13. PHOTOMETRIC STANDARD STARS

A catalogue of photometric standard stars, carrying B_T and V_T magnitudes predicted from ground-based measurements in various photometric systems, was used for the photometric calibration of the Tycho instrument.

13.1. The Preliminary Standard Star Catalogue

Before the launch of Hipparcos a program for the collection of ground-based photometric data for the mission was set up, mainly at Geneva and Lausanne (see Grenon *et al.* 1992). This program included the compilation of existing data as well as new measurements. The resulting big collection of data in a broad variety of photometric systems (UBV, uvby, Geneva, Walraven, VRI, etc.) was checked, cross-identified and homogenized as far as possible. Transformation formulae from these ground-based photometric systems to the expected photometric passbands (B_T, V_T and Hp) of the Hipparcos satellite were derived, using the pre-launch calibration data of the various detectors. The transformations were then used to compute predicted magnitudes for as many stars as possible in the expected photometric bands.

The stars with the most reliable and precise data were selected from catalogues of photometric standard stars for the in-orbit calibration of the Hipparcos and Tycho photometry. The actual use of the resulting Tycho photometric standard star catalogue in the data reductions was described in Chapters 8 and 9.

A total of 267 016 ground-based measurements was transformed to B_T and $B_T - V_T$. 1200 stars with unreasonable or discordant colours and magnitudes were rejected. Candidate standards were selected among the remaining 99 000 stars according to the following criteria:

- mean error of predicted V_T smaller than 0.035 mag;
- mean error of predicted $B_T - V_T$ smaller than 0.020 mag;
- at least two independent ground-based measurements.

These three criteria defined the first-priority candidates. The selection was relaxed to only the last of the criteria, i.e. at least two independent measurements, for an additional list of second-priority candidates.

The full list of 99 000 stars, with about 25 000 candidate standards was cross-identified with the Tycho Input Catalogue at Strasbourg. This resulted in about 65 000 matches,

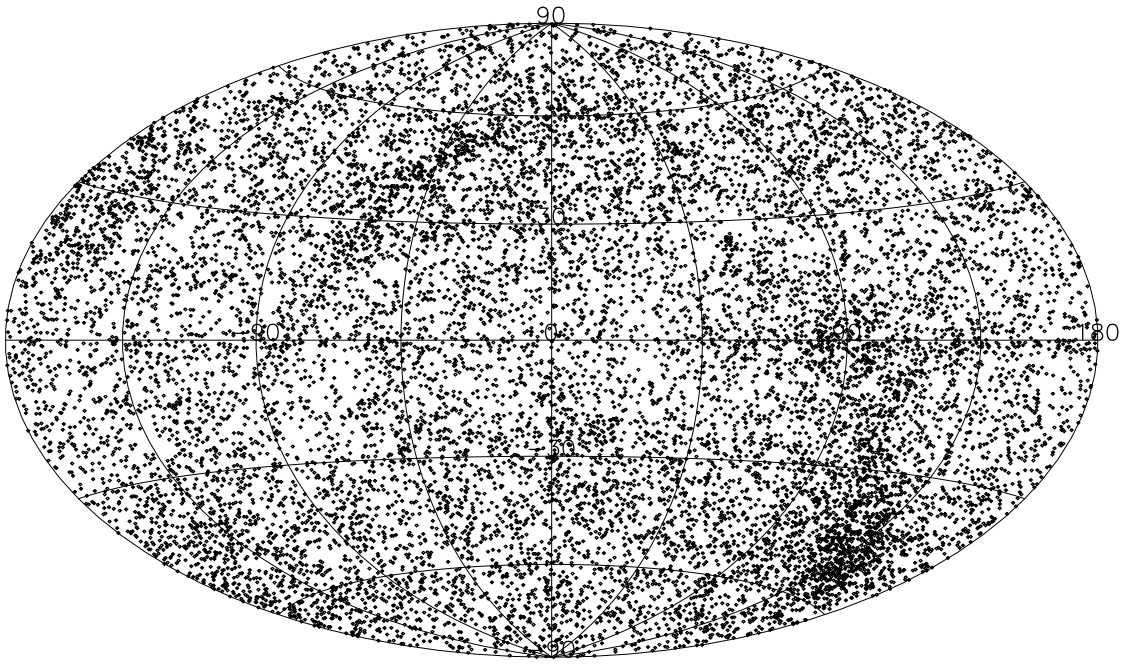

Figure 13.1. *The celestial distribution of the 13 600 stars of the revised photometric standard star catalogue which were actually used in the reprocessing calibration (equatorial coordinates, north up, right ascension increasing to the right, vernal equinox in the center). Areas of enhanced density are the galactic plane, the north and south galactic pole regions, several star clusters, and a particularly well-observed Milky Way region around* $\delta = -50°$.

including 23 502 candidates. This list was further reduced by eliminating known double stars (and a few known variables), and by excluding all stars fainter than 9 mag or brighter than 4.5 mag (for reasons explained in Chapter 8). The magnitude selection was done separately for the two spectral passbands.

In the end, slightly less than 10 000 stars were actually used for the Tycho photometric calibration, both in B_T and V_T. The selection still included a few stars with erroneous predicted magnitudes, and even a few variables, as can be seen from the outliers in Figure 8.2.

13.2. The Revised Standard Star Catalogue

The catalogue of photometric standards was revised during the mission, both in its stellar content and in the magnitudes for the individual stars. There were essentially four reasons for the revision:

- previously unknown duplicity was detected for quite a number of the standard stars from the comparison of the Hipparcos main grid ‘ac’ and ‘dc’ magnitudes (see Volume 3, Chapter 14);
- preliminary reductions of the star mapper photometric data showed that some of the predicted B_T and V_T magnitudes were incorrect;

- the preliminary photometric calibration of the star mapper yielded significant colour coefficients (index 4 in Table 8.2), indicating that the actual photometric passbands of the Tycho instrument deviated slightly from the pre-launch expectations;
- additional ground-based photometric data were included to increase the number of candidate standards.

The third of these reasons led to a re-determination of the Tycho passbands. New transformation formulae from ground-based photometric systems to predicted B_T and V_T magnitudes were derived, and used to define revised standard star magnitudes. The changes in the Tycho photometry caused by the revision were moderate: the zero-point calibration coefficient (index 1 in Table 8.2) changed by about 20 millimag for the B_T channel, and by only a few millimag for the V_T channel. The colour coefficients changed by 15–25 millimag per mag (depending on the slit group and field of view) for both channels. The change in the colour terms implied a shift of the effective wavelengths of the order of a few nanometers.

The revised catalogue contained 29 000 candidate standards. After the elimination of doubles and the reduction of the magnitude range (4.5 to 9 mag, as before), 13 600 standard stars suited for the Tycho photometric calibration remained. These were used for the reprocessing calibration. Their distribution on the celestial sphere is shown in Figure 13.1. The main processing calibration could use only 10 000 of them, for purely technical reasons, originating in the data flow organisation.

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