THE USE OF PHOTOGRAPHIC POSITIONS IN DETERMINING AZIMUTH OF A MERIDIAN CIRCLE.

C. Fabricius
Copenhagen University Observatory
Brorfelde
DK-4340 Tølløse
Denmark

ABSTRACT.

The azimuth of a meridian circle may be determined using stars within $1^o - 2^o$ of the pole combining observations in upper and lower culmination of stars which have well known right ascensions. The right ascensions are determined photographically using only declinations in the reduction, thus making the azimuth determination independent of the right ascension system. The declinations of the pole near stars are determined with the meridian circle.

INTRODUCTION.

Presented here is a method suggested by Bengt Strömgren for determining the azimuth of a meridian circle. In the first step the declinations of some 100-200 stars near the pole are determined. In the second step photographic plates covering the polar region are reduced using only these declinations in the reduction of the field errors. In the third step the photographically determined right ascensions are used to determine the Bessel parameter "n" and its variation throughout a night. The Bessel parameter "n" may be combined with level measurements, using the nadir pool, to yield the azimuth.

THE MERIDIAN OBSERVATIONS.

Nearly all stars from the AGK3 zones $+88^o$ and 89^o were observed with the Carlsberg Automatic Meridian Circle at Brorfelde during 1981-1983, using the new photoelectric moving slit micrometer. Some 2300 observations of nearly 180 stars was obtained in some 100 nights and reduced relative to the FK4 system using FK4 stars covering the whole meridian and the whole night. In the narrow zone around the pole any systematic error is not expected to have a large variation. To eliminate

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such systematic effects most of the stars were observed in both upper and lower culmination, and the mean of the positions in upper and lower culmination formed. For stars observed in only upper or lower culmination a correction was determined and applied. This correction is in the order 0".04 and has a slight variation with right ascension. For stars common to the Yale and AGK3 catalogues improved proper motions were determined.

THE SCHMIDT OBSERVATIONS.

In 1983 four plates covering the polar region were obtained with the Schmidt telescope at Brorfelde. Each plate was exposed two times two minutes, the telescope moved 1' between the two exposures. Two plates were taken with the telescope in its normal position and two plates were taken with the telescope reversed. This was done to avoid possible systematic errors arising from e.g. plate tilt. The Schmidt telescope has a field diameter of 5°.3 and a scale of 137".2/mm. The astrometric properties of this instrument have been discussed by J. Andersen (1971).

The apparent, refracted tangential coordinates derived from the meridian positions were used to determine zero point, scale and orientation of the plates. The field errors were described by linear terms, but only residuals in the declination direction (radial direction) were given any weight. Therefore the derived positions depend only on the declinations determined with the meridian circle. Only the zero point of the right ascension cannot be determined, but it is not needed for determining the azimuth.

THE AZIMUTH DETERMINATION.

Near the meridian Bessel's formula is valid. In upper culmination it says:

$$\alpha_u = \vartheta_u + m + n \tan \delta_u + (x_u - x_c) \sec \delta_u$$

and in lower culmination:

$$\alpha_l = \vartheta_l \pm 12^h + m - n \tan \delta_l - (x_l - x_c) \sec \delta_l$$

here, ϑ is the sideral time at which the star was observed at micrometer reading x. The collimation-free reading is x_c. It follows that

$$n = \frac{-(x_u - x_c) \sec \delta_u - (x_l - x_c) \sec \delta_l + \vartheta_l - \vartheta_u + \alpha_u - \alpha_l \pm 12^h}{\tan \delta_u + \tan \delta_l}$$

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If the random error of x is 0″.21, the random error of n is 0″.16 for typical declinations.

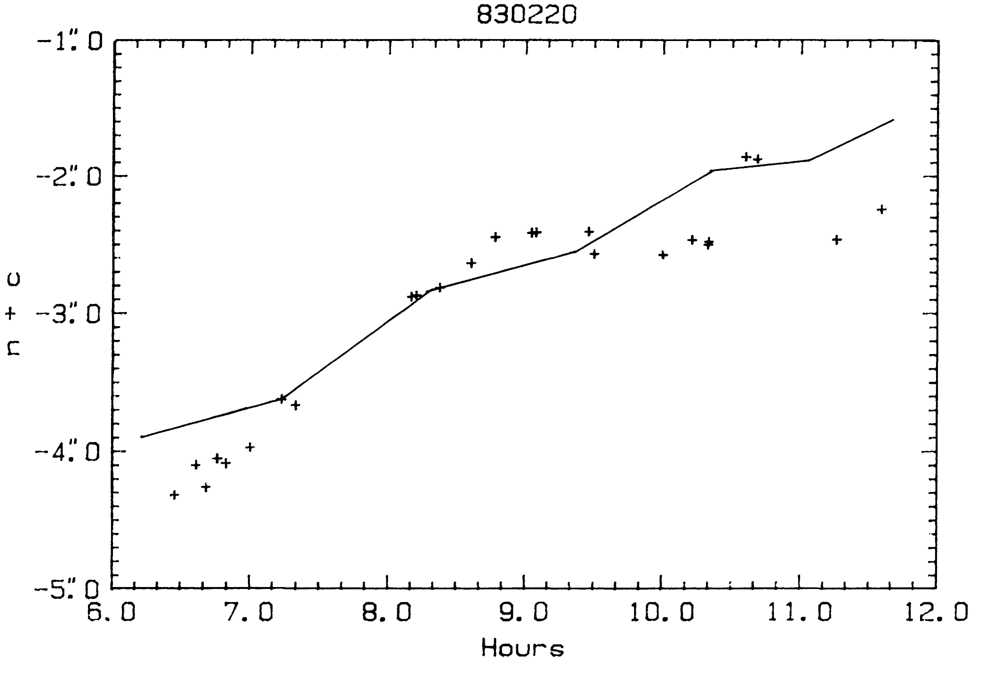

Figure I. The variation of n+c throughout one night.

An example of the determination of n is shown in figure I. On that night 9 polar stars were observed in upper and 17 in lower culmination. Each observation was combined with the preceding observation in opposite culmination to yield a value of n. These are shown as crosses. A constant value of x_c was used, therefore n+c is shown, c is the residual collimation error. The full line shows the value of n+c as expected from the reduction to the FK4 system and from the measured collimation and level. The reduction to the FK4 system yields c, n, n', m, m' here n' and m' are the hourly variations of n and m. The reduction to FK4 is thus not capable of eliminating non-linear variations of the azimuth. Apparently such a non-linear term is present on this night, and the method given here should be capable of removing it. If this is done the night could be reduced using the FK4 right ascensions only to give the zero point.

REFERENCES:

Andersen,J.: 1971, Astron. Astrophys. 13,40.
Strömgren,B.: 1980, (Private communication).

Discussion:

MURRAY: We have a set of plates of the pole at Herstmonceux, taken with the 1m telescope at the Wise Observatory in Israel some 6 or 7 years ago. These could be used to improve the proper motions of the azimuth stars.
FABRICIUS: Proper motions were taken from AGK3 and improved using Yale positions and the Brorfelde meridian observations.
TELEKI: Did you compare your results with the determination of azimuth variations by meridian marks?
FABRICIUS: No. A meridian mark was not available at Brorfelde.