Section 2.1

Contents of the Hipparcos Catalogue

2.1. Contents of the Hipparcos Catalogue

Description of Left-Hand Pages (Fields H0–H30)

Field H0: The machine-readable (main) Hipparcos and Tycho Catalogues include a character indicating whether the associated record is derived from Hipparcos (H) or Tycho (T) data. Field H1/T1 then provides the Hipparcos Catalogue number (HIP) or the Tycho Catalogue identifier (TYC) accordingly, with the interpretation of subsequent fields being, in part, catalogue dependent (see Tables 2.1.1 and 2.2.1).

Field H1: Hipparcos Catalogue (HIP) identifier

The HIP identifier uniquely defines the stars observed by the Hipparcos satellite. Entries retain the same identifier within the final Hipparcos Catalogue as in the Hipparcos Input Catalogue—thus the Hipparcos Input Catalogue may conveniently be used to ascertain corresponding pre-Hipparcos data, cross-identifications, etc. Entries in the catalogue are referred to by their Hipparcos Catalogue (or HIP) number, emphasising that the data items associated with this number are different from those associated with the Hipparcos Input Catalogue (or HIC) number.

The printed catalogue is ordered by increasing HIP number (exceptions are noted below). This numbering follows very closely ordering by right ascension (within the reference system ICRS, and at the catalogue epoch J1991.25) independent of declination.

For entries originally considered as single, but discovered to be double or multiple on the basis of the satellite observations, the single HIP number is retained. Details are given in Fields H55–67, and in the Double and Multiple Systems Annex, along with all other double and multiple system data.

'*' indicates that the entry is 'out of sequence' (in the printed catalogue) in right ascension: there are a number of cases where ordering by HIP number results in a displacement in the ordering by right ascension by one or more catalogue places, n. In the printed catalogue, all $n + 1$ affected entries are indicated by an asterisk preceding the HIP number. This affects the following numbers of entries (those with $5 < n < 16$ are omitted here):

Displacement, n:	1	2	3	4	5	...	16	17	18
Number of entries:	3406	334	61	29	19	...	1	5	1

The only exception to the ordering by HIP number is for the 34 entries with HIP > 120 000. These are objects which were allocated revised HIP numbers during the early part of the mission following the identification of significant *a priori* errors in position and/or magnitude (a subset of these were already assigned in the published Hipparcos Input Catalogue). They are inserted in the printed catalogue at the position corresponding to their right ascension (and not indicated by an asterisk).

The machine-readable catalogue is ordered by right ascension, according to Field H8, with an ordering derived from Field H3 for the 263 cases where this field is blank. It may also be interrogated by HIP number through the index file supplied.

Statistics of entries: there are a total of 118 218 HIP entries. Of these, 117 955 have associated astrometry (of the other 263 entries, 10 entries had no astrometric solution and a further 253 inadequate solutions were suppressed); and 118 204 have associated photometry. The HIP entries follow precisely the HIC numbering, with the exception of one entry (HIC 99413) which was deleted from the Hipparcos observation programme after the publication of the Hipparcos Input Catalogue, and the entries 120 401 – 120 404 and 120 411 – 120 416 which were added to the programme at a late stage. Thus, in the range HIP 1 – 118 322, 138 numbers do not appear (137 were missing in HIC), while there are 34 HIP entries with a HIP number above 120 000. The affected entries are tabulated hereafter:

HIP >120000 ordered by HIP number

HIP	Right ascension J1991.25 (ICRS)	Declination J1991.25 (ICRS)
120001	05 10 42.43	−20 45 03.0
120002	05 59 25.13	+17 48 59.1
120003	06 31 09.63	+11 15 21.1
120004	08 25 48.50	−00 24 35.3
120005	09 14 26.19	+52 41 16.7
120006	14 53 20.87	−45 51 32.7
120027	03 19 13.13	−73 38 54.2
120046	07 03 52.64	−46 25 02.5
120047	07 15 18.66	−31 54 34.9
120071	10 07 38.10	−85 07 11.4
120082	11 39 49.86	+45 09 23.8
120121	16 04 48.15	−35 52 10.1
120132	18 00 09.95	−48 20 01.9
120148	20 03 00.82	+20 05 49.8
120155	20 21 31.73	+36 55 12.8
120159	21 22 59.03	−80 04 52.8
120212	12 27 48.08	+00 29 35.3
120229	21 58 41.72	+23 04 16.3
120248	06 49 50.74	+66 21 30.2
120250	21 10 01.55	−01 51 52.1
120276	10 02 04.27	+79 42 22.6
120290	16 57 40.96	+35 16 11.0
120306	23 06 44.99	−66 04 31.0
120313	13 45 35.69	+17 44 32.8
120401	07 57 31.75	−60 37 51.3
120402	07 57 47.68	−60 36 35.0
120403	07 57 49.18	−60 41 01.2
120404	07 58 02.92	−60 36 53.3
120411	04 47 58.18	−32 09 54.2
120412	05 23 33.71	−60 55 29.0
120413	11 46 36.46	−27 27 32.1
120414	11 51 37.00	−25 54 40.3
120415	20 20 04.64	−67 22 23.4
120416	20 12 58.08	−56 50 47.9

HIP >120000 ordered by right ascension

HIP	Right ascension J1991.25 (ICRS)	Declination J1991.25 (ICRS)
120027	03 19 13.13	−73 38 54.2
120411	04 47 58.18	−32 09 54.2
120001	05 10 42.43	−20 45 03.0
120412	05 23 33.71	−60 55 29.0
120002	05 59 25.13	+17 48 59.1
120003	06 31 09.63	+11 15 21.1
120248	06 49 50.74	+66 21 30.2
120046	07 03 52.64	−46 25 02.5
120047	07 15 18.66	−31 54 34.9
120401	07 57 31.75	−60 37 51.3
120402	07 57 47.68	−60 36 35.0
120403	07 57 49.18	−60 41 01.2
120404	07 58 02.92	−60 36 53.3
120004	08 25 48.50	−00 24 35.3
120005	09 14 26.19	+52 41 16.7
120276	10 02 04.27	+79 42 22.6
120071	10 07 38.10	−85 07 11.4
120082	11 39 49.86	+45 09 23.8
120413	11 46 36.46	−27 27 32.1
120414	11 51 37.00	−25 54 40.3
120212	12 27 48.08	+00 29 35.3
120313	13 45 35.69	+17 44 32.8
120006	14 53 20.87	−45 51 32.7
120121	16 04 48.15	−35 52 10.1
120290	16 57 40.96	+35 16 11.0
120132	18 00 09.95	−48 20 01.9
120148	20 03 00.82	+20 05 49.8
120416	20 12 58.08	−56 50 47.9
120415	20 20 04.64	−67 22 23.4
120155	20 21 31.73	+36 55 12.8
120250	21 10 01.55	−01 51 52.1
120159	21 22 59.03	−80 04 52.8
120229	21 58 41.72	+23 04 16.3
120306	23 06 44.99	−66 04 31.0

HIP numbers not represented in the Hipparcos Catalogue

672	15502	31865	39151	52081	60606	69217	86018	96578	106808
1569	18193	31869	39615	52754	60656	74720	86337	96685	108292
3814	18200	32720	40207	54637	60898	76367	86909	97453	110971
5200	19006	33870	41023	55419	61056	78626	87011	98686	111772
5791	20461	33967	43168	56283	63146	78778	88138	99413	112054
8402	24045	34232	45172	56288	63158	81359	88168	99630	112313
9584	24908	34593	47481	56804	64239	82616	89395	100410	112445
9626	25384	35175	47855	57147	65576	82846	90057	101609	114095
11119	26911	35292	48831	57354	66518	82924	90682	101775	114122
11916	27274	36230	49190	58156	67089	83437	90688	101872	115426
11961	28058	36353	49361	58209	67295	83470	91787	102008	116059
12388	28810	37807	49550	59097	67920	84039	91835	102079	116992
15088	31077	38450	50224	59304	67924	85550	92357	104519	
15417	31441	38452	51431	59860	68098	85754	96513	105516	

Field H2: Proximity flag

This field provides a coarse indication of the presence of nearby objects within a specific radial distance (10 arcsec) of the given entry. If non-blank, it indicates that there is one or more distinct Hipparcos Catalogue entries (or distinct components of the system from Part C of the Double and Multiple Systems Annex if double or multiple), or one or more distinct Tycho Catalogue entries, in either case irrespective of magnitude, within 10 arcsec of the position given in Fields H8–9. The flag is assigned according to the following hierarchy (i.e. if 'H' and 'T' both apply, 'H' is adopted):

H : there is one or more distinct Hipparcos Catalogue entries, or one or more distinct components of the relevant Hipparcos Catalogue entry, within 10 arcsec of the position given in Fields H8–9 (i.e. entries flagged 'G', 'O', 'V', 'X' in Field H59 or 'S' in Field H61 are not considered);

T : there is one or more distinct Tycho Catalogue entries within 10 arcsec of the position given in Fields H8–9.

The flag 'T' implies either an inconsistency between the Hipparcos and Tycho Catalogues (e.g. discordant positions resulting in different separations), or a deficiency in one or both of the catalogues (e.g. indicating that a component detected by Tycho was not detected, or could not be solved, in the Hipparcos double-star processing; or that the Tycho detection was spurious).

The number of entries in each of these categories is as follows: H = 10 800; T = 125 (107 of these are non-blank in Field H61, with 33 flagged 'S').

Fields H3–7: Descriptor

Fields H3–4: Positional identifier: truncated coordinates (epoch J1991.25, ICRS)

The approximate right ascension and declination are given in conventional sexagesimal units with truncated precision, for epoch J1991.25, and within the reference system ICRS. Fields H3–4 are rounded values of the positions given in Fields H8–9, and are included as a convenient way of object identification.

For the 263 cases where Fields H8–9 are missing (see Field H1), Fields H3–4 provide the position taken from the Hipparcos Input Catalogue, and propagated to the catalogue epoch J1991.25. Fields H3–4 were computed directly from the solution: computation from Fields H8–9 will lead to a few cases with an apparently discrepant final digit in the descriptor.

Field H5: V magnitude

The magnitude, V, in the Johnson UBV photometric system.

The V magnitude was not measured directly from the Hipparcos observations, but derived using a series of transformations according to stellar type and the photometric information available (see Field H7). As a result, the field provides an approximate but rather homogeneous indication of the Johnson V magnitude useful, for example, for identification purposes, and for the computation of absolute magnitudes in terms of M_V. Users should, however, be aware of the limitations arising from its construction.

The source of V is given in Field H7. If a genuine Johnson V magnitude (obtained either in UBV, Geneva, or Walraven photometry) was available and accurate, this was generally retained. When stars showed a significant

difference with respect to earlier ground-based data, V estimates from Hp and $V-I$, or from B_T and V_T, were preferred, since they correspond to the median magnitude during the mission. The V magnitude for variable stars are in principle derived from the satellite data only.

The most accurate estimate of V, produced either from the ground, from Tycho data, or from Hp and Tycho data, was selected. The transformations used are given in Section 1.3, Appendix 4. See also Field H43 for cases where the derived V magnitudes correspond to non-single stars.

