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INCLINATION DETERMINATION OF THE MICROSCOPE – MICROMETERS OF BELGRADE MERIDIAN CIRCLE

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Abstract. The first inclination determination for the visual microscope-micrometers of the Belgrade Large Meridian Circle shows that for seven, out of eight, microscopes the tangential inclination component is significant.

1. INTRODUCTION

The system of the Belgrade Meridian Circle (BMC) has been regularly examined from the moment this instrument was put to work till nowadays. It has been subjected to several analyses (Erceg 1973, Dačić 1984 and Stančić 1986). According to these papers the BMC system has shown systematic deviations in declination. In order to establish if these systematic deviations are partly due to the microscope inclination and to limb corrugations we started the present determinations in May 1996.

The measurements and the data treatment for the purpose of determining the inclination of the microscope were performed following the procedure proposed by Bozhichkovich (1985). The usual activities involved by the measurements were distributed among the present authors in the following way: microscope reading in position clamp west (CW) - M. Dačić; microscope reading in position clamp east (CE) - Z. Cvetković; covering and uncovering the limb division with glass plates during both series of measurements - Dj. Bozhichkovich. The corrugations of the (Δd) circle were measured by R. Pavlović with the contact micrometer. All necessary measurements were performed in two campaigns with a total duration somewhat shorter than six hours.

2. DATA TREATMENT AND RESULTS

For each microscope the inclination is determined following Bozhichkovich's (1985) formula

$$I = M_g + \frac{d}{\Delta d_g} \frac{n}{n-1} (M - M_g) \tag{1}$$

where I is the microscope inclination (looked for here), M_g averaged reading of three marks (that under the index and the other two on both sides of the index when the limb is covered by a glass plate), M averaged reading of the same three marks when

the limb is not covered by a glass plate, d mean distance of the microscope objective from the limb (for BMC about 282 mm), Δd_g thickness of the applied glass plate (2.86 mm), n refraction index for the applied glass plate (assumed 1.52).

All inclination values obtained by using (1) are presented in Table I. In the first column are given the limb readings for which the measurements were performed. The subscripts W and E correspond to the western and eastern microscope-micrometers, respectively (in both cases four). The nineth row ($\bar{I}$) contains the mean values of the obtained inclinations for all eight microscope-micrometers of BMC. As seen immediately, except II_W (-2'.3) the inclinations of the other microscopes are high (IV_W=-17'.2; II_E=19'.7; III_E=15'.4), i. e. extremely high (I_W=-41'.0; II_W=29'.2; I_E=-27'.7; IV_E=-33'.0). It should be said here that from May 1980 on the microscopes have not been subjected to radical interventions. Then the four CE microscopes were mounted since they had been previously lent for a few months to the Belgrade Vertical Circle (BVC) of our Observatory for the purpose of examining its limb division. The CW microscopes were mounted for the last time in July 1977 after finishing the limb-division examination on BMC.

TABLE I

The Results of Inclination Determination for 8 Microscope-Micrometers of BMC

limb	I_W	II_W	III_W	IV_W	I_E	II_E	III_E	IV_E	ΔI	$\varepsilon_{\Delta I}$
13°50′	−38'.9	−1'.9	32'.6	−5'.5	−27'.2	21'.5	18'.8	−27'.8	3'.6	±1'.3
58 50	−41.5	−4.3	36.8	−19.8	−26.7	15.8	14.5	−34.4	−0.3	±1.3
103 50	−45.5	−3.4	23.6	−16.9	−29.1	18.8	10.9	−33.0	−2.2	±0.8
148 50	−38.4	4.5	34.2	−19.3	−31.7	20.6	18.6	−32.0	1.7	±1.3
193 50	−39.9	−1.9	22.8	−20.9	−25.7	21.4	17.7	−33.3	−0.3	±1.1
238 50	−35.4	−7.6	31.7	−16.4	−25.1	20.3	14.9	−36.3	0.4	±1.2
283 50	−46.6	1.3	20.3	−16.6	−29.7	20.1	14.3	−30.4	−1.3	±1.5
328 50	−42.0	−5.3	31.2	−22.0	−26.7	19.3	13.3	−37.1	−1.5	±0.9
$\bar{I}$	−41.0	−2.3	29.2	−17.2	−27.7	19.7	15.4	−33.0		±1.2
$\varepsilon_{\bar{I}}$	±1.3	±1.3	±2.1	±1.8	±0.8	±0.7	±1.0	±1.1	±1.4	±3.3

In Fig. 1 we present the differences between the measured and mean inclinations for all microscopes depending on the circle position for which they are determined. The averaged values of these differences (ΔI) according to the positions for all microscopes are given in the tenth column of Table I. From Table I and Fig. 1 it is evident that in some circle positions, in the case of all microscopes, on the average are obtained slightly higher or slightly lower inclination values.

