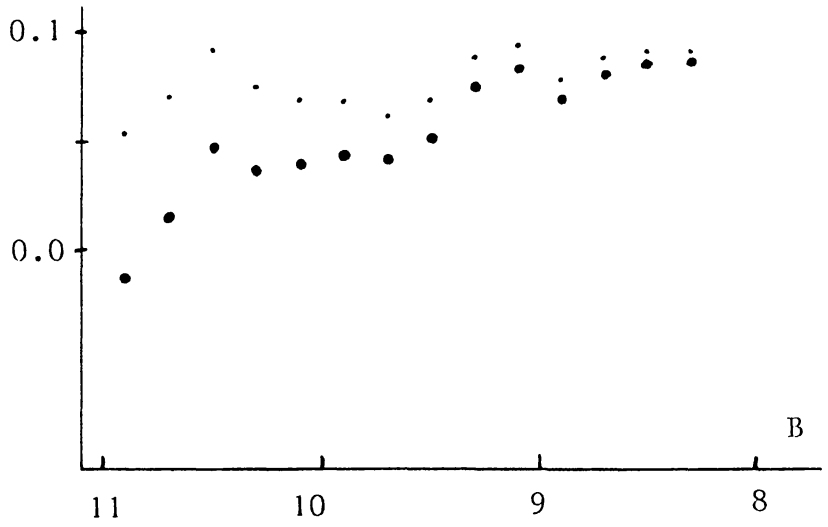

Fig. 3. Frequency of physical companions per star, within the apparent separation range 0.'1 to 1.'5 as function of magnitude B of the INCA stars. Small dots show the effect of a 10% decrease in the correction for optical companions.

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Frequencies of physical companions have been computed for several selected subsamples, taken into account the expected frequency of optical companions for given galactic position, magnitude, magnitude contrast, and apparent separation. In subsamples selected with respect to spectral type, the number of physical companions per star as a function of magnitude shows a tendency to remain constant or decrease slightly towards fainter magnitudes (the apparent decrease may be due to the selection effect at large separations mentioned with Figure 2 or/and to a 10% underestimation of the correction for optical companions). Figure 3 visualizes the situation for B7–A3 stars. If confirmed, however, the decrease should give information on the 'cut-off' separation distance. Notice that our separation field-of-view corresponds very tightly to the spectral type dependent 'cut-off' distance mentioned by Abt at this colloquium.

Better established is the presence, in our sample, of a somewhat higher density of physical companions at lower galactic latitudes for given spectral type. Table I summarizes the results for the subsample of B9–A0 stars, as a function of 'linear' separation assuming their magnitude B to be a distance indicator. The narrowing of the separation intervals for fainter stars eliminates already most optical companions, the result, therefore, being not severely dependent on the adopted correction. The presence of reddening in the galactic plane would enhance the observed difference. Hence, the observed ratio of number of physical companions per INCA star at $|b| < 7\overset{\circ}{.}5$ versus the number at $|b| > 7\overset{\circ}{.}5$ amounts at least to a factor 1.5 in the B9–A0 sample.

TABLE I

Dependence of density of physical companions on galactic latitude. The results refer to a sample of 3118 B9–A0 stars in the magnitude range B = 8–11. 'Linear' separations (first column) are given as angular separations at B = 9.5. Densities are given in units of number of physical companions per star per surface of 1′ × 1′ within the given separation range. The results at low b refer to 321 companions of which 60 were treated as optical, these at high b refer to 70 companions of which 10 were treated as optical. The separations covered is roughly 8000 to 25000 AU.

Separation at B = 9.5	Density/star/1′ × 1′ $\lvert b\rvert < 7\overset{\circ}{.}5$	Density/star/1′ × 1′ $\lvert b\rvert > 7\overset{\circ}{.}5$
0″.25 to 0″.35	0.09	0.05
0″.35 to 0″.45	0.08	0.07
0″.45 to 0″.55	0.07	0.04
0″.55 to 0″.65	0.06	0.04
0″.65 to 0″.75	0.07	0.05

Finally, an inspection of about 100 regions with at least three additional components (data in Table II and Figure 4) reveals that they might be explained by optical components (as judged from their distribution with magnitude contrast and separation) for all spectral types except for pictures centered around O and early B stars.

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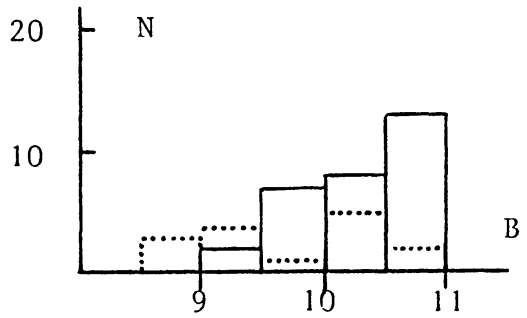

Fig. 4. Distribution with magnitude for the subsamples of INCA stars used to construct Table II. Full line corresponds to the late-B type stars, dotted line to O and early-B stars.

TABLE II

Companions of INCA stars showing 3 or more companions. Three samples are compared: two empirical ones, referring to O and early-B stars (a), respectively, late-B stars (b), and one theoretical distribution corresponding to the case of optical companions (c). The results of (b) and (c) are compatible, those of (a) and (c) not: 38 are expected, 22 are observed below the line crossing (a).

	(a)			(b)			(c)		
Separ. ΔB	0.″1–0.″5	0.″5–1.″0	1.″0–1.″5	0.″1–0.″5	0.″5–1.″0	1.″0–1.″5	0.″1–0.″5	0.″–1.″0	1.″0–1.″5
0–1	2	3	6	2	2	8	1	3	5
1–2	5	8	5	6	6	13	3	8	14
2–3	6	9	8	5	27	33	7	22	37
	52 companions			101 companions			100 companions		

4. Prospects

With respect to the analysis of HIPPARCOS data, this work draws attention to the fact that measurements may be expected to be disturbed more often by the presence of nearby stars than indicated by relying on double star catalogs that use cut-off conditions based on the probability of physicity for the system.

The discussed apparent characteristics have been derived from preliminary trial samples. Further work on the data is likely to contribute on questions related to the most wide binaries. Progress can be made by looking in more detail to the correction procedure for opticity; by considering additional information on the companions (spectral type if available, or by measuring red plates to select out obviously optical systems); by arranging results with respect to relevant physical parameters as estimates of the binding energy and distance from the galactic plane, etc. Checks on the validity of the correction model for opticity and on the reality of correlations should finally be made by long slit spectroscopy in order to find out in smaller and thus treatable selected samples which fraction of systems shows compatible radial velocities.

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