Automatic 60 cm Telescope of the Belogradchik Observatory – First Results

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Abstract

The Belogradchik Observatory of the Bulgarian Academy of Sciences is situated in the west part of Balkan mountain at 630 m altitude above the sea level. The observatory is equipped with a CARL-ZEISS 60 cm Cassegrain reflector. An one-channel photon-counting photometer with EMI 9789 QB photomultiplier is attached to the telescope.
The automatic system using IBM-PC/XT computer and synchronized moving of the dome has been recently built. The automation of the telescope includes: R.A. and D. positioning system up to 6 stellar objects in a field of 6 degrees with accuracy of 5 arcsec each, and automatic moving of the filters; A system for time synchronization based on the Russian RADIO/TV standard with accuracy 0.1 sec; An interface to the computer used for collecting and photometric data storing; A specially created software package "Automatic Photoelectric Reduction" (APR), written in Turbo-Pascal 5.0 for PC/MS-DOS 5.0 system. This software package contains programmes for data reduction in the standard UBV system and visualization of the light curves.
Two types of observations are usually run: estimate of the photoelectric magnitudes of the stellar objects and patrol observations. As far as the minimal possible integration time is 0.1 sec and the maximal one is not limited, the automatic 60 cm telescope of the Belogradchik Observatory is suitable for observations of stellar objects, asteroides, galaxies and for searching and detecting of very rapid brightness variations.

1. INTRODUCTION

The Belogradchik Observatory together with the Rozhen Observatory are both observational stations of the Department of Astronomy, Bulgarian Academy of Sciences. It is situated in the west part of Balkan Mountain, 180 km from Sofia, near the wide-known stone phenomena to the small town of Belogradchik. The coordinates of the observatory are: E. Long.: $+22^o40.1'$; Lat.: $+43^o37.6'$. The altitude above the sea level is 630 m. There are approximately 180 clear nights per year there.
The observatory is equipped with a CARL-ZEISS 60 cm Cassegrain reflector with equivalent focal length 7.5 m. The one-channel photon-counting photometer with

EMI 9789 QB photomultiplier, attached to the telescope and a set of 6 diaphragms (from 13.8 arcsec = 0.5 mm to 137.5 arcsec = 5 mm) were built at the workshop of the Department of Astronomy in Sofia. The UBV and uvby photometric systems are realized. The respective filters are mounted in a common wheel. The uvby system and the respective software are described in Kalcheva et al.(1991).
Recently an automatic system, using IBM-PC/XT computer and synchronized moving of the dome have been built. The system is shown in Fig.1.

Fig. 1. Automatic 60-cm teleskope

The automatic system includes: R.A. and D. positioning system, system for time synchronization, an interface to the computer for collecting and data storing and the software package "Automatic Photoelectric Reduction" (APR) for data proceeding.

2. R. A. AND D. POSITIONING SYSTEM

The system consists of step motors, a special interface with R.A. and D. control and automatic moving of the filters. The software is written for IBM-PC/XT/AT computers in CI 5.0. More detail description of the system is given in Staikov et al.(1992). The system allows positioning up to 6 stellar objects in a field of 6 degrees with accuracy of 5 arcsec. There are two possibilities to run the system: from a control panel of the telescope or from the control room, using the keyboard of the computer.

3. TIME SYNCHRONIZATION SYSTEM

The computer clock for measuring the time is used. In the beginning of 1992 a special system for time correction is built. The system is based on the Russian RADIO/TV 14 MHz standard with accuracy of 0.1 sec. Every minute the corrections of the clock are made.

4. INTERFACE TO THE COMPUTER, USED FOR COLLECTING AND PHOTOMETRIC DATA STORING

The interface includes hardware, entrance attenuator, amplifier-discriminator, photon counter, registers and decodators and a dialog-control software, written in CI 5.0 for IBM-PC/XT/AT computers (Staikov et al.,1992).
The minimal integration time is 0.1 sec, the maximal one is not limited. The amount of measurements is not limited too. It depends on the storage capa city of the hard disk only. In our case it is 20 MB.
During the monitoring all the data up to 640 points are displayed on the monitor in real time. There is the possibility to write every data on the hard disk during the measurement.
The software produces files, containing information about the number of every measurement, U.T., the filter used, the value of every measurement, and short indication what kind of object is measured (variable star, comparison star, background etc.).
Two types of observations are usually run: estimates of the stellar magnitude and monitoring (patrol observations).