$\varepsilon_{\bar{I}}$ in the tenth row denotes the errors of the inclination-mean-values, whereas $\varepsilon_{\Delta I}$ in the eleventh column denotes the errors of the mean inclination differences. At the end of the tenth row we give the mean error of a single inclination determination by means of the applied method which in the present examination is ±3'.3. As we see, all the mean inclination values are reliably determined.

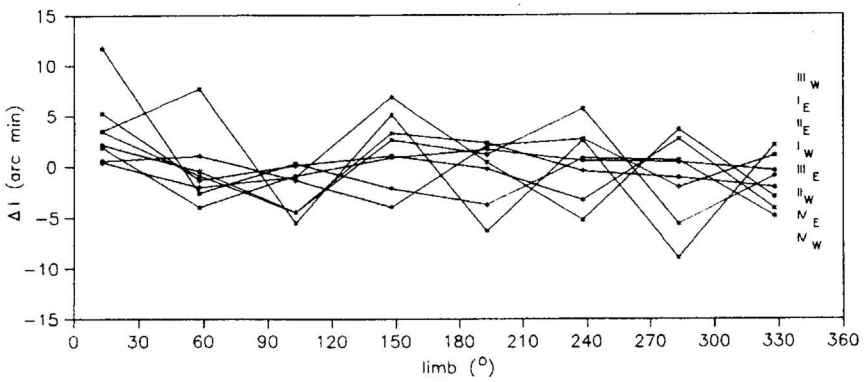

Fig. 1. Inclination deviation from the mean value for each microscope.

3. SYSTEMATIC CORRECTIONS ΔM

As said in the introduction, this time the variations (Δd) of the mean limb distance (d) from the microscope of BMC objective are also determined by using a contact micrometer. The obtained values are presented in Fig. 2. From this Figure is seen that the obtained values are relatively small and that they are within the limits of ± 0.080 mm. It is also seen that the deviations due to the lack of perpendicularity between the circle and the BMC horizontal axis, on which the circle is mounted, are of the same order of magnitude as the corrugations most likely due to the curving of the circle because of paok acting.

In order to present the amounts of the corrections in the mean circle readings obtained with four microscopes situated in such a way and with respect to the circle corrugations found above (Δd), one should apply the expression given by Podobed (1968)

$$\Delta M = \frac{\Delta d}{d}\,(M - I) \tag{2}$$

$\Delta M = M_o - M$; where M_o is the unknown true reading corresponding to the mean limb position, M is the particular reading of the micrometer requiring to be corrected, Δd is the deviation of the measured limb part from the mean position (particular values presented in Fig. 2) and I is the microscope-micrometer inclination whose value is determined following (1).

The corrections of the mean reading reduced to the first microscope and obtained for the CW (curve W), for the case of CE (curve E) are presented in Fig. 2. As seen, the most significant corrections are required in the zenithal zone for both positions of the instrument. It should be noted that in the case of BMC the reading of the circle under the first microscope in the zenithal zone is about 145^o. Since these corrections are significantly symmetric with respect to the zenith for both CW and CE, it seems that to them is due a significant part of the so-called vertical flexure component ($a \cos z$) found in the treatment of the Küstner series in all the three papers cited above whose subject is the BMC system.

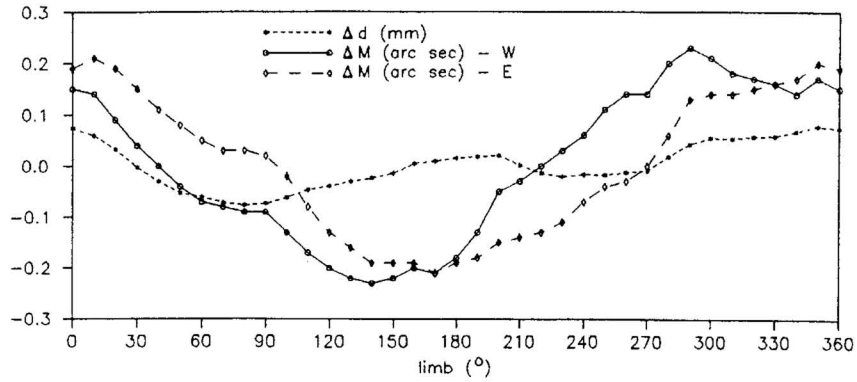

Fig. 2. Variations Δd and ΔM as function of the limb graduation (W – western microscopes, E – eastern ones).

Bearing in mind that with BMC the declinations are determined by applying the differential method and that the observations are performed largely within narrow zones (20^o do 30^o), these, relatively large, deviations have almost no effect on the calculated declinations (up to $\pm 0''.05$).

4. CONCLUSION

As a conclusion a recommendation seems approprate that before eventual beginning of a new observational cycle with instrument in the present condition (not modernised) the determinations of the microscope inclination should be repeated and only then to start their rectification.

According to the preliminary results of this examination the existing circle is of satisfactory quality and, it may remain also after the mounting of the modern circle-reading equipment.

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