

## DIGITIZATION OF THE BELGRADE ASTRONOMICAL OBSERVATORY'S VERTICAL CIRCLE OBSERVATIONAL HERITAGE

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**SUMMARY:** The aim of the paper is to present the digitization of the results of last observations of bright stars made by the Belgrade vertical circle ASKANIA N°80118 ( $D = 190$  mm,  $f = 2578$  mm) at the Astronomical Observatory of Belgrade. The observations are mainly made by Djuro Bozhichkovich in the period between 1982 and 1985. All of the found observational data and intermediary results are referenced and presented and some research possibilities are suggested.

**Key words.** Astrometry – Astronomical data bases: miscellaneous

### 1. INTRODUCTION

After detailed reconstruction of the Belgrade Vertical Circle (BVC) ASKANIA ( $D = 190$  mm,  $f = 2578$  mm) performed at the Astronomical Observatory of Belgrade (AOB) in the mid-1970s (Usanov et al. 1978), the first catalogue of declinations of 307 bright stars observed by the absolute method with the BVC – Belgrade Catalogue of Absolute Declinations (BCAD) from 1976 to 1980 in the zone  $+65^\circ - +90^\circ$  for the equinoxes B1950.0 and J2000.0, has been obtained (Mijatov et al. 1991). In order to open some specific possibilities via reduction of observation results, Djuro Bozhichkovich has prepared and organized his own observational programme for 213 FK4–FK5 bright stars in the declination zone  $\delta \subset (-30^\circ - +90^\circ)$ .

Bozhichkovich's basic idea was to resolve some existing problems by intensifying observations of 213 (212) stars with declinations in the zone  $-30^\circ, +90^\circ$ ,

out of which 52 are also observed in the lower culmination. Furthermore, Bozhichkovich carried out regular observations of solar system's outer planets, especially Mars, Jupiter, Saturn, Uranus and Neptune, and reduced their positions via the nearest bright stars. That way, not only absolute declinations were determined, but also the possibility to generate referenced star catalogue was opened as a base for relative star coordinate determination in future and possibility to research and estimate the variability of polar motion (the local latitude variation). For the general description of these possibilities, please see Smart 1977.

The astronomical data that are the subject of digitization is still belong to Mr Djuro Bozhichkovich. With Mr. Bozhichkovich we have an agreement to publish these data which could then be accessed for their further processing (not only by us).

Because of that, at this stage the paper represents a preliminary report, covering only the informational part of the work and stays half-way to the final astronomical goal. Therefore, we plan to con-

tinue the work further and use the recovered data to construct a catalog of declinations of all observed astronomical objects for the period 1982-1985.

## 2. THE MOTIVATIONS AND ACTIVITIES

The basic idea of creating a new observational list of 213 FK4(FK5) bright stars at all declinations accessible by BVC, i.e. extended to  $\delta = (-30^\circ, +90^\circ)$ , out of which 52 stars are observed in the lower culmination, as well as regular daily observations of Mars, Jupiter and Saturn in the vicinity of the brightest stars, is to allow the creation of a catalogue of stars which can be used for relative observations and determinations of declinations, as well as for simulation of the so-called Küstner's series of stars to determine the possible latitude variation, provided all the instrumental constants and terms are successfully resolved or determined, and a good refraction and aberration correction were applied.

To this day, the final processing of the observational results was not completed and it is partially done (Bozhichkovich 1984, 1986, 1996, 1997, Bozhichkovich and Pavlović 1996, Trajkovska 1986, 1988, Jovanović and Bozhichkovich 1987). For example, Bozhichkovich had used the Sinclair Spectrum Basic Interpreter and recorded all the data to audio cassettes in ZX Spectrum computer, but later "forgot" about them. Fortunately, as it is in a case of any astronomical observation, this data has raised interest later, during the creation of the modern astronomical catalogues in the 1990s. However, because of the non-standard format, these records were practically inaccessible. After the permission granted by Mr. Bozhichkovich, and some suggestions by Dr Jan Vondrak, the authors of the paper decided to digitize the above mentioned data by following the well known principle of observational practice and science that the progress can be achieved and realized as "gradus ad parnassum". The idea was to make the mentioned observations digitally recognizable and usable for further analysis and research.

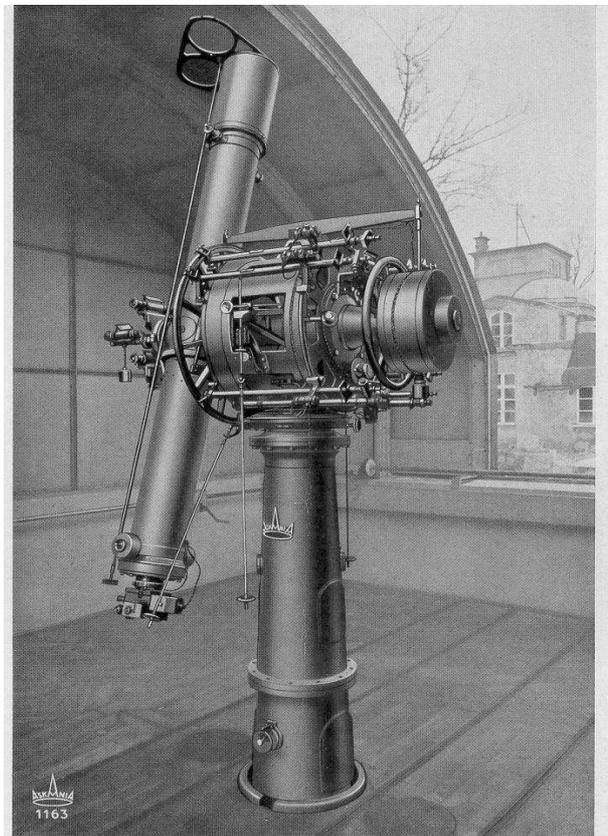
The audio cassettes with the original records were obtained from Mr. Bozhichkovich. All the records, in spite of the poor storage conditions, were completely preserved. In the first phase of the digitization process, the records from the cassettes were transferred to a PC. After installing the ZX Spectrum emulator on a PC desktop computer (under the WIN7 operating system), all the transferred records were read and the contents saved in the Z80 format on the PC. One can find this data in RECORDS folder at the address <http://www.mi.sanu.ac.rs/~msegan/SAJ/records>.

