

STATUS REPORT OF THE WORK ON THE FK5

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ABSTRACT

A survey is given on the tasks to be performed in the process of improving a fundamental system. Completed tasks are the derivation of corrections to the values for general precession and the determination of the FK4 equinox and equator. The selection of new fundamental stars and the improvement of the systematic and individual accuracy of the FK4 is in progress. A description of the observational material and of new methods of analysis is given. Preliminary results are reported.

1. MOTIVATION FOR WORK ON THE FK5

Soon after the publication of the Fourth Fundamental Catalogue (Fricke, Kopff, 1963) one has become aware of some deficiencies of the new fundamental system. The accidental errors of the FK4 positions and proper motions accumulate at 1980 to about $\pm 0''.2$ south of $\delta = -30^\circ$ so that a single modern catalogue of good quality is in that region of the same accuracy as the FK4. Moreover large systematic errors in the southern FK4 right ascensions were detected (Anguita, 1974). In addition errors in the constants for general precession and in the FK4 equinox have been found. Another severe deficiency of the FK4 is its limitation to stars brighter than about magnitude 7.5.

For these reasons agreement was achieved at the XV. General Assembly of the IAU held in Sydney (1973) that the FK4 should be improved at the Astronomisches Rechen-Institut under the supervision of Prof. Fricke.

2. COMPLETED TASKS

On the basis of the new constant of luni-solar precession (Fricke, 1977a, 1977b) and of improved values for the planetary masses corrections to the precessional quantities were derived by Lieske, Lederle, Fricke, Morando (1977); the determination of the equinox and equator of the FK5

was performed by Fricke (1982).

3. OBSERVATIONAL MATERIAL FOR CONSTRUCTING THE FK5

For the revision of the FK4 and its extension to fainter magnitudes we consider only catalogues with mean epochs later than 1900 since one must expect that observations of the last century are still affected by magnitude equations and that the effects of polar motion were not eliminated. Altogether we have examined about 290 catalogues providing 700 000 star positions which were derived by the observers from about 3.5 millions of single observations. These observations were made at about 60 observatories in 20 countries all over the world. Meridian circles, transit instruments, vertical circles and astrolabes have been used for the observations, and absolute, quasi-absolute and differential techniques of observation have been applied. About 100 of the 290 catalogues give absolute or quasi-absolute observations which can be used for the derivation of the FK5 system. Most of the catalogues result from observations made with a single instrument, but some other catalogues are compiled from observations made with various instruments. In constructing the FK5 we will include compiled catalogues as a whole adopting an appropriate weight.

Since the completion of the FK4 more than 60 catalogues with mean epochs later than 1952 have become available. About 35 of them present results of absolute or quasi-absolute observations.

4. SELECTION OF THE FUNDAMENTAL STARS

The FK5 stars will be selected from two so-called master catalogues, MCI and MCII; MCI contains the FK4, the FK4 Sup and N30 stars, MCII contains the AGK3R, SRS and NPZT stars. For the reconstruction of the history of observations of these stars the 290 catalogues under consideration have been identified with MCI and MCII. The purpose of MCI is first to find the FK4 stars which are used for the determination of the systematic differences Cat-FK4, second the new observations of FK4 stars are identified for the improvement of the individual accuracy, and third the FK4 Sup and N30 stars with magnitudes $m \leq 7$ and the best history of observations are found for inclusion in the FK5. The aim of MCII is to identify the IRS and NPZT stars with the best history of observations for the extension of the FK5 to about magnitude 9.

We expect that approximately 1000 AGK3R and 1000 SRS stars will be included in the FK5. This part of the work is done in close collaboration with the U.S. Naval Observatory. For an even distribution of the stars according to the apparent magnitude about 1000 FK4 Sup or N30 stars in the magnitude range six to seven will have to be included additionally.

The accuracy of the positions and proper motions of the new fundamentals will be low compared with the FK4 stars. For the new faint

fundamental stars proper motion errors of at least $\pm 0''.25/\text{cy}$ are expected. For this reason we intend not to include the new fundamentals in the basic FK5 catalogue which will contain only the individually and systematically improved FK4 stars.

5. DEVELOPMENT OF NEW METHODS

The basic data for the construction of the FK5 are the differences $\Delta\alpha$, $\Delta\delta$ per FK4 star between the observed positions given in a catalogue and the positions computed on the basis of the FK4. For all catalogues with relevance for the FK5 we have to determine the systematic differences Cat-FK4. These differences are used for the transformation of the catalogues to the FK4 system, they provide the residuals per star for the improvement of the individual accuracy of each FK4 star, and the systematic relations Cat-FK4 for the absolute catalogues are the basis for the determination of the FK5 system.

New analytical methods have been developed for the determination of the systematic differences Cat-FK4 and for the derivation of the systematic corrections FK5-FK4 which are represented by series developments. These methods are extensively described by Schwan (1977, 1983), and by Bien et al. (1978).

6. ERRORS IN THE FK4 SYSTEM AS INDICATED BY MODERN OBSERVATIONS

The systematic differences Cat-FK4 for the new observations as a function of the declination are given by Fricke (1985). These differences reveal significant systematic errors mainly in right ascension for the southern sky. The largest correction at the mean epoch of the modern observations (≈ 1970) will be $\Delta\alpha_\delta \cos \delta \approx -0''.025$ near $\delta = -70^\circ$ and $\Delta\delta_\delta \approx \pm 0''.15$ very near to the southern pole.

7. PRELIMINARY CORRECTIONS TO THE FK4 SYSTEM

In addition to the new absolute and quasi-absolute observations which are not yet included in the FK4 (Section 6) the method adopted for constructing the system has some influence on the result. The following deviations from the procedure applied in the FK4 should be mentioned: first we will use new analytical methods (Section 5), second we will not include observations of the last century, third each catalogue will be used individually, and fourth the system of mean positions and proper motions will be derived from the same set of observations whereas the system of the FK4 positions was determined only from part of the observations, namely the modern ones.

About 60 catalogues are suited for deriving the FK5 in α and δ , respectively. Preliminary results are: The mean FK5 epoch will be near to 1940; the errors in the system of mean FK4 positions are small, except

for the right ascensions near -70° where corrections $\Delta\alpha_\delta \cos \delta \approx -0^{\text{s}}.010$ will be necessary; the largest corrections to the proper motions in right ascension and declination, respectively, will be $\Delta\mu \cos \delta \approx -0^{\text{s}}.040/\text{cy}$ near $\delta = -70^\circ$ and $\Delta\mu' \approx \pm 0''30/\text{cy}$ near the southern pole. On the average we expect an increase of the systematic accuracy by a factor of about two.

8. IMPROVEMENT OF THE INDIVIDUAL ACCURACY OF EACH FK4 STAR

The improvement of the individual accuracy will be made by incorporating the new observations into the mean FK4 positions and proper motions. Relevant formulae were already given by Boss (1937) in the preface to the G.C. Weights for the new observations will be determined according to the principles adopted in the FK4 (Kopff, Nowacki, Strobel, 1964). We expect an average improvement of the individual accuracy by a factor of about two.

The basic FK5 will be completed prospectively in the course of the year 1986. This catalogue will contain the FK4 stars, systematically and individually improved. The proper motions will be based on the new constant of precession, and the equinox correction will be included in the mean positions and proper motions. The data will be given for the mean epoch and the equinox J2000.

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