Error estimates were computed in order to select the appropriate source of V. The internal accuracy is generally very high, with standard errors of the order of a few millimagnitudes. Nevertheless, the systematic errors induced by inadequacies of the transformation equations are larger. They are of the order of 0.01 mag for G and K stars, where $Hp-V_J$ is rather insensitive to colour index (see Figure 1.3.4). The offset may reach 0.03–0.08 mag, for example in the case of reddened stars, supergiants, WR stars, or double stars. Smaller systematic effects are also observed for metallic Am, Fm stars, and for metal-poor stars.

The selection of the appropriate transformation was made according to luminosity class. If no indication of luminosity class was available, the star was assumed to be a giant unless the 'absolute magnitude estimator' (see Field H42 = 'I' in Section 1.3, Appendix 5) indicated a late-type dwarf. The parallax was not used. The relations assume solar metallicity, and apply to low reddening stars.

Field H6: Coarse variability flag

A flag in this field indicates that the entry (or one of the components of the entry in the case of a resolved system) is variable, in Hp, at the level of:

1 : < 0.06 mag
2 : 0.06 – 0.6 mag
3 : > 0.6 mag

Fields H49–54 give further details of the photometric variability of the entry.

If, during the variability analysis, the entry was classified as a periodic or unsolved variable (Fields H52–53) the variability amplitude was taken directly from the tables in the Variability Annex (Section 2.4). Otherwise, entries were assigned this coarse variability flag according to the analysis described in Section 1.3, Appendix 2 (case 'M').

The number of entries in each of these categories is as follows: 1 = 4112; 2 = 6351; 3 = 1099.

Field H7: Source of V magnitude in Field H5

The source flag indicates that the V (Johnson) magnitude has been derived based upon:

G : ground-based multi-colour photometry, either directly in or reduced to the Johnson UBV system;
H : Hp (Field H44), combined with information on the colour index (either $V-I$ or B_T-V_T, Field H40 and Fields H32/34 respectively), in combination with the luminosity class (see Section 1.3, Appendix 4);
T : Tycho photometry, i.e. V_T and B_T-V_T from Fields H32–36 (see Section 1.3, Appendix 4);
␣ : no data available.

The number of entries in each category is as follows: G = 23 139; H = 94 669; T = 409; ␣ = 1.

Fields H8–30: Main Mission Astrometric Data

Positions are given at the catalogue epoch J1991.25. The astrometric positions and their errors can be propagated to the standard epoch J2000.0, or to any other epoch, within the ICRS system, by the methods described in Section 1.2.8. It is recommended that such propagation is based only on the five astrometric parameters given in Fields H8–13, supplemented with the radial velocity in cases where the perspective acceleration needs to be taken into account (including the 21 stars listed in Table 1.2.3). In particular the quadratic and cubic terms included in the 'acceleration solutions' ('G' in Field H59), and separately given in Part G of the Double and Multiple Systems Annex, are *not* intended for extrapolation beyond the observation interval (roughly 1989.9 to 1993.2); in this case the position and proper motion data in Fields H8–9 and H12–13, representing the mean linear motion over the mission interval, provide a more robust basis for extrapolation (see Section 2.3.3 for details). Field H8–30 are blank for the 263 entries noted under Field H1.

Fields H8–9: Equatorial coordinates (epoch J1991.25, ICRS)

The right ascension, α, and declination, δ, are expressed in degrees for the catalogue epoch J1991.25, and with respect to the reference system ICRS.

ICRS is consistent with the conventional coordinate system at J2000.0, previously realised by the FK5 Catalogue. The position is referred to the adopted common epoch for the whole catalogue, J1991.25. In practice, the satellite observations span slightly different epochs for each object; the effect is fully accounted for by providing positions, proper motions, and corresponding standard errors at the common catalogue epoch, along with the correlation coefficients.

For most entries, effective observational epochs can be computed from the data in Fields H14–28 according to precepts given in Section 1.2.7. The individual effective epochs form an approximately normal distribution with a median value of 1991.251 and with 85 per cent of the values falling between 1991.0 and 1991.5.

Field H10: Reference flag for astrometric parameters of double and multiple systems

The flag indicates that the astrometric parameters in Fields H3–4 and H8–30 refer to:

A, B,... : the specified component of a double or multiple system;

* : the photocentre of a double or multiple system included in Part C of the Double and Multiple Systems Annex;

\+ : the centre of mass. For such an entry, an orbit is given in Part O of the Double and Multiple Systems Annex, and an 'O' is given in Field H59.

Field H10 is given to account for the situations (because of the system geometry, and the magnitude difference between the components) where it is more appropriate to present the astrometric parameters of one or other of the components, or of a photocentre of two or more of the entries, or of the centre of mass. Field H10 is non-blank for all entries contained in Parts C, O, and V of the Double and Multiple Systems Annex (i.e. with 'C', 'O', or 'V' in Field H59). Entries in Parts G and X of the Double and Multiple Systems Annex ('G' or 'X' in Field H59) are blank in Field H10.

For resolved entries (with 'C' in Field H59) with separation $\varrho < 0.3$ arcsec the astrometric data in Fields H3–4 and H8–30 refer to the photocentre, which for these systems is generally better determined by the observations than the individual components (whose parameters are nevertheless given in Part C of the Double and Multiple Systems Annex).

For $\varrho \geq 0.3$ arcsec the astrometric parameters of the primary and secondary can be well estimated, and the primary is then used as the astrometric reference. If an individual component is used as reference, this will

always be the brightest component (in *Hp*), irrespective of whether this component has been identified in the literature as component A or B, etc. In certain multiple systems, it is in principle necessary to specify which components are included in the photocentre. For example, in a triple system ABC, the astrometric data may refer to the photocentre of the AB pair. This information is specified in a note (see Field H70). In practice, in all such cases in the Hipparcos Catalogue, it is AB which constitutes the adopted photocentre, never BC, AC, etc.

The number of entries in Field H10, and their relationship with the content of Field H59, is as follows:

Flag	Field H10	Field H59				
		C	G	O	V	X
A	9526	9526	0	0	0	0
B	1208	1208	0	0	0	0
C	87	87	0	0	0	0
D	10	10	0	0	0	0
E	2	2	0	0	0	0
G	1	1	0	0	0	0
S	2	2	0	0	0	0
*	2663	2375	0	0	288	0
+	235	0	0	235	0	0
Total non-blank	13734	13211	0	235	288	0

Field H11: Trigonometric parallax

The trigonometric parallax, π, is expressed in units of milliarcsec. The estimated parallax is given for every star, even if it appears to be insignificant or negative (which may arise when the true parallax is smaller than its error).

Fields H12–13: Proper motion components (epoch J1991.25, ICRS)

The proper motion components, $\mu_{\alpha*} = \mu_\alpha \cos\delta$ and μ_δ, are expressed in milliarcsec per Julian year (mas/yr), and are given with respect to the reference system ICRS.

Fields H14–15: Standard errors of the equatorial coordinates (epoch J1991.25)

The standard errors of the right ascension, $\sigma_{\alpha*} = \sigma_\alpha \cos\delta$, and declination, σ_δ, are given at the catalogue epoch, J1991.25, and are expressed in milliarcsec.

Field H16: Standard error of the trigonometric parallax

The standard error of the trigonometric parallax, σ_π, is given in milliarcsec.

Fields H17–18: Standard errors of the proper motion components

The standard errors of the proper motion components, $\sigma_{\mu_{\alpha*}} = \sigma_{\mu_\alpha \cos\delta}$ and σ_{μ_δ}, are expressed in milliarcsec per Julian year (mas/yr).

Fields H19–28: Correlation coefficients

The correlation coefficients (see Section 1.2.7) are given in per cent for the printed catalogue, but as (real) numerical values in the machine-readable version. They are given in the following order:

H19 = $\rho^{\delta}_{\alpha*}$
H20 = $\rho^{\pi}_{\alpha*}$
H21 = ρ^{π}_{δ}
H22 = $\rho^{\mu_{\alpha*}}_{\alpha*}$
H23 = $\rho^{\mu_{\alpha*}}_{\delta}$
H24 = $\rho^{\mu_{\alpha*}}_{\pi}$
H25 = $\rho^{\mu_{\delta}}_{\alpha*}$
H26 = $\rho^{\mu_{\delta}}_{\delta}$
H27 = $\rho^{\mu_{\delta}}_{\pi}$
H28 = $\rho^{\mu_{\delta}}_{\mu_{\alpha*}}$

corresponding to the sequence illustrated in the following table:

	$\alpha*$	δ	π	$\mu_{\alpha*}$	μ_{δ}
$\alpha*$	–	H19	H20	H22	H25
δ	H19	–	H21	H23	H26
π	H20	H21	–	H24	H27
$\mu_{\alpha*}$	H22	H23	H24	–	H28
μ_{δ}	H25	H26	H27	H28	–

The use of the asterisk notation, $\mu_{\alpha*} = \mu_{\alpha}\cos\delta$, etc., is not really required in the correlations, since the correlation coefficient is the same between (say) α and δ, as between $\alpha\cos\delta$ and δ. Nevertheless, it has been retained for uniformity.

Field H29: The percentage of rejected data, F1

This field gives the percentage of data that had to be rejected in order to obtain an acceptable astrometric solution.

This field provides a quality indicator for the astrometric data. It has been derived from an average of the two data reduction consortia values, and is insensitive to the precise definition of an observation (number of reference great circle observations, or field transits). It is given by: $100\ n_{\rm rej}/(n_{\rm acc}+n_{\rm rej})$, where $n_{\rm acc}$ and $n_{\rm rej}$ are the number of accepted and rejected observations. The field is non-blank for entries with an astrometric solution (but blank for the 263 entries without an astrometric solution).

A small percentage of rejections may be considered normal (due, for instance, to disturbing stars from the complementary field of view), whereas a large percentage is an indication of model mismatch. In all cases, including entries classified in one of the parts of the Double and Multiple Systems Annex, it corresponds to the percentage of data rejected in order to obtain the solution contained in Fields H8–28.

The precise number of observations associated with the astrometric results may be found from the file of intermediate astrometric data, which provides results at the level of each reference great-circle (see Section 2.8). An approximation to the number of astrometric observations (on great circles) may be obtained from Field H47 (the number of photometric observations, i.e. field transits) by dividing by a factor of 3.55.

Field H30: Goodness-of-fit statistic, F2

This number indicates the goodness-of-fit of the astrometric solution to the accepted data (i.e. excluding the percentage F1). For good fits, F2 should approximately follow a normal distribution with zero mean value and unit standard deviation. F2 values exceeding, say, +3 thus indicate a bad fit to the data.

The statistic F2 was computed from the goodness-of-fit statistic χ^2 of the least-squares fit (the sum of the squared normalised residuals, using the *a priori* standard error of each datum as the normalising factor), and ν, the number of degrees of freedom, according to the formula:

$$\mathrm{F2} = \left(\frac{9\nu}{2}\right)^{1/2} \left[\left(\frac{\chi^2}{\nu}\right)^{1/3} + \frac{2}{9\nu} - 1 \right]$$

If χ^2 follows the chi-square distribution with ν degrees of freedom, then F2 is approximately normal with zero mean and unit standard deviation. The formula above corresponds to the well-known 'cube-root transformation' of the chi-square variable (e.g. M. Kendall & A. Stuart 1977, *The Advanced Theory of Statistics*, London). It is usually quoted to be valid for $\nu > 30$, but is in fact useful for much smaller ν. The transformation of (χ^2, ν) to F2 eliminates the inconvenience of having the distribution (and hence the significance levels) depend on the additional variable ν, which is generally not the same for different stars. The 'unit weight error' of the solution is given by $(\chi^2/\nu)^{1/2}$.

