THE HIPPARCOS/TYCHO ASCII CD-ROMS AND ACCESS SOFTWARE

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ABSTRACT

The Hipparcos and Tycho Catalogues are provided on six ASCII CD-ROMs containing the catalogues with all their annexes and documentation. Direct access to the results for a given object is possible through index files. The structure and contents of the CD-ROMs are described. The use of the index files is facilitated by a set of example access software also provided on the CD-ROMs. The function of these routines is illustrated.

Key words: space astrometry; machine-readable catalogues; CD-ROMs; software.

1. INTRODUCTION

Machine-readable versions of all tables of the Hipparcos and Tycho Catalogues (ESA 1997) are provided on six ASCII CD-ROMs as Volume 17 of these catalogues. In addition to the catalogue tables, the disks contain index files, access software, documentation and figures. A detailed description is found in Volume 1 of the Catalogue (Section 2.11). This paper presents only the main features and is intended as a first introduction to the use of the CD-ROMs.

2. CATALOGUE TABLES

2.1. Contents

The list of catalogue tables is given in Table 1, together with their approximate size (where 'M' stands for 10^6 bytes). The Hipparcos Epoch Photometry Annex is split into two parts (on two CD-ROMs): the Annex itself (422M) and its Extension (648M). There is a strict correspondence between the machine-readable versions and their printed counterparts, as far as the latter exist. An exception are the Greek characters in the printed version which are represented by three-letter codes in the machine-readable version (cf. Volume 1, Section 2.4 of the Catalogue). Another noteworthy exception is the ordering of the entries in the main catalogue: in the printed version, the ordering is by increasing HIP number (with the numbers above 120 000 inserted according to their right ascension) whereas in the machine-readable version the ordering is by increasing right ascension (and where an entry for a given HIP number can be found using the corresponding index file, cf. Section 3 of this paper). For the Hipparcos main catalogue there are also a small number of supplementary fields in the machine-readable version that are not present in the printed version.

Table 1. Machine-readable catalogue tables.

Table	Size
The Hipparcos Catalogue	53M
The Tycho Catalogue	373M
The Double and Multiple Star Annexes	10M
The Variability Annexes	1.5M
Solar System Objects	0.5M
Notes (G, D, P)	1M
HIP Epoch Photometry Annex	1070M
TYC Epoch Photometry Annex	584M
Intermediate Astrometry	521M
HIP Transit Data	553M
Cross-reference tables	1.8M

2.2. Format

The CD-ROMs are formatted according to the ISO 9660, interchange level 1 standard, and are thus usable on any system supporting this standard. File names are automatically adjusted to the conventions of the user system: for example the main Hipparcos catalogue file would be called '`HIP_MAIN.DAT`' on a PC, '`hip_main.dat`' on a Unix system, '`HIP_MAIN.DAT;1`' on VAX/VMS, etc.

In all machine-readable tables the fields are separated by the '|' symbol. This makes the tables easier to read when viewed on the screen; moreover, since a field never contains this symbol, it can be used by reading software to automatically recognize the end of the field.

Each line is ended by the combination of carriage return/line feed symbols required by PC systems. In general, systems requiring only a line feed (Unix) or a carriage return (Mac) do not have problems handling this combination; in some cases a spurious carriage

return symbol may appear. Standard utilities exist on most systems to convert files to the local standard, if desired.

The user should take care of handling correctly the blank fields in the tables by incorporating adequate checks in his/her software. For example, the standard Fortran reading routines would interpret a blank numerical field as zero, which can give rise to undesired results.

3. INDEX FILES AND ACCESS SOFTWARE

3.1. Index Files

In order to facilitate access to the catalogue records corresponding to a given HIP or TYC identifier, index files are provided for all tables. The principle is that entries in the index file specify the record numbers where the desired information can be found. This is useful because the catalogue tables are generally huge files, which do not necessarily have an entry for each (e.g. HIP) number, and are not necessarily ordered by that number. In addition, the epoch photometry files contain, for each entry, a few header records and a variable number (1–385 in the case of the Hipparcos epoch photometry) of data records (one for each recorded transit). Without an index file, it would be a long way to locate the header records for a given identifier.

