

A CATALOG OF REFERENCE STARS FOR
NEW REDUCTIONS OF THE ASTROGRAPHIC CATALOG PLATES

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ABSTRACT: A high density reference star catalog is being compiled at the U. S. Naval Observatory for the purpose of making new reductions of the Astrographic Catalog. The catalog will be a replacement to the SAO catalog and will be derived from the large photographic catalogs and the modern meridian circle catalogs. It is expected that the final catalog will contain 346,000 stars, with proper motion mean errors generally $\pm 0".4$ /century or less, on a uniform system, the data having been reduced first to FK4 and then to FK5 using the International Reference Stars (IRS).

INTRODUCTION

For many years the question of how to most effectively utilize the results of the Carte du Ciel has been under discussion. It is commonly acknowledged that the plate constants given in the various volumes of the Astrographic Catalog do not give satisfactory results, since most of the solutions were based on the AGK1 catalogs. In recent years there have been two important efforts to produce improved versions of the AC. First, Guenther and Kox (1970 and 1971) derived improved plate constants for the zones north of $+31^\circ$ using the AGK3. However, only the AGK3 stars were put into machine readable form in order to derive the constants, and the bulk of the printed X-Y measures in this part of the sky still must be converted. Also, it has been shown that the proper motions of the AGK3 have significant systematic errors (Corbin, 1978). A major effort for the declinations $+31^\circ$ to -2° was made by Lacroute and Valbousquet (Valbousquet, 1977). They performed the great service of having all the X-Y values in this region keypunched and then deriving positions based on a revised version of the AGK3. Comparisons of the resulting positions with the Northern IRS made at the U. S. Naval Observatory have shown portions of the region to have systematic differences as large as $0".5$ in right ascension and $0".4$ in declination. These probably result from

uncorrected errors in the AGK2 that have propagated into the revised AGK3/2 proper motions.

The USNO has, in recent years, been continuing the work begun at Strasbourg through efforts to convert the X-Y's of the Cape, Perth, Tacubaya and San Fernando zones into machine readable form. The goal is to convert all the remaining zones and to make new reductions for the whole of the Astrographic Catalog. Such reductions will require an accurate, high-density reference star catalog. In 1973 Herget published improved plate constants for the Bordeaux zone based on a system of positions and proper motions derived from combined meridian circle and astrographic data. A similar system for a large region centered on the Hyades resulted in very satisfactory results (Corbin, Smith and Carpenter, 1975). It is now the intention of the USNO to extend this concept to cover the whole sky to produce a catalog of the required density and quality for the new reductions of the AC plates. This catalog will be known as the Astrographic Catalog Reference Stars (ACRS).

1. COMPILATION OF ACRS ON THE SYSTEM OF THE FK4

The first stage of the work involves taking currently available meridian circle and photographic positions reduced to the FK4 system and combining them to give mean positions and proper motions. The positions and motions of the International Reference Stars will be used to make the systematic reductions. The basic list of stars has been selected and is derived from the catalogs shown in Table 1.

Table 1
BASIC LIST OF STARS FOR THE ACRS

Catalog	Declinations	Number of stars
AGK3	+90° to -2.5°	186,000
Yale Zones	-2.5 to -30	74,000
Cape Photographic	-30 to -90	86,000

The data currently available for these stars are to be found in the AGK3, AGK2, Yale Zones, Cape Photographic, Sydney Southern Star Catalog (King and Lomb, 1983) and 125 meridian circle catalogs. Figure 1 shows the result of combining these data to indicate number of catalog positions versus number of stars (hatched bars). As might be expected, the two zones south of the equator show poorer observational histories than the one covered by the AGK3. In fact it will not be possible to determine proper motions at all for about 30,000 of the stars south of -2°5 in this first stage.