The resulting F2 distribution for single stars is close to normal, but with a mean of $\simeq 0.21$ and a standard deviation of 1.08; the former arising from the fact that the unit-weight error is about 1.015. For non-single stars there is an excess of large F2 values indicating the presence of modelling errors for many of these objects. Given the complexity of these solutions, even values above 3 can however sometimes represent rather 'good' solutions.

Field H30 is blank for solutions where the goodness-of-fit statistic provides no meaningful information about the fit, i.e. when the unit weight error (rms normalised residual) is equal to 1 by construction. This is the case for all 1561 stochastic solutions ('X' in Field H59), where the 'cosmic error' associated with the solution was defined precisely by the condition that the unit weight error equals 1 (see Section 2.3.6). It is also the case for the two exceptional cases of Sirius (HIP 32349) and 61 Cyg A (HIP 104214), where a realistic result could only be obtained by scaling up the formal observational errors (and consequently the astrometric standard errors in Fields H14–18) in such a way that the unit weight error became 1 (as explained in the individual notes to these objects). There are therefore 1563 entries with astrometric solutions in which Field H30 is blank.

Description of Right-Hand Pages (Fields H31–H70)

Field H31: Hipparcos Catalogue (HIP) identifier

As Field H1.

Fields H32–43: Tycho Photometry, and Colour Indices

B_T and V_T were derived from the star mapper observations, and are not available for 6301 Hipparcos Catalogue components (from the main Hipparcos Catalogue or from Part C of the Double and Multiple Systems Annex), corresponding principally to about 2300 faint entries in the main Hipparcos Catalogue (Section 1.1.1 gives further details of the relationship between the Hipparcos and Tycho Catalogues). The values of B_T and V_T listed in Field H32–35 are generally the same as the values listed in the Tycho Catalogue, Fields T32–35, for the corresponding entry, the exception being for double and multiple stars as indicated by Field H36. In these cases, furthermore, the values may be given for a different component, or combination of components, than indicated by the flags in Fields H10, H43, and H48 (see Field H36 for further details).

B_T and V_T were constructed according to the methods summarised in Section 2.2, and described in detail in Volume 4. In particular, the mean magnitudes given were based on a 'de-censoring' analysis, providing optimum estimates of the B_T and V_T magnitudes, taking into account the noise-limited nature of the fainter Tycho Catalogue observations. For further details of Fields H32–35, see the corresponding description of Fields T32–35 in Section 2.2. Field T36 in Section 2.2 summarises the methods used to obtain B_T and/or V_T, and indicates those cases where the magnitudes are not strictly 'de-censored' mean values.

The $B-V$ and $V-I$ colour indices (Fields H37–39 and H40–42 respectively) were constructed according to a variety of different methods, as indicated, and are included largely in order to complement interpretation of the Hipparcos astrometric data. Field H43 indicates those entries where particular attention must be given to the interpretation of these colour indices in the context of double or multiple star entries.

Field H32: Mean magnitude in the Tycho photometric system, B_T

Field H33: Standard error of the B_T magnitude, σ_{B_T}

Field H34: Mean magnitude in the Tycho photometric system, V_T

This magnitude is in the V_T passband, except if the B_T magnitude is missing in Field H32 (this occurs for 59 entries where V_T is given). In such cases Field H34, and the associated standard error in Field H35, refer to a passband which is a combination of B_T and V_T, as described under flag 'T' in Field T36 of the Tycho Catalogue.

Field H35: Standard error of the V_T magnitude, σ_{V_T}

Field H36: Reference flag for B_T and V_T (Fields H32–35)

This reference flag indicates, for non-single stars, the component measured in Tycho photometry (Fields T32–35), or indicates that several components have been directly measured together by Tycho, or have had their Tycho data combined in Fields H32–35.

Its purpose is to assist interpretation of the *Hp* photometric data with that in B_T and V_T, given the different resolutions of the two experiments. Thus a Tycho Catalogue entry may be resolved into two or more components in the Hipparcos Catalogue thus providing 'joint' (or combined) photometry for separate Hipparcos components. On the other hand, the Tycho Catalogue may include two or more entries corresponding to the same (main) Hipparcos Catalogue entry.

The flag takes the following values:

A, B, ... : Fields H32–35 refer to the designated Hipparcos Catalogue component;

* : Fields H32–35 refer to all components of the relevant Hipparcos entry. For systems not resolved into distinct components by Tycho, the star mapper observations provide, in principle, B_T and V_T for the combined system directly. When the system is also resolved in the Tycho observations the B_T and V_T data in Fields H32–35 have been combined from the separate Tycho Catalogue values, the photometric errors having been propagated assuming that the separate Tycho photometry errors are independent. In the case of a two-pointing triple system one entry will typically provide Tycho photometry for two of the three Hipparcos components, with Tycho photometry for the third component being associated with the second Hipparcos Catalogue entry;

– : the fields refer to a single-pointing triple system (the most common case for such a flag) or single-pointing quadruple system (in the cases of HIP 23624 and HIP 108519 only), for which only a close pair has been observed by Tycho, the other components being too faint to be detected by Tycho.

The combination and/or flagging of the Tycho Catalogue photometry for Fields H32–35 and H37–38 has been carried out to be consistent, where possible, with Field H48. In affected cases, the adjusted fields will differ from the corresponding Tycho fields for the same entry (Fields T32–35 and T37–38). Note that the detailed B_T/V_T photometry for separate Hipparcos Catalogue components is given in Part C of the Double and Multiple Systems Annex.

Close separation doubles are not always resolved in the Tycho Catalogue, and in such cases Field H36 may refer to a single Hipparcos component while Field H48 may refer to combined Hipparcos photometry (*). When the entry is not resolved by Tycho, the system's B_T and V_T magnitudes may be overestimated (i.e. the Tycho magnitudes are too faint) by an amount which depends on ϱ and Δm and which may reach several tenths of mag (especially in the range ϱ = 1 – 1.5 arcsec). The quoted standard errors on B_T and V_T do not reflect this systematic effect (although the flag in Field T49 may indicate such unresolved duplicity).

If one or more component of a multiple system is missing in the Tycho data, while the other is resolved, the main catalogue provides Tycho photometry for whichever component is brightest in V_T.

The number of entries in each of these categories is as follows: A = 4035; B = 857; C = 65; D = 7; E = 1; S = 2; * = 7795; – = 34.

Field H37: Colour index, $B - V$

The colour index in, or reduced to, the Johnson UBV system.

Although not derived directly from the Hipparcos data, the $B - V$ colour index has been included as being of direct astrophysical relevance to the interpretation of the Hipparcos astrometric data ($B_T - V_T$, the colour index in the Tycho photometric system, may be derived directly from Fields H32 and H34). See also the definition of the corresponding Tycho Catalogue quantity, Field T37.

The $B - V$ colour index has been taken either from existing ground-based observations, or derived by transforming $B_T - V_T$ according to equations given in Section 1.3, Appendix 4. The spectral type and luminosity class (Field H76) were frequently used to select the appropriate type of transformation. The source which has been adopted is given in Field H39. At the end of the construction of the $B - V$ indices, entries for which $V - I < 1.5$ mag and $\sigma_{V-I} > 0.25$ mag (see Fields H40–41) were considered as being of unacceptable quality, and Fields H37–38 were set to be blank for these entries.

Entries with relatively large values of σ_{B-V} (Field H38) may be found to occupy erroneous positions in the Hertzsprung-Russell diagram. Other entries, even with small formal errors on $B - V$, may remain with erroneous colour indices due to the use of incorrect material (such as the spectral classification) on which the transformations were based. A fraction of faint, nearby, K and M dwarfs had no photoelectric photometry in the Hipparcos Input Catalogue, and HIC colours were consequently highly uncertain. Magnitudes could be updated on the basis of the Hipparcos photometry, but if they were below the Tycho detection threshold their $B - V$ indices could not be improved. These objects (with large σ_{B-V} and $B - V > 1.5$ mag) are responsible for the apparent scatter above the lower main sequence; while their $B - V$ colour index appears systematically too red, no attempts to adjust the colour indices based on trigonometric parallax information have been made.

It should be noted that $B - V$ indices derived from such transformations will generally not reproduce a directly measured Johnson $B - V$ colour index, due to dependencies on metallicity, gravity, and reddening. The agreement should be very good for entries flagged with Field H39 = ‘G’ and Field H42 = ‘H’.

Ground-based observations will generally yield combined photometry for systems with separations $\varrho <$ 10 arcsec, and in those cases the $B - V$ colour index will therefore refer to components which may differ from that of the $B_T - V_T$ or Hp photometry for double systems with component separation in the range 8–12 arcsec (see Field H43).

Field H38: Standard error of the colour index, σ_{B-V}

The standard error of the $B - V$ colour index, either from the relevant ground-based observations, or from the Tycho $B_T - V_T$ data (see Field T38).

Field H39: Source of $B - V$

This field takes the following values:

G : indicates that $B - V$ was taken from ground-based observations;
T : indicates that $B - V$ has been determined from the transformed Tycho $B_T - V_T$ data (as described in Section 1.3, Appendix 4);
␣ : no data available.

The number of entries in each of these categories is as follows: G = 41 205; T = 75 732; ␣ = 1281.

Field H40: Colour index, $V - I$

The colour index in Cousins' system, derived as described in Section 1.3, Appendix 5. Field H40 represents the best available $V - I$ at the time of the Hipparcos Catalogue publication (i.e. frequently updated with respect to the value used for the astrometric and photometric reductions given in Field H75).

The $V - I$ colour index was used to correct for the chromatic residuals in the processing of both the astrometric and photometric data. For the astrometry the effects of an erroneous $V - I$ were small, while for the photometry the effects were more significant. One of the purposes of providing it is to permit a re-reduction of the epoch photometry as new $V - I$ colour indices become available (see Field H52). The $V - I$ index is also a useful quantity for the astrophysical interpretation of the Hipparcos astrometric data, in particular for the positioning of late K and M giants in the Hertzsprung-Russell diagram, where the $V - I$ index is more sensitive to temperature than $B - V$.

Therefore, efforts were made to present homogeneous and up-to-date information on $V - I$, including updates made on the basis of linear trends observed in the epoch photometry, or using transformed Tycho photometry. As a result, for any given entry, the value of $V - I$ used for the astrometric or photometric processing (Field H75) may not be the same as the final $V - I$ value given in Field H40. Where the value used for the data processing (given also in the Hipparcos Epoch Photometric Annex header record) differed from the true value of $V - I$, a spurious linear evolution of the Hp magnitude with time has resulted (see Field H52, flag 'R' for details).

At the end of the construction of the $V-I$ indices (as described in Field H42), entries for which $V-I < 1.5$ mag and $\sigma_{V-I} > 0.25$ mag were considered as being of unacceptable quality, and Fields H40–41 were set to be blank for these entries. The $V - I$ index for red stars ($V - I > 1.5$ mag), in particular long-period variables, are intrinsically inaccurate and were therefore retained in the catalogue independent of their associated errors.