There are two main types of index files:

- full index: this is a direct-access index, in which the nth entry gives the record number in the catalogue table where the information for entry n starts. The identifier (which is not explicitly mentioned in the index file) can be either the HIP number or the first component of the three-part TYC number (TYC1);

- only-existing-entries index: for the majority of tables the index only has entries for the identifiers that are present in the relevant catalogue table (in this case, the identifier must evidently be explicitly mentioned in the index file). In order to locate a given identifier, a binary search algorithm can be used (e.g., Press et al. 1992). Here, the identifiers are the HIP or TYC number; for the Double and Multiple Star Annex the CCDM identifier is also used.

Due to the structure of the Tycho identifier (three integers) accessing the various Tycho tables requires a more complex procedure, involving a combination of the two above-mentioned index types.

3.2. Access Software

The foregoing may sound quite complex to some users, and as a further support a set of reading routines in C (developed by W. O'Mullane of ESTEC) are provided on the CD-ROMs, one for each of the indexes. They can be included as such in other programs, or serve as a guide to the use of the various indexes.

In addition, example programs are supplied as a further help on how to read the tables; at the same time these programs are sufficiently general to satisfy the needs of many users. The implementation of the programs is eased by the included makefile.

For example, the Hipparcos main catalogue can be accessed using the program `shipmain`. Saying '`shipmain 1000`' on the command line displays the catalogue data for HIP 1000 one field per line, with a short explanation for each field (Figure 1).

Specifying options changes the way the output is presented. For example, the `-t` option results in output in the machine-readable format identical to the record on the CD-ROM, which can then be used in the user's processing software. It is also possible to specify a number of HIP entries, as in '`shipmain -t 1001 1002 1003 1004`'. Further options can be found in the documentation, or by invoking '`shipmain -h`'.

As another example, the program `shipep` accesses the results of the Hipparcos Epoch Photometry. Specifying '`shipep 10000`' finds the results for HIP 10000 and displays the header record one field per line with a short explanation per line, after which all transit data are given in tabular form, one line per transit. Specifying the `-b` option adds explanations about the 'bit flag field' HT4 (see Figure 2). Again the `-t` option gives the results in machine-readable format, but for the header records only. If the transit records are also desired, this must be specified by the `-s` (sub-record) option.

Similar programs exist for the other catalogue tables. A summary is given in Table 2. In addition a few secondary ('redundant') programs are given for individual data tables like those of the Double and Multiple Star Annex organised by HIP identifier (programs `shipdmg`, `shipdmo`, `shipdmv`, and `shipdmx` for the G, O, V, and X tables of the Double and Multiple Star Annex, respectively). Note that the 'generic' program `shipdm` will automatically select the relevant data table for a given HIP number.

4. DOCUMENTATION AND OTHER MATERIAL

The complete documentation as in Volumes 1–4 of the Hipparcos and Tycho Catalogues is provided on the CD-ROMs in Portable Document Format (PDF). The files in this format can be displayed, searched, printed, and converted to PostScript using Adobe's Acrobat Reader software which is freely available for many platforms. The documentation includes almost all of the figures; for reasons of disk space most figures from Volume 1 are to be found on a separate disk.