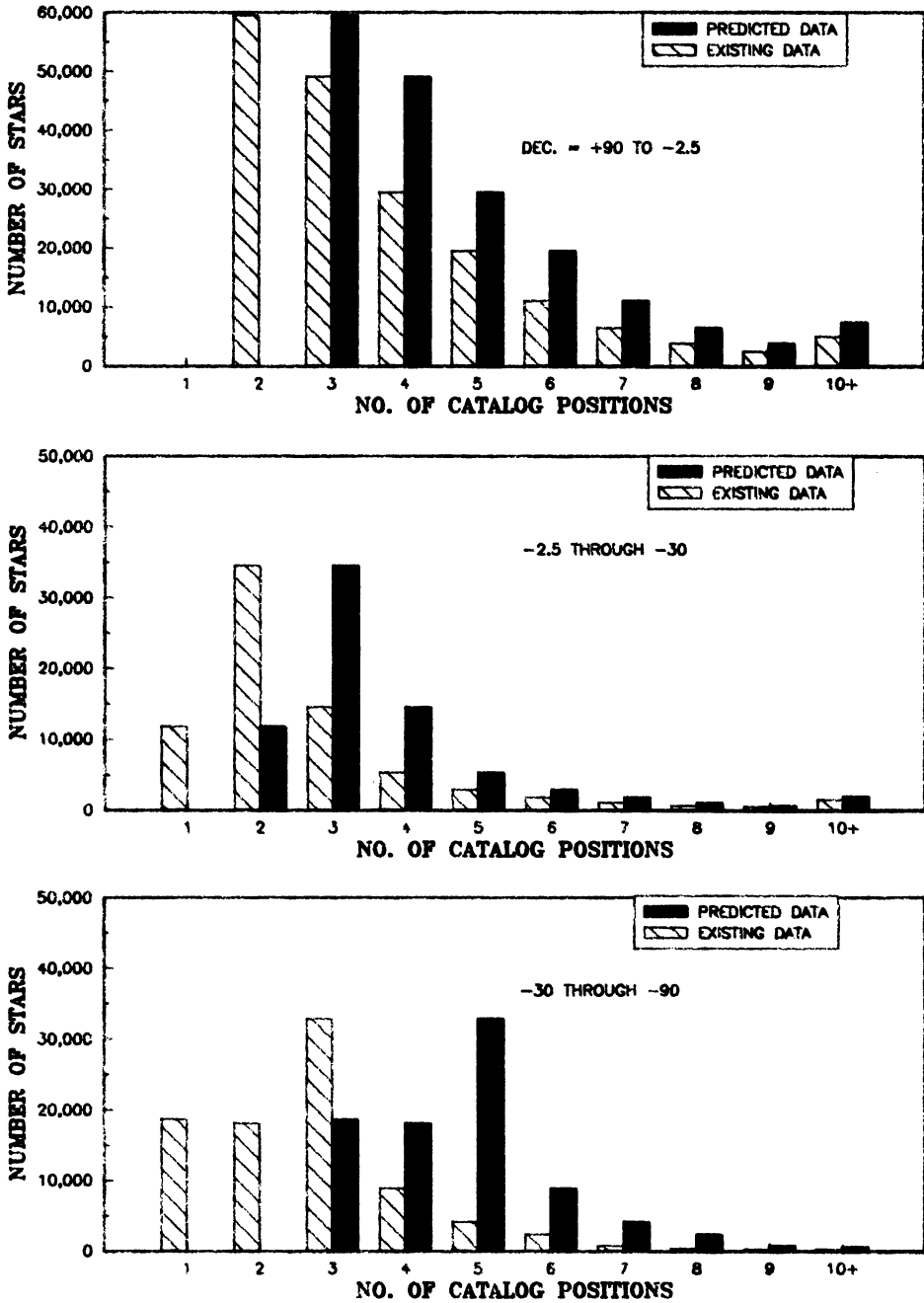


Figure 1: Observational histories of the ACRS from existing and from predicted data.

2. REDUCTION TO THE FK5 SYSTEM

While the positions and motions computed from the first stage will initially be converted to the FK5 through the use of a standard conversion FK4 to FK5 that is expected to be given in the FK5, this procedure will not give the best result possible. There are two reasons for this: First, the systematic reductions of the catalog positions to the FK4 depend on interpolative processes. Especially in the southern hemisphere, many of the catalogs, as well as the FK4 itself, have rapidly varying systems, and the interpolations can only approximate the (FK4 - catalog) differences. Second, in many parts of the sky the Auwers stars and Zusatzsterne represent two different systems in the FK4, and the systematic reduction to the FK4 that one derives for a catalog can depend on the mix of these stars in the catalog. The use of the FK5 will reduce the difficulties in both of these areas. Several steps are required, however, to do the job properly. First the AGK3R and SRS must be compiled on the FK5. New reductions of the AGK3R will be done at the USNO and will involve a detailed rediscussion of the contributors' observations. The SRS will be produced jointly by the Pulkovo Observatory and the USNO. Using the revised AGK3R and SRS a new version of the IRS will be produced. As has been the case with the FK4 version, each catalog will be compared as directly as possible with the FK5. Recent observational results such as the W6-50 and Carlsberg Meridian Circle Catalogs will be incorporated as well. Finally, the revised IRS will be used to reduce the photographic catalogs to the FK5.