$V - I$ indices derived from these transformations will not generally reproduce a directly measured Cousins' $V - I$ colour index, due to dependencies on metallicity, gravity, and reddening affecting the colour indices used to predict $V - I$. Ground-based observations will, furthermore, generally yield combined photometry for systems with separations $\varrho < 10$ arcsec, and in those cases the $V - I$ colour index will therefore refer to components which may differ from that of the $B_T - V_T$ or Hp photometry for close double systems (see Field H43).

Field H41: Standard error of the colour index, σ_{V-I}

See Field H40 and Section 1.3, Appendix 5 for further details.

Field H42: Source of the colour index $V - I$

The flag (A–T) in Field H42 indicates the method adopted to estimate $V - I$ given in Field H40. See Field H40 and Section 1.3, Appendix 5, for details.

For a small fraction of the stars, the genuine Cousins' $V-I$ was available. For the remaining programme stars, an approximate $V - I$ was derived from ground-based multicolour photometric data transformed into $V - I$, or from the Tycho data with or without spectral-type information, or from a combination of an approximate $B - V$ and the spectral type. Details of the construction of the adopted $V - I$ colour index for each star is given in Section 1.3, Appendix 5. The reliability of the methods used may be inferred from the standard error on $V - I$ given in Field H41.

Field H43: Reference flag for colour indices (Fields H37–42) and Field H5

A flag (*) indicates that the $B-V$ colour index and standard error (Fields H37–38), and also the $V-I$ colour index and standard error (Fields H40–41), refer to the combined light of double or multiple systems, otherwise resolved by the main mission astrometry and photometry.

The same flag also refers, with the same meaning, to the Johnson V magnitude given in Field H5.

Generally, this flagging results in consistency with the Hp photometry flag, Field H48. While for single-pointing double systems with $\varrho \gtrsim 10$ arcsec the $B-V$ and $V-I$ colour indices will therefore typically refer to the primary, the corresponding colour index information of the other component(s) of such systems are not provided in the catalogue.

The number of entries with '*' in this field is 10 783.

Fields H44–48: Main Mission Photometry

Field H44: Median magnitude in the Hipparcos photometric system, *Hp*

The median *Hp* magnitude, $x(0.5)$ in the notation of Section 1.3, Appendix 1, is defined on the basis of the accepted observations (or field transits) for a given star. The number of field transits, N, is different from star to star, and is given in Field H47.

The median is derived independently of any *a priori* or *a posteriori* knowledge of the object's variability. The median and related statistics (Fields H45–46 and 49–50) were determined from the epoch photometry derived on the basis of the $V - I$ colour index given in Field H75 (see also flag 'R' in Field H52).

Field H45: Standard error of the median *Hp* magnitude, σ_{Hp}

The standard error on the median was derived as:

$$\sigma_{Hp} = \frac{1}{\sqrt{N}} \frac{x(0.65) - x(0.35)}{0.615}$$

where N is the number of observations, and $x()$ the given quantile (see Section 1.3, Appendix 1).

Field H46: Scatter of the *Hp* observations, *s*

The scatter was derived as:

$$s = \frac{x(0.85) - x(0.15)}{2}$$

where $x()$ is the given quantile (see Section 1.3, Appendix 1).

In addition to the 14 entries for which no photometry is provided, Field H46 is blank for the secondary component of the 957 'two-pointing' double systems (but not blank for the secondary and/or tertiary components of a 'two-pointing' or 'three-pointing' *multiple* system). Entries in 'two-pointing' or 'three-pointing' systems are identified by the flags in Field H60.

Field H47: Number of *Hp* observations, *N*

This is the number of photometric observations used for the construction of the median, standard error, and scatter (Fields H44–46).

The number of photometric observations given in Field H47 is typically less than the total number of photometric transits recorded in the Hipparcos Epoch Photometry Annex, Field HH4. Only transits with certain values of the transit flag, Field HT4, have been used for the construction of the median.

Field H47 is blank for the same entries (and for the same reasons) as Field H46.

Field H48: Reference flag for the photometric parameters

For a double or multiple entry, this flag indicates that the photometry refers to:

A, B,... : the specified component of a double or multiple system;

* : combined photometry of a double system, corrected for attenuation by the detector's instantaneous field of view profile response (see Section 1.4);

– : combined photometry of a multiple system, *not* corrected for attenuation by the detector's instantaneous field of view profile response (see Section 1.4).

For single catalogue entries corresponding to double systems with separations up to about 10 arcsec, and indicated by '*' in Field H48, combined photometry is provided in the main catalogue. For these 'single-pointing' doubles this combined photometry has been corrected for the detector's response profile. The main catalogue photometry and the epoch photometry is fully consistent with the photometric data given in the Double and Multiple Systems Annex.

For single catalogue entries corresponding to double systems with separations larger than about 10 arcsec, and indicated by 'A', 'B', etc. in Field H48, photometry of the brightest component is provided in the main catalogue. For these 'single-pointing' doubles the photometry has also been corrected for the detector's response profile, although the corrections are larger and therefore relatively less accurate. The main catalogue photometry and the epoch photometry is fully consistent with the photometric data given in the Double and Multiple Systems Annex.

For double systems comprising two entries (i.e. the 'two-pointing doubles) Field H48 indicates the relevant component observed under each entry. The photometry for each entry was derived from the data collected during the observations of the brighter entry, using the magnitude difference determined from the double and multiple systems processing. They are corrected for the detector's response profile, although the corrections are usually rather uncertain. The main catalogue photometry and the epoch photometry is fully consistent for the brighter component, but not for the fainter. The photometric data in the Double and Multiple Systems Annex is consistent with the main catalogue photometry. The individual values in the Epoch Photometry Annex show large, usually spurious variations, especially for the fainter component.

For multiple star entries, indicated by '–' in Field H48 (i.e. the single-pointing, two-pointing, or three-pointing multiples) the main catalogue photometry and the epoch photometry have *not* been corrected for the detector's response profile—the photometric parameters refer to the light collected from all the components of the systems, each attenuated according to its position within the detector's field of view. Photometry of the components, corrected for the detector's response profile, are given in the Double and Multiple Systems Annex.

The number of entries in each of these categories is as follows:

Field H48	Entries	Field H48	Entries
A	1407	E	1
B	933	S	2
C	25	*	10590
D	4	–	249
	Total non-blank	13211	

Field H48 is non-blank for all 13 211 entries for which Field H59 = 'C'. The 249 entries flagged '–' are precisely the entries associated with the 'one-pointing', 'two-pointing' and 'three-pointing' *multiple* systems described further under Field H60. Entries for which Field H48 = '*' may have either '*' or one of the components given in Field H10.

Fields H49–54: Main Mission Variability

Fields H49–50: Observed magnitude at maximum and minimum luminosities

Fields H49–50 provide the 5th and 95th percentiles of the epoch photometry respectively, i.e. $x(0.05)$ and $x(0.95)$ in the notation of Section 1.3, Appendix 1. They thus provide an estimate of the magnitudes at maximum and minimum luminosities detected throughout the observational period.

In many cases, in particular for the entries flagged in Field H52 as 'C', the difference between the two values will not be statistically significant.

Fields H49–50, as well as the median and related statistics (Fields H44–46), were determined from the epoch photometry derived on the basis of the $V - I$ colour index given in Field H75 (see also flag 'R' in Field H52).

The percentiles are given even for entries with small numbers of Hp observations (Field H47), and in those cases appropriate caution must be exercised in interpreting the given values. In such cases, $Hp_{\rm max}$ and $Hp_{\rm min}$ may be equal or, due to rounding, the median magnitude may lie outside the tabulated values of $Hp_{\rm max}$ or $Hp_{\rm min}$. The number of transits accepted for photometry may be significantly less than the number of transits accepted for astrometry, so that there are also situations where entries with small N (Field H47) nevertheless correspond to an astrometric solution.

Fields H49–50 are blank for the same entries (and for the same reasons) as Field H46.

Field H51: Variability period from Hipparcos observations, P

The variability period, or a provisional estimate of such a period, was derived on the basis of the Hipparcos data (possibly in combination with ground-based observations). It is expressed in days, with a precision of 0.01 days.

Further details of the variability of the entry, including the variability period with the appropriate number of (significant) decimal places, are given in the Variability Annex (Section 2.4). Truncating the period to this fixed format precision means that the contents of Field H51 will generally differ from the (more precise) value given in the Variability Annex (Section 2.4, Field P11).

Periods presented in the Variability Annex may have been derived from the Hipparcos data (Field P11) or taken from the literature (Field P18). Field H51 is taken from Field P11 only; this means that some of the entries contained in the table of Periodic Variables (where the period has been taken only from the literature) may not have a period listed in the main catalogue.

Field H52: Type of variability

The sources of scatter in the photometric data are various, and the flag in Field H52 indicates the origin of the extra scatter, which may be astrophysical, or in some cases instrumental. A more detailed description of the following categories, and the manner in which they were derived, is given in Section 1.3, Appendix 2. Amongst astrophysical sources of variability, Field H52 only distinguishes between 'M' (micro-variables), 'P' (periodic variables), and 'U' (unsolved variables). Further variability details for the periodic or unsolved variables are included in the Variability Annex (see Field H53). The flag takes the following values (see Figure 2.1.1):

C : 'constant' stars or, more strictly, stars not detected as variable. These include stars used as photometric standards. The category also includes cases noted as variable in the Hipparcos Input Catalogue. Caution must be exercised in assuming that entries flagged 'C' are non-variable: they may be variable at levels below the Hipparcos detectability threshold (see Figure 2.1.1), or they may have shown variability in the past (e.g. Be stars, or long-period eclipsing binaries). For details of the use of such entries as photometric standard stars, see Section 1.3, Appendix 2;

D : a 'duplicity-induced variability' flag was assigned according to the difference between the 'dc' and 'ac' magnitudes (see Section 2.5) and according to the angular separation and magnitude difference of a double or multiple system. If 'D' is set, the entry is not necessarily a physical variable, and not necessarily seen as variable in Hp ('dc scale');

M : possibly micro-variable, with amplitude below 0.03 mag (stars classified with high confidence as micro-variable are flagged 'U');

P : periodic variable (see Field H53). This flag may supersede entries for which flag 'D' is also appropriate;

R : revised colour index. When the flag 'R' is set the $V - I$ colour index was corrected during the variability analysis. The effect of an erroneous $V - I$ index is a spurious linear trend in the Hp magnitude of the epoch photometry, with no physical origin. When identified during the data analysis, this could be taken into account in classifying the type of variability, i.e. whether spurious or not. Corrections on the $V - I$ index brought at a later stage are not flagged in this way;

U : unsolved variable (see Field H53). Entries are classified as 'unsolved' if they do not fall into the other variability categories—this class also includes irregular or semi-irregular variables, and possible variables with amplitudes $\gtrsim 0.03$ mag;

␣ : a blank indicates that the entry could not be classified as variable or constant with any degree of certainty (e.g. due to the presence of one or more outliers in the epoch photometry).