Moreover, the complete Volumes 5–11 of the printed catalogue (i.e. the Hipparcos main catalogue, Double and Multiple Systems Annex, and Variability Annex tables) are provided in PDF format. This allows, for example, inspecting visually the catalogue pages when the printed copy is not readily available, and

```
[23] shipmain 1000

H0   : H                    Catalogue (H = Hipparcos, T = Tycho)
H1   :      1000            Identifier (HIP number)
H2   :                      Proximity flag
H3   :   00 12 30.13        Identifier RA,  h m s (J1991.25)
H4   : -22 04 01.5          Identifier Dec, d m s (J1991.25)
H5   :         8.73         V (Johnson) magnitude
H6   :                      Coarse variability flag
H7   : G                    Source of magnitude identifier
H8   :         3.12556151   alpha, degrees (J1991.25)
H9   :       -22.06708268   delta, degrees (J1991.25)
H10  :                      Reference flag for astrometry
H11  :        15.32         Trigonometric parallax (mas)
H12  :       215.67         mu_alpha* (mas/yr)
H13  :       -96.10         mu_delta (mas/yr)
H14  :         1.18         Standard error in alpha* at J1991.25 (mas)
H15  :         0.71         Standard error in delta at J1991.25 (mas)
H16  :         1.34         Standard error in pi (mas)
H17  :         2.08         Standard error in mu_alpha* (mas/yr)
H18  :         0.83         Standard error in mu_delta (mas/yr)
H19  :         0.05         Correlation: alpha*/delta
H20  :         0.01         Correlation: alpha*/pi
H21  :        -0.13         Correlation: delta/pi
H22  :        -0.24         Correlation: alpha*/mu_alpha*
H23  :         0.06         Correlation: delta/mu_alpha*
H24  :         0.06         Correlation: pi/mu_alpha*
H25  :         0.06         Correlation: alpha*/mu_delta
```

Figure 1. Part of the result of invoking the `shipmain` *program for HIP 1000.*

```
[235] shipep -b 2

HH1  :         2            HIP number
HH2  :                      Component flag
HH3  :         1.042        V-I (mag)
HH4  :       124            Total transits, Ntot
HH5  :       120            Accepted transits, Nacc
HH6  :         9.4017       Median magnitude,  Hp (mag)
HH7  :         0.0017       sigma Hp (mag)
HH8  :         9.37          5th percentile (max) (mag)
HH9  :         9.44         95th percentile (min) (mag)
HH10 :                      Variability period, P (day)
HH11 :                      Reference epoch (day)
HH12 : C                    Variability type
HH13 :                      Annex flag (tables)
HH14 :                      Annex flag (light curves)
TRANSITS
HT1        |HT2    |HT3   |HT4
7876.93100| 9.3842|0.017 |1        (NDAC data only)
8028.38039| 9.3836|0.028 |1        (NDAC data only)
8028.55819| 9.4131|0.015 |32       (FAST quality flag set)
8028.57254| 9.3983|0.017 |0
8050.33166| 9.4130|0.015 |0
8050.34598| 9.3756|0.012 |0
8050.42055| 9.3972|0.017 |0
8050.43488| 9.4051|0.016 |0
8077.33750| 9.4150|0.016 |0
8077.35184| 9.3845|0.016 |0
```

