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SYSTEMATIC DEVIATIONS OF FUNDAMENTAL STAR DECLINATIONS OBTAINED WITH THE BELGRADE VERTICAL CIRCLE

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SUMMARY: A short review of systematic differences of star declinations obtained on the Belgrade Vertical Circle using the absolute method is given. These results reduced to equator are compared with their analogues from five well known vertical circles of clasic construction.

1. INTRODUCTION

The author made visual observations of 212 FK4 stars during 1983, '84 and '85, by the absolute method. The stars are from the declination zone $-30°$, $+90°$. All stars with $\delta > +59°$ (52 in all) were observed at the lower transit. During 113 nights, 2143 stars observations and 157 series of measurements of the horizontal component of flexure were made. The values of the flexure of the Belgrade Vertical Circle (BVC) obtained in this period were small, but stable, practically temperature indepedent. Its mean value $\Sigma b_c/157$ was $0''.20 \pm 0''.34/\sqrt{157}$. The zenith distances ($Z$) were corrected by the quantity $-b_c \sin Z$, obtained on the same day (evening).

Analyzing the preliminary results (Bozhichkovich 1991), for the random error of a single observation, the value of $\varepsilon_\delta^2 = (0''.38)^2 + (0''.18 \tan Z)^2$ is obtained. In the mentioned examination a significant presence of residual flexure ($-0''.86 \sin Z$ when the flexure obtained with collimators for individual night is applied and $-0''.69 \sin Z$ when the flexure is not applied) has been stated by making comparison with FK4 positions. In addition it was shown that the flexure was very dependent on measured temperature – t_{ij} ($\Delta b = 0''.043/°C$ and $0''.037/°C$ respectively, as above).

This made the author try to obtain the temperature coefficient (Δb) of residual flexure from the differences $\Delta\delta_{ij}$ of observed and mean values of declination [$\Delta\delta_{ij} = \delta_{ij} - \delta_j$; $j = 1, .., 264 (= 212+52)$; $i = 1, .., n_j$ (n_j – the number of observations of the same star running from 2 to 34)]. By using the least squares method, besides some, for this analysis less important corrections, even somewhat greater values for temperature coefficient of residual flexure [$(0''.057 \pm 0''.0028)/°$C and $(0''.054 \pm 0''.0026)/°$C for both cases indicated above] are obtained. By applying the correction $\Delta\delta_t = (-0''.054/°\text{C})(t_{ij} - 12.5°\text{C}) \sin Z_j$ to the measured declinations not only the seasonal variation is practically eliminated in the obtained declinations but the internal accuracy of the individual observations is noteceable increased [$\varepsilon_\delta^2 = (0''.34)^2 + (0''.18 \tan Z)^2$]. More details of this problem are given in Bozhichkovich and Pavlović (1996).

2. PROCEDURE AND RESULTS

By applying the Bessel formal method of absolutization of the obtained observatios at the BVC from 52 differences of mean values of star declinations observed at upper and lower culminations a correction $+0''.08 \pm 0''.09$ to the mean applied latitude ($\varphi = 44°48'08'' + \Delta\varphi_{BIH}$; $\Delta\varphi_{BIH}$ – the mean-latitude corrections given by the Bureau International de L'Heure) is obtained. The correction $(-0''.21 \pm 0''.07) \tan Z$ to applied refraction tables (Pulkovo Tables V) is also obtained. When the measured flexure is applied the correctons $\Delta\delta_{\Delta\varphi,\Delta\rho}$ are $(0''.17 \pm 0''.10) - (0''.20 \pm 0''.07) \tan Z$.

If we compare such corrected mean values of measured declinations with the positions from FK4 one obtains by the least squares method

$$\pm(\delta_{BVC} - \delta_{FK4})_j = (0\,''.\,49 \pm 0\,''.\,02) - (0\,''.\,58 \pm 0\,''.\,07)\sin Z_j - (0\,''.\,08 \pm 0\,''.\,03)\tan Z_j\ ;$$
$$\varepsilon_j = \pm 0\,''.\,27.$$

For the case when corrections for measured flexure are applied it is

$$\pm(\delta_{BVC} - \delta_{FK4})_j = (0\,''.\,58 \pm 0\,''.\,02) - (0\,''.\,74 \pm 0\,''.\,07)\sin Z_j - (0\,''.\,08 \pm 0\,''.\,03)\tan Z_j\ ;$$
$$\varepsilon_j = \pm 0\,''.\,28.$$

For stars south of zenith, zenith distance (Z_j) is negative and for the lower culminations left-hand side of above relations is taken with the sign minus. As it can be seen the error of the obtained latitude is proportional to the value of residual flexure. With the above values it turns out that declinations determined with the Belgrade VC reduced to the equator need a correction of $-1''.0$ in the first case and $-1''.2$ in the second case, while about the pole in both cases it is zero.

Table I is in fact a reproduction of the table given by Zverev (1950) with added values resulting from the BVC corrected by $-0''.1$ required by the transition from FK4 to NFK in the equatorial zone.

Table I Systematic corrections to declinations at the equator obtained by observations with vertcal circles

Observatory	VC	Observer	$\Delta\delta_\delta$	Obs. year
Pulkovo	Ertel 6″	Dneprovski	$0''.0$	1919-1925
Berlin–Babelsberg	Wanschafft 7″	Courvoisier	−0.5	1916-1927
Wroclaw	Repsold 6″	Wilkins	−1.1	1922-1925
Nikolayev	Repsold 4″	Cimmerman	−1.4	1925-1927
Munich	Askania 7″	Rabe	−1.6	1927-1930
Belgrade	Askania 7″	Bozhichkovich	−1.1	1983-1985

3. CONCLUSION

As it appears from Table I, the puzzle called "residual flexure" is present, even after seventy years, in the observations made with the Belgrade Vertical Circle too. Apart from the exception of the first Struve-Ertel vertical circle in Pulkovo, there exist with all other vertical circles systematic deviations in the declinations, reduced to equator, all of them being of the same order of magnitude.

In view of the possibilities of the present-day computing technique it might be expected that, through a critical revission of both old and more recent observations and of the applied processing, a final clearance of this problem might be achieved. It is thereby anticipated that great expectations from the new observing techniques have left some room for old and new results furnished by the classic unmodernized and modernized instruments.

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СИСТЕМАЦКЕ ГРЕШКЕ ДЕКЛИНАЦИЈА ФУНДАМЕНТАЛНИХ ЗВЕЗДА ДОБИЈЕНИХ БЕОГРАДСКИМ ВЕРТИКАЛНИМ КРУГОМ

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У овом кратком раду се разматрају систематска одступања у деклинацијама фундаменталних звезда добијених из посматрања Београдским вертикалним кругом. Резултати, свedени на екватор, се пореде са слично добијеним на познатих пет вертикалних кругова класичне конструкције.