The flag 'D' is a photometric rather than strictly a 'duplicity' indicator, and indicates entries where there is a possibility that the Hp magnitudes may be disturbed; for other double or multiple star entries the photometry is unlikely to be affected. Thus 9722 of the 13 211 entries of Part C of the Double and Multiple Systems Annex are flagged 'D', 76 of the 2622 entries of Part G, 4 of the 235 entries of Part O, 2 of the 288 entries of Part V, and 155 of the 1561 entries of Part X.

Flag 'R' originates because (as explained in Section 1.3) the photometric reductions could only proceed on the basis of the best-available value of the $V - I$ colour index for each entry, as given in Field H75. Fields H44–46 and Fields H49–50 were derived from the resulting (possibly erroneous) epoch photometry, and the corresponding parameters (including the value of $V - I$ used) appear in the relevant header record of the epoch photometry annex. Subsequently, however, improved determinations of $V - I$ were available in some cases, and the $V - I$ colour index provided in Field H40 is the best available at the time of the catalogue publication.

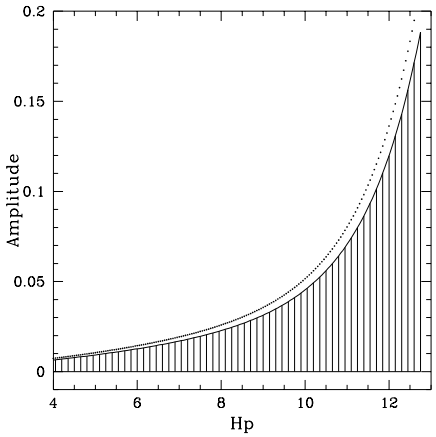

Figure 2.1.1. *The figure shows the peak-to-peak amplitude of variability which could be detected versus the Hp magnitude for an object observed an average number of times throughout the mission. To the upper left of the diagram, variability can be identified, and objects are classified as 'P' or 'U' accordingly. The shaded region is inaccessible to the Hipparcos variability analysis, and objects in that region are typically classified as 'C'. The narrow intermediate region is occupied by 'U' objects suspected as possible variables with amplitude* $\gtrsim$ *0.03 mag, or 'M' objects suspected as micro-variable with amplitude* $\lesssim$ *0.03 mag.*

Many of the significant revisions in $V - I$ were well correlated with the 1000 or so cases where the Hipparcos epoch photometry displays a secular change of magnitude with time. However, neither the epoch photometry, the summary photometry (Fields H44–46 and H49–50), or the epoch photometry header records were modified, so that they remain consistent with the value of $V - I$ given in Field H75.

A correction algorithm is included in Section 1.3.4, providing the details needed to make the appropriate corrections to the calibrated magnitudes and resulting statistics using any revised value of $V - I$, in particular that given in Field H40. This algorithm is also applicable to any new value of $V - I$ which becomes available in the future.

The number of entries in each category is as follows: C = 46 552; D = 12 361; M = 1045; P = 2708; R = 1172; U = 7784; ␣ = 46 596 (including the 14 entries for which no photometry is provided).

Field H53: Variability annex flag: tabular data

A flag indicates that variability periods, amplitudes, reference epochs, etc., compiled from the Hipparcos *Hp* data, along with associated ground-based data, are given in the corresponding tables of the Variability Annex (see Section 2.4 for further details):

1 : additional data are provided in a table of periodic variables (Volume 11, Part 1);
2 : additional data are provided in a table of 'unsolved' variables (Volume 11, Part 2).

Flags '1' and '2' generally correspond to flags 'P' and 'U' in Field H52 respectively, with the exception of some 'R' or 'D' flagged objects which occasionally superseded the 'P' and 'U' flags. Thus the 2712 entries in the periodic variables table, flagged '1', comprise all 2708 entries flagged 'P' in Field H52, and 4 entries flagged 'R'. The 5542 entries in the unsolved variables table, flagged '2', comprise 5486 of the entries flagged 'U' in Field H52, 55 flagged 'R', and 1 flagged 'D'.

Field H54: Variability annex flag: light curves

A flag in Field H54 indicates that a light curve, or folded light curve, compiled from the Hipparcos *Hp* data, is provided in the Variability Annex (see Section 2.4 for further details):

A : a (folded) light curve is given in Volume 12, Part A. This part corresponds to the 'periodic variables', generally with flag 'P' in Field H52, and with flag '1' in Field H53. The light curve has been folded at the period given in Field P11 of the Variability Annex (the period is truncated to 2 decimal places in Field H51). If Field P11 is blank, this indicates that no reliable period was obtained from the Hipparcos data, and in these cases the period as given in the literature (Field P18) was used to fold the data;

B : a light curve (not folded) is given in Volume 12, Part B. The light curve has been fitted to the data derived and transformed from the data base of the AAVSO (American Association of Variable Star Observers). This part corresponds to large-amplitude variable stars which have been observed systematically by ground-based observers for, and during, the Hipparcos mission. In these cases, a combination of the Hipparcos and AAVSO data have allowed a more complete light curve to be derived, including refined estimates of the maximum or minimum magnitudes during the mission. Entries for which the flag 'B' is set are also contained in the compilation of folded light curves if the variability is periodic; the corresponding folded light curve is then included at the relevant place according to its HIP running number;

C : a light curve (not folded) is given in Volume 12, Part C. This part generally corresponds to unsolved systems, with conspicuous features in their light curves, independent of amplitude. It includes irregular or semi-irregular variables.

The Hipparcos Catalogue Epoch Photometry Annex contains all of the data on which the light curves were based. From this, light curves not presented in the printed annexes, or constructed using different periods or data selection criteria, may be constructed.

The relationship between the non-blank entries in Fields H53 and H54 is summarised as follows:

	H53 = 1	H53 = 2	Total
H54 = A	2480+213*	–	2693*
H54 = B	213	61	274
H54 = C	8‡	819	827
H54 = ␣	11‡	4662	
Total	2712	5542	

* The 213 entries with Field H53 = '1' and Field H54 = 'B' are also included in Part A of the light curve compilation.

‡ The 8 periodic variables assigned to Part C of the light curve compilation, and the 11 periodic variables without published light curves, are variables with very long periods, well-established in the literature, where the Hipparcos data were considered to be better displayed unfolded or not at all.

For the majority of unsolved variables, flagged either 'U' in Field H52, and/or '2' in Field H53, unfolded light curves were considered to be of limited interest, showing mainly scatter, and are not included within Part C of the light curve compilation.

Fields H55–67: Multiplicity Data

Field H55: CCDM identifier (J2000.0)

The CCDM Catalogue, the Catalogue of Components of Double and Multiple Stars (described in Section 1.4.4) provides the principal cross-reference to information on double and multiple systems.

CCDM identifiers were taken from the CCDM Catalogue, and CCDM identifiers following the previous conventions were constructed for previously unknown double or multiple systems. These newly-constructed CCDM identifiers have, simultaneously, been included within the CCDM. The CCDM identifier is given if an entry is included in Part C of the Double and Multiple Systems Annex (see Field H59), or if a CCDM identifier was given in the Hipparcos Input Catalogue. Otherwise this field is blank.

There are a total of 19 393 entries with associated CCDM identifiers. A CCDM identifier has not been specifically assigned (as a result of the Hipparcos work) to entries in Part G (acceleration), Part O (orbital), Part V (variability-induced), or Part X (stochastic). CCDM identifiers associated with entries in Parts G, O, V and X arise from the assignment of CCDM identifiers to these entries in the Hipparcos Input Catalogue, and therefore have an 'I' in Field H56.

There are six cases where the CCDM identifier supersedes the corresponding CCDM identifier listed in the Hipparcos Input Catalogue:

HIP	CCDM (HIP)	CCDM (HIC)
18377	03558 + 4323	03557 + 4322
37037	07366 – 1428	07367 – 1427
47174	09367 + 5754	09368 + 5755
67635	13515 – 4626	13515 – 4627
80346	16258 + 4821	16242 + 4821
90273	18252 + 3017	18252 + 3015

Field H56: Historical status of the CCDM identifier

The flag takes the following values:

H : Hipparcos—indicates that the system was determined as double or multiple by the Hipparcos observations, and was previously unknown as double or multiple.

I : Input Catalogue—indicates that the system had been previously identified, as given in Annex 1 of the Hipparcos Input Catalogue.

M : miscellaneous—indicates that the system had been previously identified, after publication of the Hipparcos Input Catalogue, using other more recently available catalogues and compilations, in particular through the pre-release version of the Washington Catalogue of Visual Double Stars (WDS; C.E. Worley & G.G. Douglass, US Naval Observatory, Washington).

Of the 19 393 entries with associated CCDM identifiers, the number in each of these categories is as follows: H = 3001; I = 15 966; M = 426.

Field H57: Number of separate catalogue entries with the same CCDM identifier

The CCDM identifier links different components of an identified double or multiple system. If an entry itself comprises the double system, the CCDM identifier is associated only with that entry. If two or more entries are considered part of a double or multiple system, the entries are assigned the same CCDM identifier.

There are 19 393 entries with associated CCDM identifiers. Of these, 15 816 refer to a single entry, 1714 link two entries (i.e. affecting 3428 entries), 43 link three entries (affecting 129 entries), and 5 link four entries (affecting 20 entries). Part C of the Double and Multiple Systems Annex contains component information only for those cases where a catalogue entry comprises more than one component (i.e. Field H58 ≥ 2), and for those multiple entry systems taken together in the data reductions and referred to as the 'two-pointing' or 'three-pointing' doubles or multiples (there are no 'four-pointing' multiples). Entries which constitute part of a 'two-pointing' or 'three-pointing' system may be recognised by the flags 'P' (primary), 'F', 'I', or 'L' appearing in Field H60.

A double or multiple system which is comprised of two or more distinct, unresolved, and independently treated, catalogue entries, is not included in Part C of the Double and Multiple Systems Annex—the relative astrometric and photometric parameters may be derived from data for the separate catalogue entries (which are linked by their common CCDM identifier).

More complex systems may superficially appear to contradict this scheme. Thus the 4-entry (actually 6-component) system CCDM 05353–0524 comprises the 'three-pointing' system HIP 26220, HIP 26221 and HIP 26224, which all have Field H57 = 4 (four entries with the same CCDM identifier), Field H59 = 'C' (details provided in Part C of the Double and Multiple Systems Annex), and 'F' or 'P' in Field H60, indicating that they are part of a multiple-pointing system (in this case, a 'three-pointing' system). The fourth entry, HIP 26235, has Field H60 = ␣ (i.e. not observed as part of a multiple-pointing system). The 'C' in Field H59 arises because this entry is itself double (Field H58 = 2), not because of its association with CCDM 05353–0524. Similarly, two of the entries comprising the three-entry system CCDM 21555+5232 were observed as a 'two-pointing' system and have corresponding data in Part C, while the third entry was reduced independently, and is not referenced in Part C.

For entries in Part C of the Double and Multiple Systems Annex, the following table summarises the number of systems (n_s) in each of the multiple-pointing configurations (n_p = 1, 2, 3, corresponding to the 'single-pointing', 'two-pointing', and 'three-pointing' doubles or multiples respectively) as a function of the number of components in the system (n_c):

Components in system n_c	Multiple-pointing configuration, n_p			Total systems Σn_s	Total entries $\Sigma n_p n_s$	Total components $n_c \Sigma n_s$
	1	2	3			
2	11048	957	0	12005	12962	24010
3	129	50	3	182	238	546
4	6	1	1	8	11	32
Systems, Σn_s	11183	1008	4	12195	–	–
Entries, $n_p \Sigma n_s$	11183	2016	12	–	13211	–
Components, $\Sigma n_c n_s$	22507	2068	13	–	–	24588

The quadruple with two entries consists of AB for one entry and CD for the other, while the quadruple with three entries includes one entry resolved into two components. From these statistics, it follows that there are 11 101 (11 048 + 50 + 2 × 1 + 1) entries with relative double star information in the main Hipparcos Catalogue, Fields H63–67.

