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Research Note

Hipparcos photometry: The least variable stars*

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Abstract. The data known as the Hipparcos Photometry obtained with the Hipparcos satellite have been investigated to find those stars which are least variable. Such stars are excellent candidates to serve as standards for photometric systems. Their spectral types suggest in which parts of the HR diagrams stars are most constant. In some cases these values strongly indicate that previous ground based studies claiming photometric variability are incorrect or that the level of stellar activity has changed.

Key words. stars: activity – stars: general – stars: statistics – techniques: photometric

1. Introduction

The Hipparcos satellite (ESA 1997) provided very useful astrometric data which improved our knowledge of distances as well as photometric data of two kinds. Hipparcos photometry uses a wider bandpass and has smaller errors than Tycho photometry, but has just one bandpass instead of two. Most observed stars have typically of order 100 values. Hipparcos photometry is extremely useful in determining which stars to use as comparison and check stars for differential photometry (Adelman 1998a). Further these data indicate the variability of various kinds of stars (e.g., slowly pulsating B stars, Waelkens et al. 1998) and the metallic line stars (Adelman 1998a) and can characterize class properties (e.g., the early A Ia and Ib supergiants, Adelman & Albayrak 1997, the S stars, Adelman & Maher 1998, and selected types of peculiar A stars, Adelman 1998b). That the observations tend to be bunched in time is a substantial problem in evaluating and using this photometry.

This research note identifies the stars which were the most photometrically stable during the Hipparcos mission and hence which should be considered as candidates for standards for photometric and spectrophotometric systems. Differential photometrists know that among their local standards some are more stable than others. In particular, Lockwood et al. (1993) found 6 G stars which appear to be particularly stable. Of these, σ Dra and 70 Vir are among the least variable stars of this paper while ρ CrB, 64 Cet, and 31 Com belong to the next group of stars to be considered (0.02 mag amplitudes). But HD 103095 (HR 4550, Groombridge 1830) is noted in Celestia 2000 (ESA 1998) as an unsolved variable with an amplitude of 0.14 mag. Although the Hipparcos amplitudes of the first five stars thus indicate that many other stars will be relatively stable, the discrepancy for HD 103095 suggests that its stellar behavior changes with time. Hence astronomers must use all the high quality photometry available to them and knowledge concerning variability as a function of spectral type in selecting standards.

2. Hipparcos photometry statistics

The number of accepted transits, the mean magnitude, the standard error, and the amplitude (the difference between the 95th and 5th percentile values) were found for each star by reading the headers from the Hipparcos Catalogue: Epoch Photometry Annex (Vol. 17, ESA 1997). Both the standard error of the mean magnitude and the amplitude are measures of the variability and their values tend to correlate. Discordant results might indicate variability of an unusual type. When one uses stars as standards, the amplitudes of variability directly affect the observations. Thus the stars were sorted by amplitude which is calculated to 0.01 mag.

Table 1 lists the minimum standard errors and amplitudes found for stars within given ranges of Hipparcos magnitudes. These values tend to occur close to the brighter bounds. They are roughly in agreement

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* Table 2 is only available in electronic form at the CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via http://cdsweb.u-strasbg.fr/cgi-bin/qcat?J/A+A/367/297

Table 1. Minimum standard errors and amplitudes

Magnitude Range	Standard Error (mag)	Amplitude (mag)
1.00−1.99	0.0004	0.01
2.00−2.99	0.0002	0.01
3.00−3.99	0.0003	0.01
4.00−4.99	0.0003	0.01
5.00−5.99	0.0003	0.01
6.00−6.99	0.0004	0.01
7.00−7.99	0.0004	0.03
8.00−8.99	0.0006	0.03
9.00−9.99	0.0010	0.03
10.00−10.99	0.0015	0.05
11.00−11.99	0.0024	0.08
12.00−12.99	0.0044	0.14
13.00−13.99	0.0168	0.42

with Adelman's (1998b) empirical noise model. For stars brighter than 7th mag, corrections for noise are unimportant. More realistic noise estimates should be based on a larger sample and will likely be somewhat larger. After correction, the revised standard errors and amplitudes should not depend on brightness. As only a few stars considered are fainter than 7th mag, no corrections were applied. Most stars fainter than 6.5 mag which have variability properties similar to those considered are not in the sample investigated.

Table 2 contains information on those stars with amplitudes of 0.01 mag and at least 15 accepted transits. These 681 stars are listed in order of HIP number within groups with the same standard error. In comparison there are 5956 stars with amplitudes of 0.02 mag. The columns are the HIP number, the number of accepted transits, the mean magnitude in magnitudes, the standard error in magnitudes, the HD number, the spectral type from Celestia 2000 (ESA 1998), and the Bayer, Flamsteed, HR, BD, or CoD designation with comments on possible variability. Table 2 shows that the number of accepted transits tends to decrease with increasing standard error, which confirms that amplitude is a more appropriate measure of variability. A few spectral types indicate variability which is not confirmed by Hipparcos photometry.

It is unclear whether most of these stars are always so non-variable or were just observed in such a stage. A few may be extremely long period photometric variables (e.g. HR 8216, Adelman & Rice 1999). This is a topic for future very precise and accurate photometry. Celestia indicates which stars show spurious variability due to binarity or are microvariables. Some of the 78 stars in the former category may still be sufficiently constant for use as standards. The later designation should be regarded as a caution and study of the relevant literature is appropriate before using any as standards. 53 Ari is listed as a β Cepheid variable, two HgMn stars are noted incorrected as α^2 CVn or magnetic CP star variables, HR 5422 as a Cepheid, and HR 2512 as a semi-regular variable. The spectral types listed in Table 2 are somewhat different from what I would have expected. But a much larger sample is required to find the region of the HR diagram with minimum variability (see, for example, Eyer & Grenon 1997).

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