Publ. Astron. Obs. Belgrade No. 98 (2018), 233 - 239 *Progress Report*

THE FIRST YEAR OF THE "MILANKOVIĆ" TELESCOPE

O. VINCE, S. SAMUROVIĆ, R. PAVLOVIĆ, Z. CVETKOVIĆ and G. DJURAŠEVIĆ
Astronomical Observatory, Volgina 7, 11000 Belgrade, Serbia
E–mail: ovince@aob.rs

Abstract. Telescope Milanković is a 1.4m Nasmyth telescope installed at the Astronomical Station Vidojevica (ASV) named after the famous Serbian scientist Milutin Milanković. The telescope was installed in May 2016 and immediately delivered the first astronomical images. The Commisioning period (CP) for the telescope was defined to last one year. In this paper we summarize the telescope status after the CP. We announce the possibility of using our telescopes at ASV and summarize the rules that are defined in the Statute of telescope time allocation.

1. INTRODUCTION

Most of the observational activities on the telescopes at the Astronomical Observatory of Belgrade (AOB) were terminated in 1980's due to severe light pollution in Belgrade. Despite our lasting efforts to move our observational activities to more appropriate place, a new observational site was established only in 2003. It is located on the summit of the mountain Vidojevica (South-East Serbia) and it is named Astronomical Station Vidojevica (ASV). At altitude of about 1150 m, the astro-climate measurements shows excellent conditions for observations (Jovanović et al. 2012). The yearly mean of clear days is 80-100 (Arsenijević, 1981) and the median seeing is 1.2 arcsec. Only a small percentage of nights suffer strong winds when we are not allowed to open the pavilions for observation.

We started observations at ASV with the 60cm Cassagrain telescope, which was purchased from Astro Systeme Austria (ASA) company in 2005. Due to various construction works on the site, it was installed only in 2010. Although we have provided equipment both for astrometric, photometric and spectroscopic measurements, the later was abandoned due to technical difficulties to properly run the spectrograph.

Important turning point at ASV was the installation of 1.4 m telescope in May 2016. The telescope was purchased through the BELISSIMA FP7 project with the support of Ministry of Education, Science and Technological Development of the Republic of Serbia (Samurović, 2016 and Samurović, 2017). Like the 60cm telescope, it was also purchased from ASA company.

In this paper, we provide technical details on Milanković telescope and instruments that are currently used for observations. We specify observational projects that are performed on the telescope. After the Commissioning period (CP) of the telescope, we have formed the Time allocation committee (TAC) whose main task is to evaluate applications for observing time on our telescopes. This new program starts on 1st of January 2018 and we briefly discuss the main elements of the Statute of telescope time allocation.

2. CURRENT STATUS OF THE TELESCOPE MILANKOVIĆ

Telescope Milanković is a Nasmyth telescope with four usable stages, that is, Nasmyth ports. The telescope mount is Alt-Azimuth, with the characteristic of image rotation in the focal plane of the telescope while slewing. The mount is direct drive motor and provides maximal slewing speed of 6 degree/second on the sky. All moving parts of the telescope (Atl-Az rotational axis, secondary mirror for focusing, tertiary mirror, and de-rotators) are equipped with absolute encoders which enables their extremely precise positioning.

The telescope control system (TCS) is entirely placed inside the telescope fork which is an unique feature of the instrument. The telescope is easy to run via ethernet connection by terminal computer. Currently, all software run under the Windows operating system but Linux version will be also possible in the future.

Only two ports (toward the left and right forks of the telescope) are equipped with de-rotators which corrects for image rotation. One of the ports with the de-rotator is additionally equipped with field corrector which provides about half a degree field of view without significant optical aberrations at focal distance of 10.5 m. The other port with de-rotator is free of any additional optics and has 11.2 m focal distance. Ports without de-rotator can be also used for observational projects with short exposure time (e.g. planetary imaging, seeing measurement etc.).

We take an advantage of multiple Nasmyth ports to run various observational programs. One of the ports with de-rotator is equipped with iKonL CCD camera and 9 positions filter wheel from Andor company. The silicone chip resolution is 2048x2048 and provides about 9 square arcmin field of view (FOV) at 10.5 m focal distance. In principle, the only way to take advantage of full 30 arcmin aberration-free FOV is a CCD camera with 14 cm diagonal chip size which is currently a very expensive solution. Nevertheless, we plan to purchase a 0.5x focal reducer which will increase the available FOV to about 17 square arcmin with the available camera.

The second port with de-rotator is currently equipped with a portable fibre-feed low resolution spectrograph SpectraPro 2750 from Princeton Instruments company. It has a rotating turret with three gratings of 300, 600 and 1200 grooves per millimeter providing 44, 22, and 10 $\AA$/mm spectral resolution. The CCD camera with 1024 pixels in the dispersion direction and 26 μm in pixel size provide spectral coverage of about 1120, 560 and 250 $\AA$ in the tree grating mode. Due to tracking errors of the telescope, the maximal exposure time for a single shot is limited to about 5 minutes, which is sufficient for detection of about 8 magnitude stars (in V band) with a relatively good signal to noise ratio.