3. FINAL VERSION OF ACRS ON THE FK5 SYSTEM

In addition to the data just described, it is hoped that several other sources will be available for this work within the next few years. The second epoch plates of the Cape Photographic Catalog are measured and are currently being reduced (Nicholson et al. 1984). This CPC-II catalog will be of great importance in giving high-quality southern positions at a fairly recent epoch. New reductions of the AGK2 have been discussed by de Veigt (1978). This should yield a much better set of positions than can be obtained by simply using the IRS to compute systematic differences for the current AGK2. The plates of the Yale Zone Catalogs in the region of the Zodiac have been remeasured at the USNO and are currently being reduced by R. Harrington. If the process gives good results, it would be highly desirable to remeasure the rest of the Yale plates. The USNO Dual Eight-Inch Astrograph has completed the northern portion of its whole-sky survey. Currently the plates are being measured and reduced by Harrington. The southern portion is about to commence at the USNO station at Black Birch, NZ, and G. Douglass will take the plates in conjunction with the transit circle work there. Thus the USNO program will contribute positions over the whole sky at a very recent epoch.

Combining all of the data described up to this point will give a much stronger system than the hatched bars in Figure 1 indicate. This final

version is shown by the solid bars in Figure 1. The improvement in the Southern Hemisphere is particularly notable. Thus the final version of the ACRS will be a catalog of some 346,000 stars on the system of FK5. If the work with the IRS can be used as a guide, Figure 2 indicates that the mean errors of the proper motions should mostly be in the 0".3/century to 0".4/century range.

4. CONCLUSION

While the ACRS is being created by the USNO for its work with the Astrographic Catalog, it is realized that such a catalog will have many other applications. In particular, the catalog will have a density of stars one third greater than that of the SAO catalog while also providing star positions with much smaller random and systematic errors than are currently available in high-density catalogs. The current goal is to finish the work described in Section 1 within one year and to produce the final catalog in about five years.

REFERENCES

- Corbin, T. 1978, in IAU Symposium 109, Modern Astrometry, ed. F. Prochazka and R. Tucker, Vienna, p. 505.
- Corbin, T., Smith, D. and Carpenter, M. 1975, Bull. Am. Astron. Soc., 9, 597.
- de Vegt, C. 1978, in IAU Symposium 109, Modern Astrometry, ed. F. Prochazka and R. Tucker, Vienna, p. 527.
- Guenther, A. and Kox, H. 1970, Astron. Astrophys., 4, 156.
- Guenther, A. and Kox, H. 1971, Astron. Astrophys., 12, 175.
- Herget, P. 1973, Publ. Cincinnati Obs., 24.
- King, D. and Lomb, N. 1983, Sydney Obs. Papers, 96.
- Nicholson, W., Penston, M., Murray, C. and de Vegt, C., 1984, Mon. Not. R. Astron. Soc., 208. 911.
- Valbousquet, A. 1977, Bull. Inform. CDS, 13, 2.

Discussion:

OJA What about the data of the AGK1; are they just rubbish?

CORBIN No, we are using them, especially those in the south, though they tend to have rather low weight.

WHITE Astrometric plates that could extend the Sydney Catalogue (King and Lomb) to the South Pole exist but have not yet been measured.

CORBIN I certainly hope a way can be found to measure these. Good data in the South are especially valuable.

EICHHORN The epochs for the positions in the Sydney -8° to -54° catalogue can be found in the AJ article which described its constructions.

MURRAY I am glad you mentioned the repeat of the Cape Zone in the 1920's. As far as I am aware, only differential measures, giving relative proper motions, were made. The same applies to the Greenwich Zone.

CORBIN I hope we can reconstruct positions at epoch from these. Or, perhaps, the plates could be measured.

MURRAY The Greenwich plates are still in good condition. I do not know about Cape, am I hearing an offer?