It also follows that the number of CCDM flagged entries which are not resolved into two or more components by Hipparcos is 4633 (15 816 – 11 183). There are 706 double systems (1714 – 1008) corresponding to 1412 entries in which two catalogue entries are linked by the same CCDM identifier but which were not 'reduced' as 'two-pointing' systems; and 39 triple systems (43 – 4) corresponding to 117 entries in which three catalogue entries are linked by the same CCDM identifier but which were not 'reduced' as 'three-pointing' systems. The further 5 CCDM identifiers each linking four entries (affecting 20 entries) were also not reduced as multiple-pointing systems.

Field H58: Number of components into which the entry was resolved

This field gives the number of components into which the entry was resolved as a result of the satellite observations and data reductions.

A value of '1' is given in Field H58 for all entries not in Part C of the Double and Multiple Systems Annex (thus, entries with 'G', 'O', 'V' or 'X' in Field H59 are not considered as resolved by Hipparcos and are assigned a value of '1'). For entries in Part C, Field H58 may take a value of 1, 2, 3, or 4 (for example, the value 1 occurs in the 1975 cases where an unresolved entry is nevertheless 'linked' to another entry, through a common CCDM identifier) in those cases where the reduction of the combined data was made as part of a 'single-pointing', 'two-pointing' or 'three-pointing' double or multiple.

Thus a single star has Field H58 = 1; a resolved double system contained within a single entry has Field H58 = 2; a double system represented by two entries has Field H58 = 1 for each entry; a resolved triple system contained within a single entry has Field H58 = 3; a triple system comprising two entries has Field H58 = 1 for the unresolved entry and Field H58 = 2 for the close pair, etc.

Only when Field H58 = 2 is relative information given in Fields H62–67 (this information is given irrespective of the quality of the solution). In particular, for 'two-pointing' doubles (where both entries have Field H58 = 1) values of ϱ, θ and ΔHp are not given.

The number of entries in each of these categories as follows: 1 = 106 719; 2 = 11 101; 3 = 129; 4 = 6; ␣ = 263. The 263 blank entries correspond to those without final astrometric solutions, with the total number of entries 1+2+3+4 = 117 955.

Field H59: Double and multiple systems annex flag

A flag indicates that further details of this system are given in one of the five (mutually exclusive) parts of the Double and Multiple Systems Annex (see Section 2.3). These five parts are labelled C, G, O, V, and X. The flags, and the corresponding parts of the annex, refer to the following types of solution:

C : component solutions; solutions are given for double and multiple stars in which the relative motions of the components can be described, to the precision of the observations, as a linear function of time. This condition is generally met for systems having orbital periods longer than several times the length of the Hipparcos observing interval (3.3 years), which applies to the majority of systems resolved into components by the Hipparcos instrument, or to systems not physically linked;

G : acceleration (or higher-order) terms; for some apparently single (unresolved) stars it was found that the observed motion on the sky could not be properly modelled by the standard five astrometric parameters, while an acceptable solution was obtained by adding higher-order terms to the model. These objects are probably astrometric binaries with periods above some 10 years, so that the photocentric motion over the

mission interval (roughly 1989.9–1993.2) is adequately represented by a quadratic or cubic polynomial in time. In these cases, the proper motion given in Fields H12–13 is a mean value over the mission duration;

O : orbital solutions; for a few hundred systems observed with Hipparcos it has been possible to determine at least one of the orbital elements from the space observations, in addition to the five astrometric parameters referring to the centre of mass. The remaining orbital elements, varying in number from zero to seven, had to be adopted from ground-based data such as the published orbits of spectroscopic binaries. The main results on the orbital elements are given in the annex, while the astrometric parameters for the centre of mass are given in the main catalogue. Such a solution always corresponds with '+' in Field H10 (parameters referred to the centre of mass);

V : 'variability-induced movers'; in which the apparent motion of the photocentre is considered to arise from variability of one of the components of a double system;

X : stochastic solution; for some unresolved stars it was not possible to find an acceptable single or double star solution in reasonable agreement with the statistical uncertainties (standard errors) assigned to the individual measurements. These objects are probably astrometric binaries with relatively short periods (< 3 years), for which a simple polynomial model was clearly inadequate, while the satellite data alone did not allow a full orbital solution. In the individual measurements, the displacement of the photocentre from an assumed linear motion of the centre of mass thus appears like a random scatter in excess of the measurement noise. For the stochastic solutions, the solution's goodness-of-fit, Field H30, is left blank.

This flag is tied to the entry and not to the system: e.g. HIP 185 is an unresolved entry, but with the same CCDM identifier as the close double HIP 190. Data for the two close components contained within the entry for HIP 190 are given in the annex, but no data are given there for HIP 185.

The number of entries in each of these categories is as follows: C = 13 211; G = 2622 (2163 7-parameter and 459 9-parameter solutions); O = 235; V = 288; X = 1561. The 13 211 'C' entries correspond to the 12 195 single- or multiple-pointing systems distributed according to the observational configuration summarised under Field H57.

For some entries with Field H59 non-blank, standard errors may be large compared with the single stars solutions (e.g. HIP 66182 has σ_π = 114 mas), rejection rates (Field H29) reach 47 per cent, and the goodness-of-fit (Field H30) is as large as F2 = 27.22. In exceptional cases such behaviour has been accepted, in view of the complexity of the solutions, in preference to providing no data at all.

Field H60: Source of the absolute astrometry in Fields H8–30

This field qualifies the source of astrometry in Fields H8–30 for some of the entries with a 'C' in Field H59 (and which therefore appear also in Part C of the Double and Multiple Systems Annex). Flags 'F', 'I', 'L', and 'P' indicate a component of a 'two-pointing' or 'three-pointing' system in which the astrometric solution may have been constrained in a certain way (these flags provide the only method of determining whether a given entry was observed as part of a 'two-pointing' or 'three-pointing' system).

Flag 'S' indicates that the astrometric parameters of the photocentre were constrained to the values obtained by treating the system as a single star, i.e. by merging of the intermediate astrometry from the two data reduction consortia. This procedure was

used, when possible, for close binaries (separation $\varrho < 0.2$ arcsec), where the single-star processing generally gave a more accurate determination of the photocentre than the double-star processing. The quality of the astrometric data in Fields H8–30 is then comparable to that of 'single' stars (blank in Field H59), and in particular the standard errors in Fields H14–18 are on exactly the same scale as for the single stars—and therefore generally more reliable than for other double and multiple systems. Full consistency between Fields H8–30 and the component data in Part C of the Double and Multiple Systems Annex, also for the 'S' systems, has been achieved by means of very small adjustments of the component data resulting from the double-star processing.

The flag in this field has the following meaning:

- F : this is the secondary or tertiary target of a two-pointing or three-pointing system solved, in the double-star processing, as a 'fixed' system (solution type 'F'). Consequently its parallax and proper motion were constrained to be the same as for the primary target—the latter identified by a 'P' in this field and the same CCDM identifier as the current entry;
- I : this is the secondary or tertiary target of a two-pointing or three-pointing system solved, in the double-star processing, as an 'independent' system (solution type 'I'). Consequently the parallax and proper motion were not constrained with respect to their values for the primary target—the latter identified by a 'P' in this field and the same CCDM identifier as the current entry;
- L : this is the secondary or tertiary target of a two-pointing or three-pointing system solved, in the double-star processing, as a 'linear' system (solution type 'L'). Consequently its parallax, but not the proper motion, was constrained to be the same as for the primary target—the latter identified by a 'P' in this field and the same CCDM identifier as the current entry;
- P : this is the primary target of a two-pointing or three-pointing system;
- S : Fields H8–30 were taken from the 'single-star merging' process. This flag implies a binary with separation $\varrho < 0.2$ arcsec (Field H64), with astrometry and photometry referred to the photocentre (Field H10 = '*' and Field H48 = '*');
- ␣ : the astrometric data in Fields H8–30 have been obtained from the double-star processing (if Field H59 = 'C') or from the single-star merging (otherwise).

The primary of a two-pointing or three-pointing system is flagged 'P', while secondary or tertiary components are flagged 'F', 'I' or 'L' as described above. An entry can therefore be recognised as a component of such a system by the flags in this field. (In the Double and Multiple Systems Annex, Field DC3 gives the corresponding flag for all solutions, not only the multiple-pointing ones).

Of the 3236 non-blank entries, the number in each of these categories is as follows: F = 129; I = 843; L = 44; P = 1012; S = 1208.

These entries may be understood as follows. There are 1012 'two-pointing' or 'three-pointing' systems. These comprise 1012 entries related to primary targets (flagged P), and 1016 entries related to secondary targets (flagged F, I, or L), giving a total of 2028 affected entries, all of which have Field H57 > 1 and Field H59 = C. Of these, there are 1008 'two-pointing' systems with 2016 related entries, themselves comprising 957 two-pointing double systems (1914 entries), 50 two-pointing triple systems (100 entries), and 1 two-pointing quadruple system (2 entries). The remaining 'three-pointing' systems have 12 related entries, comprising 3 three-pointing triple systems (9 entries), and 1 three-pointing quadruple system (3 entries).

Field H61: Solution quality flag

This provides an indication of the reliability of the double or multiple star solution; the flag is set for all entries in Part C of the Double and Multiple Systems Annex. An additional flag, 'S', gives further indications of suspected non-single systems. The quality rating of a solution was made according to a combination of criteria based on the availability and agreement of solutions from the two data reduction consortia, and on the ease by which the system was resolved by Hipparcos. The flags can be understood as follows (further details for cases A–D are given in Section 2.3, Field DC5):

A : 'good', or reliable solution;
B : 'fair', or moderately reliable solution;
C : 'poor', or less reliable solution;
D : 'uncertain' solutions;
S : suspected non-single, i.e. possible double or multiple, although no significant or convincing non-single star solution was found. Flag 'S' may or may not be associated with 'X' in Field H59 (these flags were derived independently), but is not associated with any other flags in Field H59.

The number of entries in each of these categories is as follows: A = 9521; B = 1668; C = 909; D = 1113; S = 7624. The total number of entries A+B+C+D = 13 211 is equal to the number of entries in Part C of the Double and Multiple Systems Annex.

643 entries have 'S' in Field H61 and 'X' in Field H59. A large part of the 7624 'S'-flagged entries are probably effectively single as observed by Hipparcos, with the flag induced by photometric variability or inadequate astrometric sampling. There is however an increased probability for real non-singles in this group as compared with the 'non-S' entries, as can be seen by the ratio of the 643 'X' (Field H59) among the 'S' entries, compared with 918 among roughly 100 000 'non-S' entries.

The totality of entries classified as either known or suspected to be double or multiple is given by entries which are non-blank in Field H59, combined with entries with 'S' in Field H61 (some of which may also have 'X' in Field H59), combined with separate entries linked by a common CCDM identifier but not observed as part of a multiple-pointing system (the statistics of solved or detected systems do not include the latter).

