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THE EFFECT OF STAR POSITION ERRORS ON DETERMINATION OF PLUMB-LINE DEVIATIONS

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The determinations practisized in Geodetic Astronomy, i.e. the determination of astronomical time, the direction of the plumb-line (natural coordinates) and of astronomical azimuth of the geodetic sides, are performed with high precision instruments, making for the results obtained to be highly precise as well. However, the results of the contemporary determinations show discrepancy between the precision and the accuracy (internal and external accuracy). One of the origins of this discrepancy is presented by the considerable systematic and random errors in the position of stars used in these determinations.

In order to answer the question as to the origin of discrepancy referred to above, it is necessary to analyse the methods employed in the Geodetic Astronomy from the aspect of star position errors participation in the results of determinations. This because the same position errors produce different effects on the results, depending on the method applied and the star position in the horizon system. On the other hand, it is necessary to evaluate the systematic and random errors in the position of stars used in the determination.

Moreover, the geodetic-astronomical determinations have been carried out over a long period, hence the necessity the star coordinates to be referred to a unique system in order to secure their successful use. Here, as the basic system has been taken that of FK5, the relations of systems of other catalogues in the FK series with respect to the FK5 having subsequently been investigated.

The primary goal of the present analysis was the adoption of a model for referring the star positions as given in different catalogues used to a unique system, i.e. to the FK5 system, as well as the accuracy estimate of their positions referred to this system. By proceeding in this way a more reliable foundation is provided for researches needed in geodesy, geophysics and geodynamics. As a matter of course, according to the model here presented, referring to any other system is possible, consequently to that of the ICRS as well (International Celestial Reference System), in force as from January 1st, 1998.

From the data given in the FK3, FK4 and FK5 catalogues tables were calculated allowing the referring of NFK to the FK5 system for the epoch 1906.0 . This is the

mean epoch of Bošković's astro-geodetic determinations from which he obtained the deviations of the plumb-line at 30 points throughout the then Kingdom of Serbia. Otherwise, one of the tasks being solved in this paper, is the referring of Bošković's determinations of deviations of the plumb-line to the basic FK5 system.

It is to be particularly indicated that the systematic differences in right ascensions are mainly a consequence of the error in the Newcomb's vernal equinox point (correction to it is about $-0^s.050$), entered into NFK catalogue. The systematic differences in declination arise in the main from the difference FK3 – NFK for the given epoch, having a positive sign, not exceeding the amount of $+0''.20$. As to the average systematic errors in the positions of Auwers's stars (stars in NFK; their FK5 numbering is 1 to 925), they are five to six times less in FK5 than in the NFK catalogue. The calculated tables served for estimating the effect of the star position errors on the astro-geodetic determination.

Zinger's method of clock correction determination, Pevcev's method of latitude determination and the method of azimuth determination from the Pole-Star observations as classical methods of geodetic astronomy, are considered in great detail and the most convenient observing conditions suggested. A mathematical and sohastic model was conceived for the calculation of the effect of star coordinates errors on the results of these determinations.

For each one of the methods mentioned above a specific model was derived for calculating a priori the weight unit error depending on registering precision of the time of star observation. Calculated also were a priori errors of the results of determination in the fictitious pairs, representing the Bošković's observations and conclusion advanced for establishing particular effects of the random and systematic errors on the results of determination.

The derived model was applied to the Bošković's determinations of deviations of the plumb-line in Serbia and obtained final results of referring them to the FK5 system. Special review is given concerning the precision of time registering involved in Bošković's latitude determinations. The concrete application of the model reveals, that the results of transfering of Bošković's astro-geodetic determinations (at the begining of the present century) from the NFK system into the FK5 system, with the corrections introduced, did not essentially change the amount of the plumb-line deviations by astro-geodetic method which is being intensely used for geoid determination.

In addition, it has been established that in the fundamental catalogues of the FK series there are sufficient data for calculating the errors in the star positions to be referred to the chosen epoch. The accordance of a priory errors and of a posteriory errors in determination of time (Zinger's method), of latitude (Pevcev's method) and of azimuth (from Pole-Star observations) demonstrate as possible the advance estimates of the effects of errors in the star positions on the determinations dealt with here. Likewise, the conclusion that the precision of time registering in Bošković's astro-geodetic determinations, with regard to the technical level of the time, was very high, represents one of the results of the present analysis.