At the same address one can find the SPECTACULATOR, ZX Spectrum emulator for PC, which is possible to download and exploit with recorded files.

In order to be able to compare and control all audio tracks, at first we had to obtain the original observational notebooks. It took some time due to a communication problem and the archival description of the data itself. Thanks to the efforts of Bozhichkovich, observation notebooks were found. Ms Miljana Jovanović, the

AOB associate, managed to scan all Bozhichkovich's BVC observation notebooks from the period 1982-1985. In that way a control basis for the examination and digitization of audio recordings was created. The scanned notebooks are stored in the folder CONTROL, which is available online at: <http://www.mi.sanu.ac.rs/~msegan/SAJ/CONTROL>.

Further, according to the specific instructions of the authors of this article, a group of IT students had created and tested a special program *ZX80 Extractor*. It enables each Z80 file to be converted into a separate ASCII file or more such files, depending on whether the Z80 file consists of a program and/or data. Instructions for using this program are provided by the program itself. Please see README file in the folder Z80EXTRACTOR, which is available online at: <http://www.mi.sanu.ac.rs/~msegan/SAJ/Z80EXTRACTOR>.



### Vertikal - Kreis

Objektiv: Öffnung . . . . . 190 mm  
Brennweite . . . . . 2578 mm

Vertikalkreis: 800 mm Durchmesser, 2' Teilung, Ablesung durch 4 Mikroskope auf 0'.1 • Horizontalkreis: 380 mm Durchmesser, 10' Teilung, Ablesung durch 2 Mikroskope auf 1" • 2 Horrebow-Niveaus mit 1' Teilung.

Zuletzt geliefert für die Sternwarten München, Babelsberg u. Belgrad.

**Fig. 1.** The photo of BVC before delivery to Belgrade (Source: Catalogue - Askania-Werke AG, Astronomical Instruments, Berlin-Friedenau 1935, p. 11, private library of authors).

The current challenge is the systematization of observational material and its alignment and labeling in accordance with the content of the observational notebooks. Unfortunately, the data in BASIC routines do not provide enough information about it. This part of the work is partly done but only as a trial program. The result is presented as a sample in the folder SAMPLE, which is available at: <http://www.mi.sanu.ac.rs/~msegan/SAJ/SAMPLE>.

For the control of the previous program modules and their results, special executable program routines are given. They are originally written in the FORTRAN77 code for calculation of apparent positions of stars and planets according to the IAU 1976 recommendations and MERIT standards (that are valid at the observational interval of interest), which are almost identical to the later identified VSOP87 standard. This source code can be delivered on request, and programs and databases are located in the FORTRAN folder, which is available at: <http://www.mi.sanu.ac.rs/~msegan/SAJ/FORTRAN>. The folder contains the FK5 catalogue where positions of the stars and their proper motions for the corresponding epoch J2000.0 are given. Also, the base of the solar system bodies rectangular JPL heliocentric coordinates for the interval 1960-2001 is attached (as direct access files).

### 3. CONCLUSION

By the look at the characteristics of modern catalogues, one can see that they are very precise. However, their main quality problem is the accuracy of the proper motions of most of their stars due to a very short observational interval. It is clear that this problem can be partly overcome by improving the internal accuracy of contemporary catalogues. The best way to do that is by comparing their star positions with the positions obtained by different astronomical instruments, no matter how few of them, if the accuracy is satisfactory.

In this sense, the system of 213 (212) stars of the BVC catalogue of declination should be gen-

erated firstly, and then the stability of the system checked, as well as its usability for determining the proper motion of stars, especially of the stars that are common with the previous BVC catalogue of 307 stars (Mijatov et al. 1991).

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**ДИГИТАЛИЗАЦИЈА НАСЛЕЂЕНИХ ПОСМАТРАЊА НА ВЕРТИКАЛНОМ  
КРУГУ АСТРОНОМСКЕ ОПСЕРВАТОРИЈЕ У БЕОГРАДУ**

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*Стручни чланак*

У овом раду бавили смо се прикупљањем и класификацијом посматрачког материјала добијеног из посматрања која је у периоду 1982-1985. на вертикалном кругу АСКА-НИА N°80118 ( $D = 190$  mm,  $f = 2578$  mm) Ас-

трономске опсерваторије у Београду, обавио Ђуро Божичковић. Сви подаци су наведени и смештени у одговарајуће базе. Предложене су и неке процедуре и могућности истраживања.