We also procured the iXon897 EMCCD camera from Andor company. With fast readout (56 fps) it will be used for speckle imaging but other observational programs are also feasible. We plan to attach it to the telescope port along with our portable spectrograph.

Figure 1 illustrates the current instrumental setup of the Milanković telescope. Although the instruments have already been provided, not all of them are attached to telescope due to some technical difficulties at this moment. For instance, we still seek

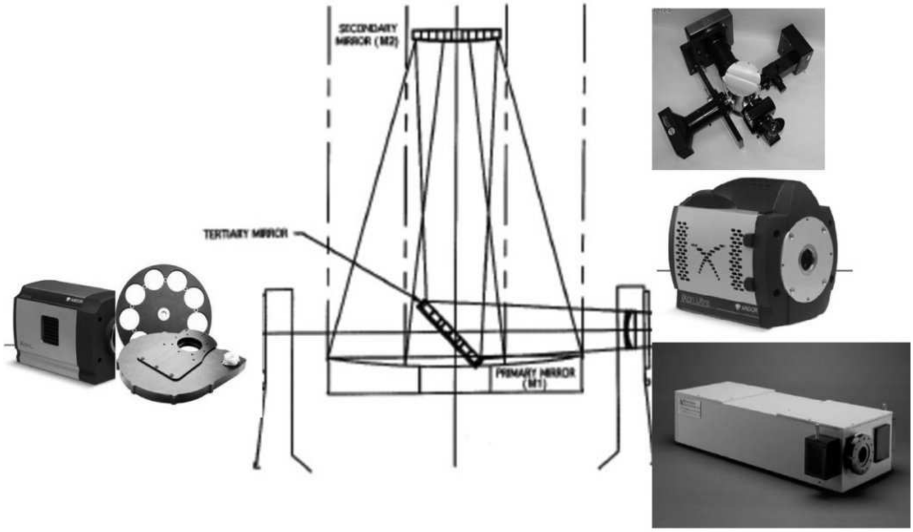

Figure 1: Current instrumental setup of the 1.4m telescope.

for solution on how to attach iXon897 camera on telescope along with the portable spectrograph. One proposed solution is shown by the most upper picture on the right which is an OPTEC Pegasus instrument selector that enables to attach 4 instruments in to the telescope at the same time.

Milanković telescope is currently installed in the roll-roof pavilion but it will be mounted in the pavilion with a rotating dome in the first half of 2018. While the construction works are carried out by Serbian company, the dome is purchased by Italian company Gambato. The pavilion and the telescope will be suitable for automatisation (or robotization) which is the ultimate goal for this telescope.

3. COMMISSIONING PERIOD OF THE TELESCOPE

After installation of the Milanković telescope in May 2016 we started with the CP that was defined to last one year. First several days of the CP were used to calibrate the telescope (mirrors collimation and making pointing model). It was followed by training, that is, learning how to handle the telescope. The rest of the CP was used for regular observational programs within AOB projects that were performed earlier on the 60cm telescope. No major issues with the telescopes mechanics and electronics were noted.

Figure 2 shows the first images taken with the telescope. The image is a combination of images made in B, V and R standard Johnson filters. At the time the images were taken, the seeing was exceptionally good with 0.7 arcsec measured on focused stellar images.

Figure 2: The first light images taken with the 1.4m telescope.

4. OBSERVATIONAL PROJECTS

Currently, we have ten observational projects that are performed systematically with the 60cm and the 1.4m telescopes at ASV. They can be summarized as follows:

1. Study of eclipsing binary stars. The project uses observations and performs modeling of the light curves of close binary stars with the aim to determine orbital elements and some fundamental parameters of stellar components and inter-binary and circum-binary gas components. These models are based on Roche geometry and incorporate a number of orbital and physical parameters of binaries. For more details see for example Djurašević et al. (2013).

2. Study of visual double and multiple stars. This project is aimed at determining the orbital elements of binary/multiple stars by measuring the position angles together with the angular separations between components. Generally, double/multiple stars with separations between 1.8 and 10 arcsec are observed but with new iXon897 fast-readout CCD camera the lower limit will be pushed below 1". For more details see Pavlović et al. (2018).

3. Gaia photometric follow-up program. There are several Science Alerts Working Groups within Gaia project aimed at real-time detection of variable sources. We joined the Photometric Follow-up Science Alerts Group in 2013. The main goal of this group is to make photometric observations of alerted targets with the aim to characterize and study the source. More details about the project can be found in Damljanović, Vince & Boeva (2014).