Corresponding data are given in Fields H62–67 when Field H58 = 2 only, irrespective of the solution quality flag in Field H61; however, for Field H61 = D there will be alternative values of ΔHp, θ, and ϱ given in a note, as described under Field DC5 of the Double and Multiple Systems Annex.

Field H62: Component designation for parameters in Fields H63–67

The first letter of Field H62 gives the 'reference' component, with the second letter giving the subsidiary component. In the case of the Hipparcos observations, the reference component is always defined to be the brighter component (in median Hp), such that the magnitude difference between the components (Field H66) is always positive.

Thus, in particular, the position angle in Field H63 is for the fainter component (in median Hp) relative to the brighter component. Maintaining conformity with existing designations of certain previously known double systems therefore requires that the components considered are explicitly stated. Of the 11 101 entries with Field H62 non-blank, 10 200 are designated 'AB'. Other combinations occur: AC, AD, AE, AF, AG, AK, AP, BA, BC, BD, CA, CB, CD, CR, DC, DE, EN, GH, and PA. AS is used for cases where component identification is doubtful (for close binaries with a small magnitude difference) and consequently where the system is to be interpreted as either AB or BA.

Fields H63–64: Position angle and angular separation (epoch J1991.25), rounded

These fields give rounded values for the position angle between the components, θ, expressed in degrees, and the angular separation, ϱ, expressed in arcsec, respectively. The position angle is that of the component given by the second letter of Field H62 with respect to the component given by the first letter of Field H62.

Fields H63–64 provide information on the system geometry in the more standard 'double star' form for entries observed as precisely double, i.e. where Field H58 = 2. The position angle is measured counterclockwise, as seen on the sky, from the $+\delta$ direction. The position angle and the component separation are referred to the catalogue epoch, on the basis of the geometrical model defined in the Double and Multiple Systems Annex. Details, with full numerical precision, are given only in the Double and Multiple Systems Annex.

Providing corresponding information for systems with two or more separate entries was considered impractical in such a concise summary format, given that one or more of the related entries could themselves be double or multiple. Determination of which catalogue entries constitute such separated systems should utilise the CCDM identifier of the system (Field H55) from which relative astrometric and photometric data may be inferred from the parameters of the individual entries. Separate entries treated as 'multiple-pointing' systems are, however, also contained explicitly within Part C of the Double and Multiple Systems Annex.

The tabulated value of ϱ was derived rigorously from the absolute positions. For $\varrho \sim 20$ arcsec the resulting differences compared with a linear approximation, based on $\Delta\alpha \cos\delta$ and $\Delta\delta$, may reach several milliarcsec.

Field H65: Standard error of the angular separation, σ_ϱ

The standard error of the angular separation is given in arcsec.

The standard error of the position angle is not given in the catalogue, but may be computed from the complete data given in Part C of the Double and Multiple Systems Annex. It may be roughly estimated as $\sigma_\theta \sim \sigma_\varrho / \varrho$ (in radians).

Field H66: Magnitude difference of components, ΔHp

This field gives the magnitude difference between the components, expressed in mag.

The magnitude difference, ΔHp, assumed to be constant with time, was derived on the basis of the geometrical model defined in the Double and Multiple Systems Annex. ΔHp is always positive since the reference component given in Field H62 is the brighter component.

For 'multiple-pointing' systems, no relative information is given (as explained under Fields H63–64). For non-single variables, the standard variability information is given in Fields H49–54, and ΔHp is always an average value of some real (but unspecified) variability.

Field H67: Standard error of the magnitude difference, $\sigma_{\Delta Hp}$

The standard error of the magnitude difference, $\sigma_{\Delta Hp}$, is given in magnitudes.

Fields H68–70: Miscellaneous

Field H68: Flag indicating 'survey' star

The 'survey' was the basic list of bright stars added to and merged with the total list of proposed stars, to provide a stellar sample (almost) complete to well-defined limits. A flag 'S' given in Field H68 indicates that the entry is contained within this 'survey', whose limiting magnitude is a function of the star's spectral type and galactic latitude, b, and is defined by:

$V \leq 7.9 + 1.1|\sin b|$ for spectral types earlier or equal to G5

$V \leq 7.3 + 1.1|\sin b|$ for spectral types later than G5

If no spectral type was available, the break was taken at $B - V = 0.8$ mag. The survey was defined during the construction of the Hipparcos Input Catalogue, using HIC data for V, b, and spectral type, and was not adjusted as a result of revised Hipparcos photometry. 52 045 entries are flagged as 'S'.

Field H69: Flag indicating identification chart

Where identification of the star using ground-based telescopes might prove difficult or ambiguous (e.g. for faint stars, for crowded zones, or for components of double or multiple systems), identification charts were constructed and are included in Volume 13 of the printed catalogue. Charts correspond to the object observed by the satellite (i.e. at the position given in the Hipparcos Catalogue), even if it was not the intended target. The flag takes the following values:

D : charts produced directly from the STScI Digitized Sky Survey (776 entries);
G : charts constructed from the Guide Star Catalog (10 877 entries).

Field H70: Flag indicating a note given at the end of the volume(s)

Three categories of notes have been compiled during the construction of the Hipparcos Catalogue: notes associated with the general catalogue compilation; notes specifically associated with the photometry or variability of the entry; and notes associated with the double or multiple solution determined for the entry.

General notes are included at the end of the relevant volume of the main catalogue (Volumes 5–9). Photometric notes are collected together at the end of the Variability Annex (Volume 11), although these also include certain notes to stars considered as non-variable by Hipparcos. Notes specifically related to double and multiple systems are collected together at the end of the Double and Multiple Systems Annex.

The flag has the following meaning:

D : double and multiple systems note only (Volume 10);
G : general note only (Volumes 5–9);
P : photometric (including variability) notes only (Volume 11);
W : 'D' + 'P' only;
X : 'D' + 'G' only;
Y : 'G' + 'P' only;
Z : 'D' + 'G' + 'P'.

The general notes in Volumes 5–9 also include a pointer to 'D'- and 'P'-type notes where appropriate (i.e. if Field H70 is 'X', 'Y', or 'Z', then the general notes will include 'D', 'P', or both additional pointers, respectively).

The same note flag given in Field H70 is strictly reproduced in Field P16/U16 of the Variability Annex (Section 2.4), and in Field DC6, DG12, DO17, DV12, and DX4 of the Double and Multiple Systems Annex (Section 2.3), so that notes on a given entry—independently of their source—may be simply identified.

References, included within the photometric notes, can be located for variable stars directly using Fields P23 or U23 of the Variability Annex. They cannot be located directly from Field H70, but only via their sequential HIP number.

The 'general notes' cover the following situations:

- entries with no astrometric or photometric solution, including entries where no signal was detected at the position specified in the Hipparcos Input Catalogue;
- misidentified stars mentioned in the photometric notes;
- poorly observed stars with rejected solution;
- stochastic solutions (see Part X of the Double and Multiple Systems Annex) with associated 'cosmic error' larger than 100 mas, or stochastic solutions rejected for other reasons;
- general notes produced during the construction of the Double and Multiple Systems Annex;
- noted and updates related to the CCDM (Field H55);
- extended sources.

The formats of the machine-readable notes are given in Section 2.11.

Fields not in the Printed Catalogue (Fields H71–77)

The following fields are included only in the machine-readable version (ASCII CD-ROMs). Additional cross-identifications are available through the Hipparcos Input Catalogue (printed as ESA SP–1136, 1992; on the Hipparcos Input Catalogue CD-ROM; on *Celestia 2000*; and through the CDS).

The HD, and DM (BD, CoD, and CPD) identifiers have been derived as a result of cross-identifications using the CDS's SIMBAD facility. As of mid-1996, about half of the DM stars are not included in SIMBAD. For all other cross-identifications, the user is referred to the 'star names resolving facility' of SIMBAD, where the Hipparcos Catalogue identifier (HIP) is included.

Reliability tests were performed during the construction of the Hipparcos Input Catalogue, to check, for example, the coherence between the zones of the DM (BD, CoD, and CPD) and the declination at the mean epoch of the catalogue (1855 for BD, 1875 for CoD and CPD), and for typing errors (originating from the source catalogue, from an intermediate transcription, or confusion between the CoD and CPD identifiers). Resulting corrections were included in the Hipparcos Input Catalogue. Additional corrections are included in the corresponding fields; if the corresponding fields differ, the associated cross-identifications given in the Hipparcos Input Catalogue should be considered with caution.

Field H71: HD/HDE/HDEC identifier

Cross-identifications are given to stars in the HD Catalogue, with numbers in the range 1 – 225 300 (A.J. Cannon & E.C. Pickering, 1918–24, *Ann. Harvard Obs.*, 91–99), and its two extensions: HDE numbers in the range 225 301 – 272 150 (A.J. Cannon, 1925–36, *Ann. Harvard Obs.*, 100), and HDEC numbers in the range 272 151 – 359 083 (A.J. Cannon & M. Walton Mayall, 1949, *Ann. Harvard Obs.*, 112).

Field H72: DM identifier (BD)

This gives the DM identifier for objects contained within the Bonner Durchmusterung (BD), with the format B±ZZ␣NNNNa (coded with leading zeros in ZZ where appropriate). BD identifiers, unlike the CoD and CPD identifiers, may carry a lower-case suffix letter for additional stars, i.e. stars with suffix 'a', 'b', 'p', or 's' (these stars were added to the BD Catalogue after the original numbering was made; such suffixes do not imply that the entry is a component of a double or multiple system).

Field H73: DM identifier (CoD)

This gives the DM identifier for objects contained within the Cordoba Durchmusterung (CoD), with the format C±ZZ␣NNNNN (coded with leading zeros in ZZ where appropriate).

Field H74: DM identifier (CPD)

This gives the DM identifier for objects contained within the Cape Durchmusterung (CPD), with the format P±ZZ␣NNNNN (coded with leading zeros in ZZ where appropriate).

Field H75: $V - I$ used for the photometric processing

This is not necessarily the same as the 'final' value of $V - I$ given in Field H40. See Field H40 for details.

The value which has been used for the astrometric processing is the same as the value given in Field H75, to within 0.01 mag, for all entries except the following eight, which had their colours updated at a late stage of the processing:

HIP	H75	astrometric processing
87863	+0.31	+0.021
99483	+1.58	+2.220
102964	+1.05	+0.516
120401	+0.12	+0.090
120402	+0.00	−0.080
120403	+0.07	+0.040
120404	−0.04	−0.120
120415	−0.16	−0.250

Field H76: Spectral type

Acquired from ground-based compilations, the spectral types given in this field come primarily from the Hipparcos Input Catalogue, with some updates, especially for variable stars. Spectral types that were published in a truncated form in the Hipparcos Input Catalogue (composite spectra, or spectra with many peculiarities) are given here in their original form for a subset.

The spectral type has not been derived from the satellite observations, and is therefore not considered as a product of the mission. It is nevertheless provided partly for its astrophysical relevance, but also because it was used for the photometric transformations between B_T/V_T and $V/B-V$ for a subset of the entries (see Section 1.3, Appendix 4, and Field H37 for further details). A complete listing of the available spectral types is also given in Volume 11.

