Using the FK5 Extension on the B1950.0/FK4 System to Test the AGK3U

The purposes of this note are to relate our bringing the FK5 Extension onto the FK4 system and to use the result on the context of the AGK3U (Bucciarelli, Daou, Lattanzi & Taff 1992). This independently verifies the system of the AGK3U and the quality of the AGK3U positions and proper motions. This kind of independent confirmation is especially important as the AGK3U is the only astrometric catalog to use Schmidt plates.

To place the FK5 Extension, at B1950.0 epoch of place and equinox, on the FK4 system means correcting for all the systematic differences between the new I.A.U. system of constants and the old ones as well as applying the FK5/FK4 systematic differences to the positions and separately to the proper motions. Each of these steps was performed using the method of infinitely overlapping circles twice (see Taff, Bucciarelli & Lattanzi 1990; Bucciarelli, Daou, Lattanzi & Taff 1992). There are two different steps involved because the FK5 Extension has no overlap with the Basic FK5. First consider doing the computations for the positions.

We calculated, by the method of infinitely overlapping circles, the FK5/FK4 systematic differences, in the sense FK5 minus FK4, at B1950.0. This computation was necessarily executed at the position of each of the 1535 FK stars. Next we fixed on a single FK5 Extension star and found every Basic FK star within a small circle of radius 9.25 deg of it. (A small circle of this size contains, on the average, 10.62 ± 3.79 Basic FK5.) Then we computed the systematic difference between the FK5 and FK4 systems, at the position of the FK5 Extension star, again using the weight formula of the infinitely overlapping circle method. (This is the second application of the technique.) No magnitude or color index terms were included. This entire procedure was then repeated except instead of positional differences we formed proper motion systematic differences.

We used our new version of the FK5 Extension to verify both that the AGK3U is on the FK4 system and that its quoted mean errors are substantially correct. (The AGK3U is comprised of the AGK2 and the AGK3 positions, corrected for known systematic effects, and updated with positions taken from a re-reduction of the Hubble Space Telescope Guide Star Catalog 'Quick V' Schmidt plate collection.) The AGK3U represents the first attempt to combine astrometrically reduced Schmidt plate data with that from astrographic plates.

Six hundred and twenty-six FK5 Extension stars north of declination -3 deg and fainter than magnitude 6.^{m}5 were successfully matched in position — within 5″ — and magnitude — within ±0.75 mag — with stars in the AGK3U catalog. Using the version of the FK5 Extension at B1950.0 produced as indicated above, but without the FK5/FK4 systematic differences applied, the average difference between the equatorial coordinates for these 626 stars are on the left-hand side of the top line in Table 1.

Table 1. AGK3U/FK5 Extension Positional Systems

$\Delta\alpha\cos(\delta)$ (arc secs)	$\Delta\delta$ (arc secs)	$\Delta\alpha\cos(\delta)$ (arc secs)	$\Delta\delta$ (arc secs)
without FK5/FK4 systematic differences		with FK5/FK4 systematic differences	
-0.0172 ± 0.2636[a]	-0.0308 ± 0.2096	0.0193 ± 0.2650	-0.0180 ± 0.2111
0.0161 ± 0.1908[b]	-0.0309 ± 0.1970	0.0183 ± 0.1934	-0.0180 ± 0.1983
0.0187 ± 0.2648[c]	-0.0179 ± 0.2108	0.0177 ± 0.1932	-0.0179 ± 0.1981

[a] All 626 stars in common. [b] 9 outlier stars removed. [c] Double area smoothing.

Redoing the computation, but first applying the FK5/FK4 systematic positional differences to the B1950.0 version of the FK5 Extension, the results are on the right-hand side of the topmost line

in Table 1. It is obvious that the two catalogs are on the same positional system and that the results are just slightly better when the FK5 Extension is completely placed on the FK4 system. The standard deviations about the mean are about twice what would be expected from the formal AGK3U error estimates alone (i.e. 0."118 per equatorial coordinate [Bucciarelli, Daou, Lattanzi & Taff 1992]; the FK5 Extension positional errors are a minor contribution to the standard deviation of the combination [FK5 Extension minus AGK3U] coordinate differences). The cause of this discrepancy is, in fact, 9 outlier stars (clearly visible in Figs. 1a and 1b).

If these 9 stars, which differ in one of their equatorial coordinates by more than 1" in amplitude, are removed and the computation repeated the new results are in better accord with our expectations; see the second line of Table 1. Remembering that the stars in the AGK3U which successfully matched the FK5 Extension stars are among the brightest stars in the AGK3U, so that their positions from the Hubble Space Telescope Guide Star Catalog 'Quick V' Schmidt plates are among the poorest (see Taff, Lattanzi & Bucciarelli 1990; Taff et al. 1990), this is not surprising. Plots of $\Delta\alpha\cos\delta$ and $\Delta\delta$ versus magnitude are shown in Figs. 1a and 1b.