5. SOFTWARE PACKAGE "AUTOMATIC PHOTOELECTRIC REDUCTION" (APR)

This specially created package, written in Turbo-Pascal 5.0 for PC/MS- DOS 5.0 system contains programmes for data reduction to the standard UBV photometric system and visualization of the light curves in the instrumental system (Kirov et al.,1991). The method of differential photometry has been applied. The reduction equations used are (Hardie, 1962 and Jerzykevicz, 1966):

$$\begin{aligned}
\Delta V &= \Delta v - k_v.\Delta X + \varepsilon.\Delta(B-V) \\
\Delta(B-V) &= \mu.\Delta(b-v) - \mu.k'_{bv}.\Delta X - \mu.k''_{bv}.\Delta(b-v).\overline{X} \\
\Delta(U-B) &= \psi.\Delta(u-b) - \psi.k'_{ub}.\Delta X - \psi.k''_{ub}.\Delta(u-b).\overline{X}.
\end{aligned}$$

Here Δ is the difference between the variable and comparison star values. C is the average mass for two stars. X is the air mass for a star. kv, k'_{bv} and k'_{ub} are the first-order extinction coefficients, and k''_{bv} and k''_{ub} are the second-order extinction coefficients. ε , μ and ψ are the transformation coefficients from the instrumental to the standard UBV system. In 1992 the mentioned above coefficients have the following values:

$$\varepsilon = -0.093; \quad \mu = \quad 1.166; \quad \psi = \quad 0.945; \quad k''_{bv} = \quad 0.04; \quad k''_{ub} = \quad 0.08.$$

There are four possibilities for approximation: mean value; nearest time point value; linear approximation; parabolic approximation.
Some statistic characteristics (mean value and dispersion) can be calculated and displayed numerically and graphically too.

6. FIRST OBSERVATIONS

The automatic 60 cm telescope at the Belogradchik Observatory is suitable for searching and detecting of very rapid brightness variations and for observations of stellar objects, asteroids and galaxies up to V = 13.5 mag.
A programme for investigation of the fast flare events (few second duration) has been started at Department of Astronomy, Bulgarian Academy of Sciences since 1990. In Fig. 2 a flare of AD Leo (Antov et al., 1991), using the 60 cm telescope at the Belogradchik Observatory is shown.

Fig. 2 Flare of AD Leo

It was observed during the regional simultaneous observations, using also the 60 cm telescope at the Rozhen Observatory on 2/3 February 1990. The both telescopes are identical ones, except the automation. The distance between them is 270 km. Another fast flare of the flare star V1285 Aql is shown in Konstantinova-Antova et al.(1992). The collaborative programmes for further investigation of the fast flares are desirable in order to clarify their nature. Another intriguing problem are the flare-like events, detected on some evolved stars out the Main Sequence (Pettersen B.R., 1989). We have started a programme for investigation of these events,using the Belogradchik telescope and the 60 cm and 2 m telescopes at Rozhen since 1991. We began observations of the red giants stars V654 Her and IU Ori unknown to be in multiple systems. In the course of monitoring we found a star, use d as check star of V654 Her to flare. The flares are shown in Fig. 3.

Fig. 3 Flare of V654 Her

The star is unknown to be variable until now, and its UBV colours are close to the late K giants. In this problem simultaneous observations and collaborative programmes are desirable too. Another programme at the Belogradchik Observatory is investigation of the flickering of some cataclysmic and symbiotic variables including KR Aur, TT Ari, MWC560 etc. Some photoelectric observations of the star MWC 560 are shown in Tomov et al.(1990).

7. PLANS FOR THE FUTURE

The automatic 60 cm telescope is the first step on the way to the robotic telescope at the Belogradchik Observatory.
An guide CCD, R.A. and D. system for automatic moving to the object from park position, and a modem with connection to e-mail are necessary for the future. In the next years a CCD for photometry and a two-channel electrophotometer are desirable. Equipped in this way the Observatory might participate in the European set of robotic telescopes, to take part in international monitoring programmes for robotic telescopes, simultaneous observations and collaborative programmes. The authors will be very thankful for every remark and advice for further building of the automatic telescope.

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