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ABSOLUTE AZIMUTH AT LOW LATITUDE WITH A POLARISSIMA

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RESUMO. É discutida uma série de observações da estrela polarissima FK4Suppl 3985 (δ=-89°42', m=6.6). O azimute das miras é obtido com a precisão de 0"85 para uma observação.

ABSTRACT. A series of observations of the polarissima star FK4Suppl 3985 (δ=-89°42', m=6.6) is discussed. The absolute azimuth of the meridian marks is obtained with the accuracy of 0"85 for a single observation.

Key words: absolute azimuth, polarissima, transit circle.

1. INTRODUCTION

Standard methods for absolute azimuth determination are not suitable for low latitude sites, since the night time interval is much too short, even in winter, to allow the collection of a meaningful number of observations of both transits of circumpolar stars. Furthermore lower culminations occur at great zenith distances, where images are usually very poor.

The polarissima method (Fabritius, 1879, Podobed, 1965) seems to be the only adequate alternative, provided the pole altitude is high enough to give, reasonably often, images of acceptable quality.

Fortunately for Southern hemisphere observers, there is presently a very attractive polarissima star: FK4Suppl3985 (GC 17838), magnitude 6.6, is at only 18' polar distance, and this will be decreasing to a minimum of 9', which will occur some fifty years from now.

At such small polar distances the polarissima is permanently in the field of view of usual transit telescopes. It can thus be observed at any hour angle, more than once each night. With at least three such observations we can derive, in principle, an absolute solution.

The University of São Paulo "Abrahão de Moraes" Observatory at Valinhos (ϕ=-23°00'.1, $\lambda=3^h07^m52^sW$) started in 1981 a polarissima programme, for the determination of the absolute azimuth of the AM-190 transit circle from Zeiss Oberkochen.

In the interval from March 1981 to May 1983 we collected 148 observations in the course of the current programme, which includes fundamental stars transits and nightly determinations of inclination, colimation and azimuth relative to the meridian marks, with reversal of the instrument.

2. CONDITION EQUATIONS

We assume that the level b, the colimation-free micrometer position u and the mean azimuth a' relative to the North and South marks have been obtained. We further assume that the clock correction has been determined by clock stars with adequate accuracy. This assumption is not very demanding, since the clock correction will appear multiplied by the factor $\cos\delta \sim 0.005$.

We may write, for each observation,

$$n = k(v-u) + (x+\Delta x)\sin\theta - (y+\Delta y)\cos\theta \ , \quad (1)$$

where the symbols not yet defined have the following meaning:

n - the unknown Bessel's n, that is the rotation axis declination,

k - angular value of the screw pitch, affected by a sign depending on the instrument position,

v - observed micrometer setting on the image,

θ - observed sidereal time, including clock correction,

$x = \cos\delta\cos\alpha$, and

$y = \cos\delta\sin\alpha$, star rectangular coordinates,

Δx and Δy, corrections to the star coordinates, to be determined.

By means of the standard expression

$$n = b\sin\phi - a\cos\phi \ , \quad (2)$$

where a is the usual rotation axis azimuth, and introducing the mean azimuth A of the marks by

$$A = a' - a \ , \quad (3)$$

we may recast (1) in the form

$$A - \Delta x\sec\phi\sin\theta + \Delta y\sec\phi\cos\theta = h \ , \quad (4)$$

where h denotes a sum of observed and known terms.

Three observations, at least, are needed to solve (4) for the three unknowns A, Δx, and Δy. On several occasions we had enough observations to form solutions for individual nights. These results turned out to be heavily scattered, because of the unavoidable low observational accuracy. Another inconvenient feature of such nightly solutions was the fact that the sidereal time range was often limited to a few hours with, as a consequence, the appearance of strong correlation among the unknowns.

We have tried instead a long term solution, where the marks azimuth is assumed to be adequately representable by some function of the time. We have adopted a piecewise constant function.

The observations have been grouped in fortnightly intervals and the least squares solution of the system of 142 equations (4) has been obtained.The unknowns are the corrections to the star coordinates and as many azimuth values as the number of selected intervals.

3. RESULTS

The resulting solution for the mean of the azimuths of the marks is displayed in Fig. 1, under the form of monthly means with one standard deviation error bars. With due account to the errors, the points draw a smooth curve with a total amplitude of less than 2" and no evidence of secular trends.

We may draw the conclusion that the marks mean azimuth is very stable and forms a time function that lends itself to useful and safe interpolation to

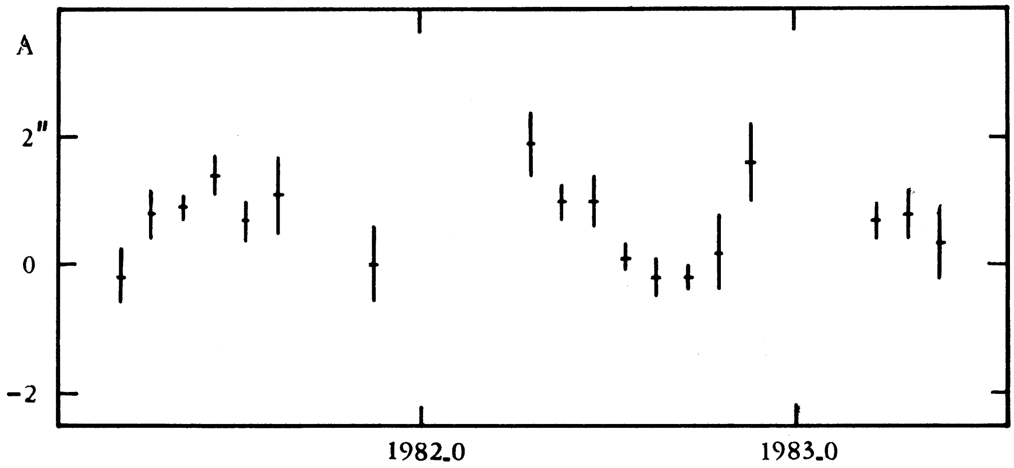

Fig. 1 Monthly means of the marks mean azimuth with one rms error bars.

cover nights with no or few polarissima observations.

The standard deviation for a single azimuth determination turned out to be 0".85. This relatively high value is due to the poor image quality. At 67° zenith distance the seeing usually amounts to several seconds. Also the atmospheric extinction is often severe and more than once the polarissima has been observed at the limiting apparent magnitude.

However, the number of observations permiting, we may have monthly azimuth averages with standard deviation of 0".2 and less.

Finally we may conclude that the low individual accuracy, together with the marks stability, calls for long term solutions. These should be refined to take into account the polar motion and continuity conditions.

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