4. Whole Earth Blazars Telescope (WEBT) follow-up progaram. The project involves a large number of telescopes all around the globe with the aim to monitor a list of 28 blazars. We joined WEBT in 2013. These objects are highly variable in

all spectral domains and in high activity state, when they may change in brightness by several magnitudes in optical within several days, alert is triggered for intensive observations with all kind of telescopes from radio to gamma ray. More details about the project can be found in Vince & Damljanović (2014).

5. Study of asteroids. The project is aimed at photometric investigations of asteroids which allows to determine very important rotation and physical characteristics which are crucial for understanding of the conditions during the creation of our planetary system. For more details see Hanush (2011).

6. Study of cataclismic variable (CV) stars. CVs are studied by simultaneous observations (using the Bulgarian-Serbian telescopes or just Bulgarian Belogradchik-Rozhen ones) to determine and to make analysis of color changes, flickering amplitude and some other properties of the fast variations in the light curve in different states of cataclysmic objects. For more details see Boeva et al. (2011).

7. Study of galaxy formation and evolution. The project is using our telescopes to detect dwarfs galaxies and tidal streams of nearby spiral galaxies with the aim to study galaxy formation and evolution. More detail can be found in Javanmardi et al. (2016).

Three projects are part of PhD and MSc thesis and they are also performed systematically with our telescopes:

1. Study of Gaia quasars flux variability. The main objective of the PhD thesis is to test Gaia quasars for flux variability for astrometry purposes. For more details see Taris et al. (2016).

2. Study of Gaia quasars morphology. The objective of this PhD thesis is similar to the previous one except that instead of flux variability, changes in morphology are studied. For more details see Malkin (2016).

3. Observational characteristics of the SpectraPro portable spectrograph. The main goal of the MSc thesis is to study spectral characteristics of our portable spectrograph which is attached onto 1.4m telescope (throughput and spectral resolution). This is part of the bigger picture to introduce spectrograph into astronomical research. More details can be found in Vince et al. (in this publication)

Beside these projects we have several projects that are related to education and popularization of astronomy. Student practice is of particular importance, which is organized every year and involves students from different Universities with the aim to educate our student on working with telescopes/instruments and image reduction/measurements. We also organize workshops with amateur astronomers with the aim to define and develop common observational projects.

There are also observations on our telescopes that are not systematically performed.

5. TIME ALLOCATION

One of the tasks of the BELISSIMA project was to form a Time Allocation Committee (TAC) that will administrate the usage of the telescopes according to the submitted proposals. We start to operate the telescope in this regime on 1st of January 2018 and the rules are regulated with the Statute of telescopes time allocation at ASV. Main items in the Statute can be summarized as follows:

- One semester is provided for Proposals submission (4 months), Proposals evaluation by TAC (1 month) and final preparations for observations (1 month). The subsequent semester is an open time, that is, used for observations according to allocated telescope time.

- Proposals are read and evaluated by the TAC which consist of five permanent members employed at the AOB and consultative members who will be contacted in necessary.

- The telescopes are run by telescope operators but applicants are responsible to guide/control the observations either in live or remotely via internet.

Proposals are evaluated and ranked by TAC according to the following criteria:

1. Scientific background and technical capability of the Proposal.
2. Bilateral agreement on collaboration between AOB and institute which employs the applicant.
3. Efficiency in delivering papers based on data previously acquired with ASV telescopes.
4. Agreement on exchange of observation time on telescopes between AOB and institute which employs the applicant.
5. Donation of instruments to ASV.

There are different application types and they can be shortly summarized as follows:

1. Research applications.
2. PhD applications.
3. Educational applications.
4. Instrumental applications.
5. Target of opportunity applications.
6. Director's granted time.

We note that all relevant information related to time allocation on our telescopes will be publicly available by 1st of January 2018 at our web site http://vidojevica.aob.rs/

6. CONCLUSIONS

The main goal of the BELISSIMA FP7 project was to provide a 1.5m-class telescope which will enforce astronomical observations in Serbia and encourage collaboration in the region and wider. The project started in 2010 and, after two extensions, ended in 2016 with installation of 1.4m telescope called Milanković. This event was followed by precise calibration of the instrument and training. The Commissioning period of the telescope lasted one year. In this paper, we shortly describe the Commissioning period and the current status of the telescope regarding instrumentation and its usage. At the end, we introduce the main elements of the Statute of telescope time allocation.

Acknowledgment

This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia through projects no. 176021, "Visible and Invisible Matter in Nearby Galaxies: Theory and Observations", no. 176004 "Stellar

Physics", and no. 176011 "Dynamics and Kinematics of Celestial Bodies and Systems". We thank the Ministry of Education, Science and Technological Development of the Republic of Serbia for the continued support related to the construction works at the Astronomical Station Vidojevica. We acknowledge the financial support by the European Commission through project BELISSIMA (BELgrade Initiative for Space Science, Instrumentation and Modeling in Astrophysics, call FP7-REGPOT-2010-5, contract No. 256772).

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