Figure 2. Part of the result of invoking the `shipep` *program for HIP 2 with the* `-b` *option decoding the bit patterns in Field HT4*
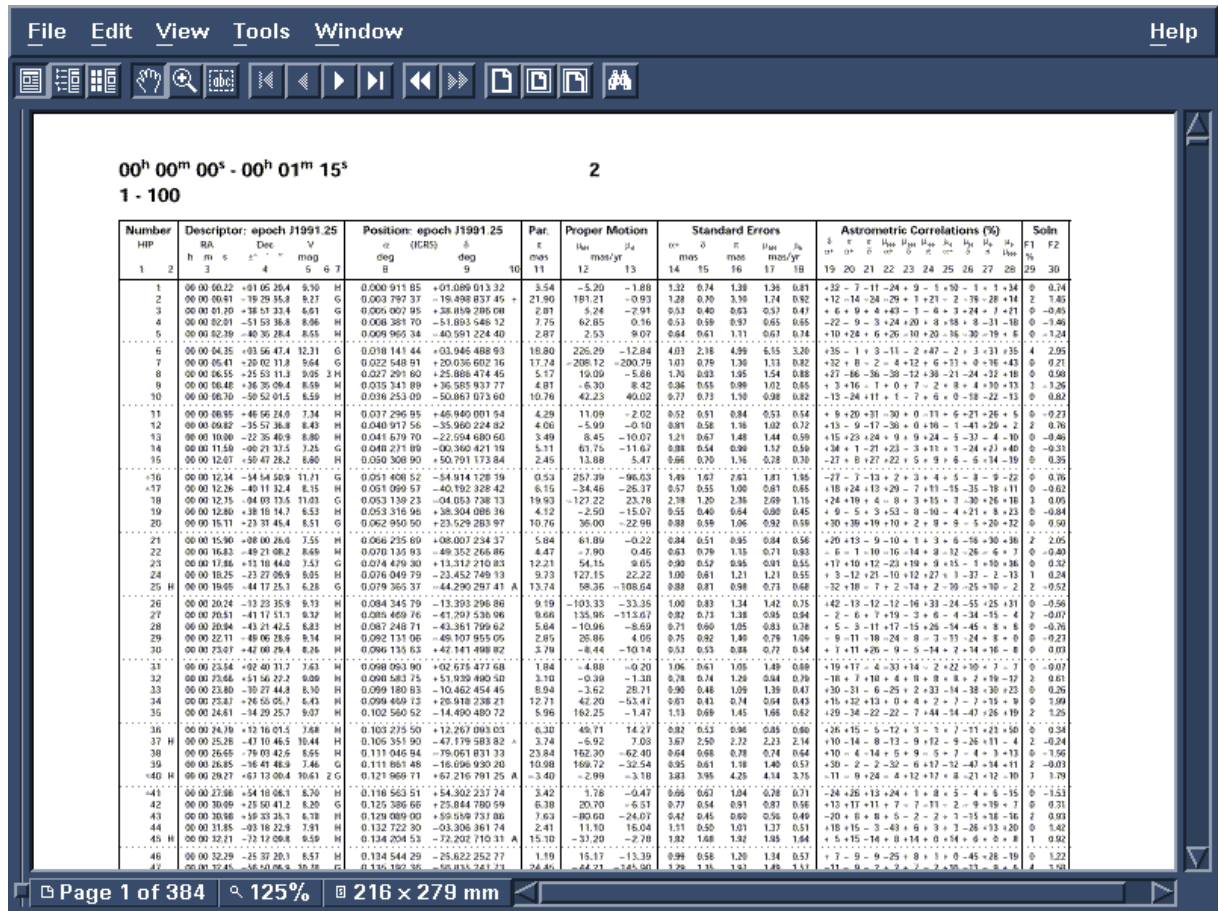
Figure 3. The first tabular page of Volume 5 (the Hipparcos main catalogue) in the Acrobat Reader window.

printing of selected pages. This is illustrated in Figure 3.

The light curves from Volume 12 and the identification charts from Volume 13 are included on the CD-ROMs in PostScript format; they can thus be easily included in publications, if needed.

The CD-ROMs include Fortran and C implementations of algorithms for rigorous epoch transformation of the astrometric parameters and their covariances (applying the equations found in Volume 1, Section 1.5 of the Catalogue).

Files for the conversion of the machine-readable catalogue tables to FITS format are also included on the CD-ROMs.

REFERENCES

ESA, 1997, The Hipparcos and Tycho Catalogues, ESA SP–1200

Press W., Teukolsky S.A., Vetterling W.T., Flannery B.P., 1992, Numerical Recipes in C, 2nd Edition, Cambridge University Press, Cambridge

Table 2. Access programs.

Program	Table	Search*
shipmain	Hipparcos main catalogue	HIP
stycmain	Tycho main catalogue	TYC
shipdm	Double & mult. star annex	HIP
shipdmc	Double & mult. star annex	CCDM
shipva	Hipparcos variability annex	HIP
ssolar	Solar system objects	SSO
shipep	Hipparcos epoch photometry	HIP
shipepe	Hipp. epoch phot. extension	HIP
stycep	Tycho epoch photometry	TYC
shipi	Hipparcos interm. astrometry	HIP
shipj	Hipparcos transit data	HIP

*HIP: Hipparcos identifier (1–120 416)
 TYC: Tycho identifier (three integers)
 CCDM: identifier for multiple-star systems
 SSO: solar system object identifier (1–904)