Although we chose R = 9.25 deg (or 10 stars per enveloping circle), we have also done computations with circle sizes the square root of two larger (i.e. 20 stars per circle). These results are in the third lines of Tables 1 and 2 (but the FK5 Extension circle still had a 9.25 deg radius; only the FK5/FK4 catalog-to-catalog differences utilized the larger circle). Note the stability.

The same type of computation for the proper motion components yielded the results shown in Table 2 (which has the same format as Table 1). Clearly the right ascension proper motion systems are better aligned than the declination proper motion systems but there is also no doubt that the declination systems are substantially identical. The formal error in an AGK3U proper motion component is 0."58/cy so that the bulk of the standard deviations about the mean are a consequence of the AGK3U proper motion errors. This can be double checked by repeating these calculations with the 9 outlier stars removed; see the second line of Table 2. Figures 2a and 2b show the variation in the proper motion component differences with V magnitude.

Table 2. AGK3U/FK5 Extension Proper Motion Systems

$\Delta\mu\alpha\cos(\delta)$ (arc secs/cy)	$\Delta\mu\delta$ (arc secs/cy)	$\Delta\mu\alpha\cos(\delta)$ (arc secs/cy)	$\Delta\mu\delta$ (arc secs/cy)
without FK5/FK4 systematic differences		with FK5/FK4 systematic differences	
0.0037± 0.606[a]	0.0799 ± 0.675	-0.0260 ± 0.602	0.0784 ± 0.671
0.0043 ± 0.607[b]	0.0835 ± 0.673	-0.0253 ± 0.604	0.0817 ± 0.669
-0.0272 ± 0.601[c]	0.0778 ± 0.671	-0.0264 ± 0.603	0.0812 ± 0.669

[a] All 626 stars in common. [b] 9 outlier stars removed. [c] Double area smoothing.

We can deduce several different, strong, conclusions from this work. We start with the assumption that the FK5 Extension is a very good catalog. First examining the standard deviations in the Tables, and seeing that they remain essentially constant before and after the application of the FK5/FK4 systematic differences, we can say that the method of infinitely overlapping circles is introducing no additional noise. Still examining the standard deviations, and taking the mean errors in the FK5 Extension at face value, we can also conclude that the formal error estimates given in the AGK3U are substantially correct. Finally, from the small values of the averages in the Tables, we can validate that the AGK3U it is on the FK4 system. Another deduction one can make from the numerically small magnitudes of the means is that we have been successful in astrometrically reducing Schmidt plates by the method of subplate overlap (Taff 1989) and then integrating the results with those from the AGK2 and 3 astrographic plate material.

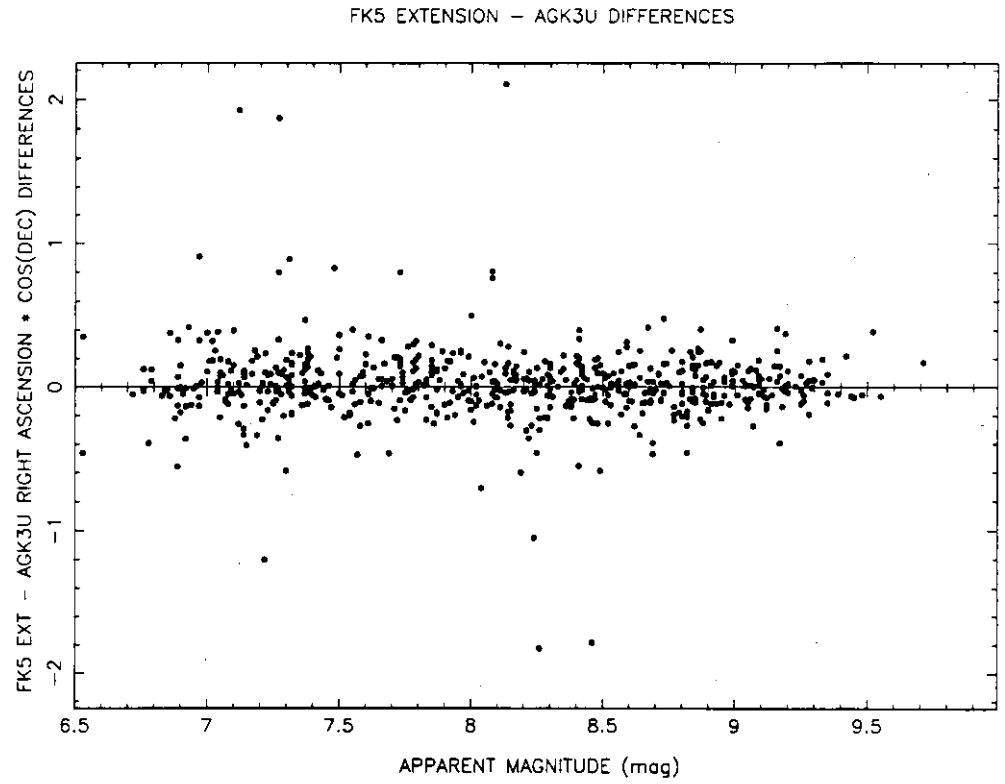

Figure 1a. Right ascension differences in arc seconds, on a great circle, between the FK5 Extension (on the FK4/B1950.0 system) and the AGK3U vs. *V* magnitude. Note that there is no magnitude dependence nor any sizeable bias.