The data included in the Variability Annex (Volume 11, see also Section 2.4) includes the object's spectral type. This means that for variable stars, the spectral type is found in the ASCII files in two places (within the main catalogue Field H76, and within the Variability Annex, see Section 2.4, Field P3 and U3).

Spectral types in the Hipparcos Input Catalogue were taken from the SIMBAD data base or from the original proposal when the data were not available in SIMBAD. The latter included data from the Michigan Spectral Survey, Volumes 1–3; Volume 4 was also made available to the INCA Consortium in 1988. For variable stars, many spectral types were taken from the Fourth Edition of the General Catalogue of Variable Stars. Furthermore, many additions and corrections were made from the various programmes proposed for Hipparcos observation, or from individual searches in the literature. Confidence tests were performed from a correspondence between the spectral types and the colour index when both B and V magnitudes were considered reliable, and subsequently between the spectral type and B_T and V_T. Many resulting corrections were made either to the spectral types or to the photometric data.

Spectral types follow various classification systems (MK, HD, etc.). In the case of the MK classification system, the spectral type, luminosity class, and peculiarity code are given with the following designations:

- O, B, A, F, G, K, M plus sub-type (0, 1, etc.), and sometimes intermediate sub-type (for example F7.2, F7.5, F7.7) for the spectral types of 'normal stars';
- R, S, N, C for carbon stars;
- DB, DA, DF, DG for white dwarfs;
- WR, WN, WC for Wolf-Rayet stars.

For the luminosity class, the following designations are used: Ia0, Ia, Iab, Ib for supergiants, II for bright giants, III for giants, IV for sub-giants, V for dwarfs. The sub-dwarfs are either noted sd followed by the spectral type, or class VI. Peculiarities of the spectra are noted in lower case letters (e for emission lines, m for enhanced metallic lines, n for nebulous lines, nn for very nebulous, p for peculiarity in the chemical composition, s for sharp lines, sh for a shell, v for variations in the spectrum, w for weak lines, etc.). CN indicates stars cyanogen abundance anomaly.

Additional qualifiers have the following meaning:

: indicates some doubt about the determination of the spectral type or luminosity class;
/ between two spectral types or luminosity classes indicates that the two classifications were made during the Michigan Spectral Survey;
– between two spectral types or luminosity classes indicates that the parameter is intermediate between those given;
\+ indicates composite spectra (the second spectrum is not given in these cases);
... indicates truncated spectra (the source catalogue gives further details, including peculiarities).

The above description does not cover all MK designations which may be found in Field H76. A more complete description can be found in the introduction to the Michigan Spectral Survey.

Spectral types given in this field are homogeneous for the HD and HDE numbered stars from $-90°$ to $-12°$ in declination (i.e. in the zones covered by the Michigan Spectral Survey, Volumes 1–4). North of $-12°$ their quality is heterogeneous. This compilation of spectral types is provided for the convenience of the catalogue users. Although the highest quality spectral classification was selected to produce estimates of $B - V$ and $V - I$ where appropriate, no claims about the reliability of the spectral types are implied. For more careful use, SIMBAD or other original sources should be consulted.

Field H77: Source of spectral type

The flag indicates the source of the spectral type, as follows:

1 : Michigan Spectral Survey, Vol. 1 (N. Houk & A.P. Cowley, 1975, Univ. Michigan);
2 : Michigan Spectral Survey, Vol. 2 (N. Houk, 1978, Univ. Michigan);
3 : Michigan Spectral Survey, Vol. 3 (N. Houk, 1982, Univ. Michigan);
4 : Michigan Spectral Survey, Vol. 4 (N. Houk & A. Smith-Moore, 1988, Univ. Michigan);
G : updated after publication of the Hipparcos Input Catalogue;
K : Fourth Edition of the General Catalogue of Variable Stars (GCVS, P.N. Kholopov (ed.), 1985, 1987, Moscow);
S : SIMBAD;
X : miscellaneous;
␣ : entry without corresponding information.

As indicated under Field H76, spectral types and corresponding source flags were generally taken directly from the Hipparcos Input Catalogue (HIC) compilation. In cases where the spectral type given here differed from the HIC value (either because it was truncated in the HIC compilation, or because it was updated following investigations in view of discordant photometric data), the flag 'G' has been assigned. The number of entries in each category, compared with those in HIC are as follows:

	H77	HIC
1	12201	12348
2	9309	9375
3	11122	11232
4	10181	10304
G	1223	0
K	696	929
S	56983	57081
X	13469	13993
␣	3034	2947
Total	118218	118209

Table 2.1.1. Summary of the machine-readable Hipparcos Catalogue format
(a) fields also in the printed Hipparcos Catalogue, and in common with the Tycho Catalogue

Field	Bytes	Format	Description
H0/T0	1–2	A1,X	Catalogue (H = Hipparcos, T = Tycho)
H1	3–15	6X,I6,X	Identifier (HIP number)
T1	„	I4,I6,I2,X	TYC1–3 (TYC number)
H2/T2	16–17	A1,X	Proximity flag
H3/T3	18–29	A11,X	Identifier RA, h m s (J1991.25)
H4/T4	30-41	A11,X	Identifier Dec, ± ° ′ ″ (J1991.25)
H5/T5	42–47	F5.2,X	V (Johnson) magnitude
H6	48–49	A1,X	Coarse variability flag
T6	„	1X,X	Blank for Tycho
H7/T7	50–51	A1,X	Source of magnitude identifier
H8/T8	52–64	F12.8,X	α, degrees (J1991.25)
H9/T9	65–77	F12.8,X	δ, degrees (J1991.25)
H10/T10	78–79	A1,X	Reference flag for astrometry
H11/T11	80–87	F7.2†,X	Trigonometric parallax (mas)
H12/T12	88–96	F8.2†,X	$\mu_{\alpha*} = \mu_\alpha \cos\delta$ (mas/yr)
H13/T13	97–105	F8.2†,X	μ_δ (mas/yr)
H14/T14	106–112	F6.2†,X	Standard error in $\alpha*$ at J1991.25 (mas)
H15/T15	113–119	F6.2†,X	Standard error in δ at J1991.25 (mas)
H16/T16	120–126	F6.2†,X	Standard error in π (mas)
H17/T17	127–133	F6.2†,X	Standard error in $\mu_{\alpha*}$ (mas/yr)
H18/T18	134–140	F6.2†,X	Standard error in μ_δ (mas/yr)
H19/T19	141–146	F5.2,X	Correlation, $\rho^{\delta}_{\alpha*}$
H20/T20	147–152	F5.2,X	Correlation, $\rho^{\pi}_{\alpha*}$
H21/T21	153–158	F5.2,X	Correlation, ρ^{π}_{δ}
H22/T22	159–164	F5.2,X	Correlation, $\rho^{\mu_{\alpha*}}_{\alpha*}$
H23/T23	165–170	F5.2,X	Correlation, $\rho^{\mu_{\alpha*}}_{\delta}$
H24/T24	171–176	F5.2,X	Correlation, $\rho^{\mu_{\alpha*}}_{\pi}$
H25/T25	177–182	F5.2,X	Correlation, $\rho^{\mu_{\delta}}_{\alpha*}$
H26/T26	183–188	F5.2,X	Correlation, $\rho^{\mu_{\delta}}_{\delta}$
H27/T27	189–194	F5.2,X	Correlation, $\rho^{\mu_{\delta}}_{\pi}$
H28/T28	195–200	F5.2,X	Correlation, $\rho^{\mu_{\delta}}_{\mu_{\alpha*}}$
H29	201–204	I3,X	Data points rejected (per cent)
T29	„	I3,X	Data points accepted, $N_{\rm astrom}$
H30/T30	205–210	F5.2,X	F2 (goodness-of-fit)
H31/T31	211-217	I6,X	HIP number
H32/T32	218–224	F6.3,X	B_T (mag)
H33/T33	225–230	F5.3,X	σ_{B_T} (mag)
H34/T34	231–237	F6.3,X	V_T (mag)
H35/T35	238–243	F5.3,X	σ_{V_T} (mag)
H36/T36	244–245	A1,X	Reference flag for B_T and V_T
H37/T37	246–252	F6.3,X	$B-V$ (mag)
H38/T38	253–258	F5.3,X	σ_{B-V} (mag)
H39	259–260	A1,X	Source of $B-V$
T39	„	1X,X	Blank for Tycho

† For these fields, the second decimal digit for the Tycho format is always blank

The Hipparcos and Tycho Catalogues are similar up to Field H39/T39; thereafter, the fields and their meanings are catalogue specific. Thus Tables 2.1.1(a) and 2.2.1(a) are identical. Due care must be taken in ensuring that blank fields are not interpreted as numerically zero.

Table 2.1.1. Summary of the machine-readable Hipparcos Catalogue format (cont.)
(b) Hipparcos specific catalogue data, also contained in the printed Hipparcos Catalogue

Field	Bytes	Format	Description
H40	261–265	F4.2,X	$V - I$ (mag)
H41	266–270	F4.2,X	σ_{V-I} (mag)
H42	271–272	A1,X	Source of $V - I$
H43	273–274	A1,X	Reference flag for colour indices
H44	275–282	F7.4,X	Median Hp (mag)
H45	283–289	F6.4,X	σ_{Hp} (mag)
H46	290–295	F5.3,X	Scatter, s (mag)
H47	296–299	I3,X	Accepted transits, N
H48	300–301	A1,X	Reference flag for photometry
H49	302–307	F5.2,X	Mag at max, Hp (5th percentile)
H50	308–313	F5.2,X	Mag at min, Hp (95th percentile)
H51	314–321	F7.2,X	Period (days)
H52	322–323	A1,X	Flag (variability type)
H53	324–325	A1,X	Flag (variability tables)
H54	326–327	A1,X	Flag (light curves)
H55	328–338	A10,X	CCDM Identifier
H56	339–340	A1,X	Historical status flag
H57	341–343	I2,X	Number of catalogue entries
H58	344–346	I2,X	Number of components
H59	347–348	A1,X	Double/Multiple Systems Annex flag
H60	349–350	A1,X	Astrometric source flag
H61	351–352	A1,X	Solution quality
H62	353–355	A2,X	Component identifiers
H63	356–359	I3,X	Position angle (degrees)
H64	360–367	F7.3,X	Angular separation (arcsec)
H65	368–373	F5.3,X	σ_ϱ (arcsec)
H66	374–379	F5.2,X	ΔHp (mag)
H67	380–384	F4.2,X	$\sigma_{\Delta Hp}$ (mag)
H68	385–386	A1,X	Survey flag
H69	387–388	A1,X	Chart flag
H70	389–390	A1,X	Notes

Table 2.1.1. Summary of the machine-readable Hipparcos Catalogue format (cont.)
(c) Hipparcos specific catalogue data, not contained in the printed Hipparcos Catalogue

Field	Bytes	Format	Description
H71	391–397	I6,X	HD identifier
H72	398–408	A10,X	DM (BD) identifier
H73	409–419	A10,X	DM (CoD) identifier
H74	420–430	A10,X	DM (CPD) identifier
H75	431–435	F4.2,X	$V - I$ (mag) used for reductions
H76	436–448	A12,X	Spectral type
H77	449–450	A1,X	Source of spectral type