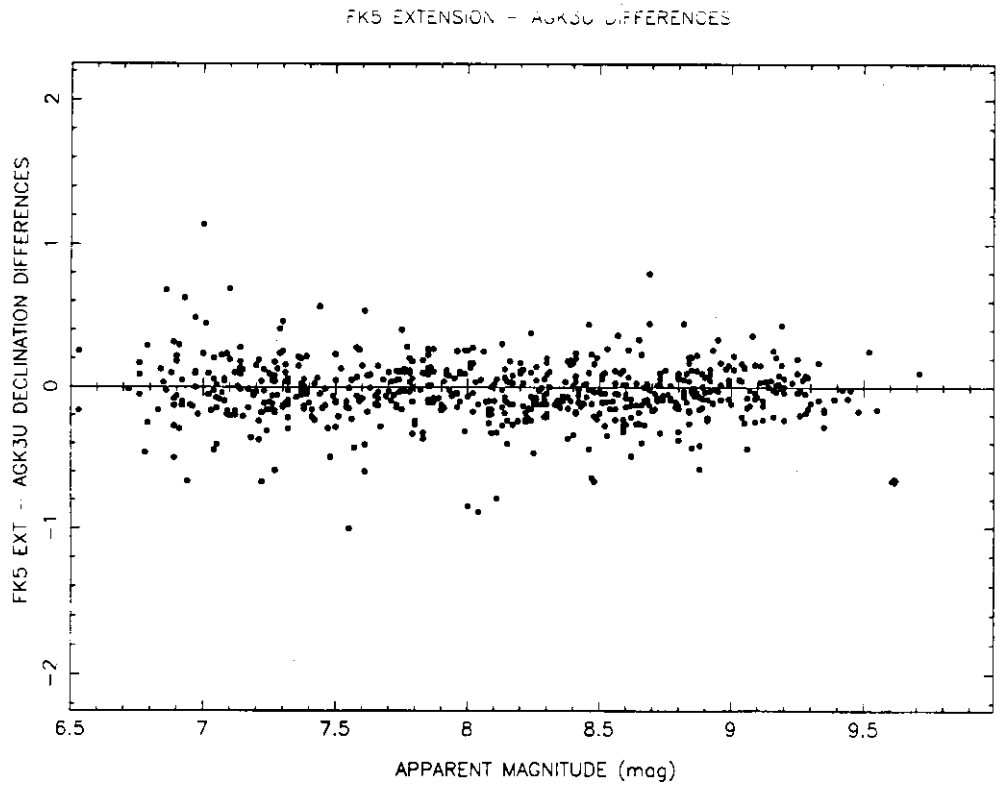

Figure 1b. Same as Fig. 1a but for declination.

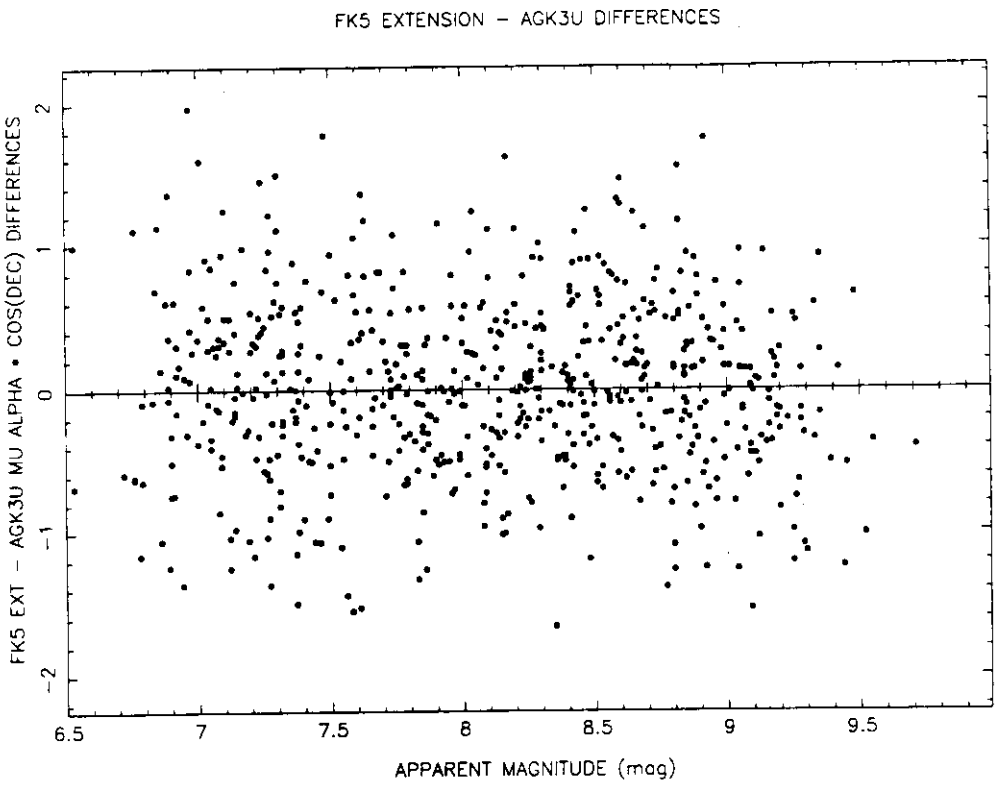

Figure 2a. Same as Fig. 1a but for the right ascension proper motion differences on a great circle ("/yr).

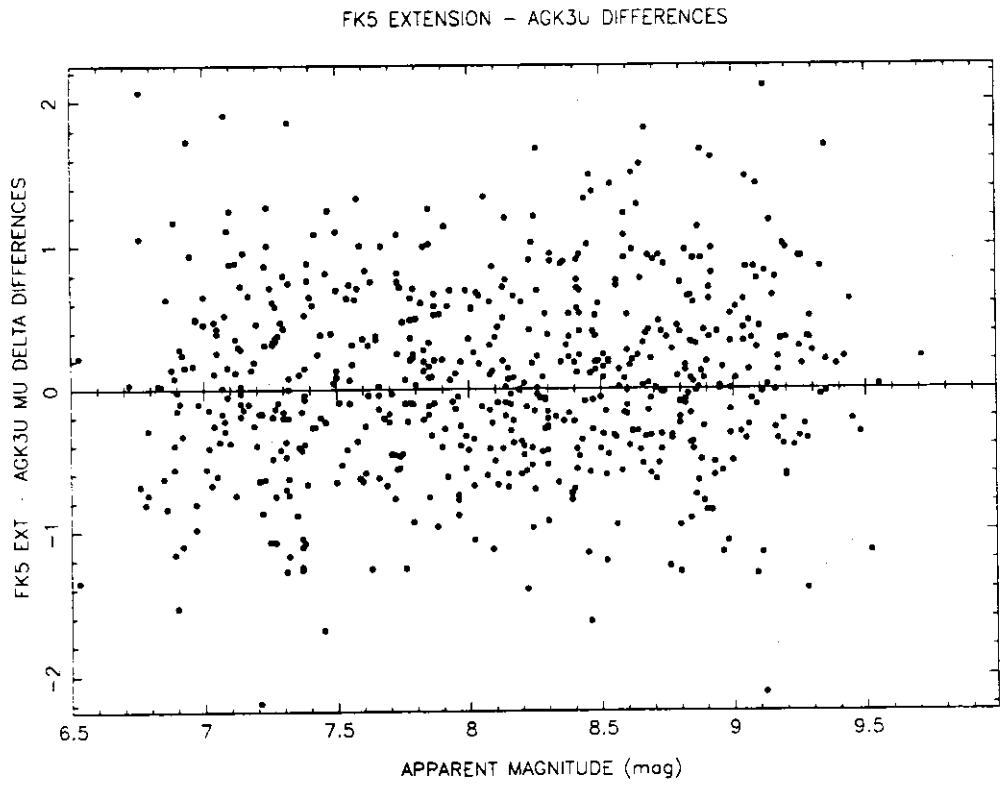

Figure 2b. Same as Fig. 2a but for the declination proper motion differences.

Acknowledgments

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News about the Wide-field Plate Archive Database

Since the last information about the Wide-field Plate Archive Database in Newsletter No. 2 (Tsvetkov 1992), we have received a lot of letters and e-mails with useful new information and corrections. We would now like to inform you in a systematic way about these remarks, suggestions and contributions by arranging them according to the following topics:

- new information about the WFPA list;
- development of the WFPA Database;
- future plans — digitisation of the WF plates;
- some general comments and remarks.

1. New Information about the WFPA List

Additional information has been received about some observatories which were not included in the first WFPA list of observatories with WFPA. It is given in Table 1, which contains the name of the observatory (with the country indicated), the number of the wide-field plates available there and the name of the astronomer who reported the information: