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RECENT UPGRADES OF THE 2-METER TELESCOPE OF THE NATIONAL ASTRONOMICAL OBSERVATORY – ROZHEN

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Abstract. The official commissioning of the 2-meter reflector of the National Astronomical Observatory was in March 1981. Since that time observations with the telescope were made continuously, with only short breaks for maintenance operations, e.g. aluminization of the mirrors or introduction of new detectors. In this paper upgrades of the telescope performed during the last 5 years period are described.

1. INTRODUCTION

The 2 meter reflector of the National Astronomical Observatory (NAO) Rozhen offers two main modi of observations: imaging in the Ritchey-Chretien (RC) focus and spectroscopy in the Coude focus. In the direct imaging mode a back-illuminated CCD camera VersArray 1330B is used, comprising 1340x1300 px with a spatial scale = 0.25arcsec/px. A faster alternative for direct imaging is provided by a two-channel focal reducer. This instrument allows observations in the blue and red spectral region simultaneously. It transforms the focal ratio from f/8 to f/2.8 and offers several additional modi of observations: narrow-band imaging, polarimetric imaging, Fabry-Perot imaging, low-dispersion spectroscopy. The Coudé spectrograph allows obtaining high signal-to-noise, high resolution (up to 35000) stellar spectra. Several upgrades of the 2 meter telescope, performed in the period 2004 - 2009, are presented.

2. THE HIGH-SPEED PHOTOMETER

High-speed photometry is an important tool for characterizing the physical properties of variable stars. This is especially important in cases where the observed objects experience sudden and fast-changes, like e.g. flare stars. To facilitate high quality observational data in this field of research, scientists at the Institute of Astronomy at the Bulgarian Academy of Sciences, in a joint project with the Main Astronomical Observatory, National Academy of Sciences of Ukraine, designed and manufactured a high-speed universal photoelectric photometer for the Astronomical Observatory Belogradchik (see Antov et al., 2001). In 2004, a similar instrument was commissioned at the 2-meter telescope at Rozhen Observatory. This instrument is a component of a network-based synchronous system for high-speed electro-photometry. Detailed description of the photometer, inclusive the heart of the network of synchronously operating telescopes, the Photon Counting Module, is given by R. Bogdanovski (2006).

3. THE 2-CHANNEL FOCAL REDUCER - FORERO2

The 2-channel Focal Reducer Rozhen (FoReRo2) is a multimode instrument which is best suitable for observing low surface brightness objects. It makes the 2-meter telescope faster by changing its focal ratio from f/8 to f/2.8. This instrument has been developed and continuously improved during a period of more than 20 years in the Max-Planck-Institute for Aeronomy, today MPSS (Max-Planck-Institute for Solar System Research: mps.mpg.de). Description of the instrument is given by K. Jockers et al. (2000). The 2-channel focal reducer offers following modes of observations: Broad-band imaging, Narrow-band imaging, Long-slit spectroscopy, Fabry-Perot imaging, and Imaging polarimetry. Recent results obtained with FoReRo2 by using broad-band and polarimetric images can be found in Bonev et al. (2008). Narrow-band images have been used to analyse the rotational state and emission patterns in the CN coma of comet 8P (Waniak et al. 2009). Using low-dispersion spectra, Borisov et al. (2008) and Borisov (2010) derived the chemical composition and reddening of the continuum in comet 8P/Tuttle and C/2007 N3 Lulin, respectively.

4. THE AUTOGUIDING SYSTEM

The aim of the autoguiding system is to correct the telescope position during tracking for deviations caused by mechanical errors or by not perfect functioning of the telescope control system. The autoguider of the Rozhen 2-meter telescope uses the image of a star outside of the observed field of view. The system consists of an opto-mechanical module, detector, controller, relays-module and a PC. The detector is a Peltier cooled CCD SONY ICX 204. which is operated with the open source code uClinux. The user interface is a program running under Windows XP and communicating with the detector via TCP/IP.

The opto-mechanical part is mounted at the offset module of the telescope which allows selecting a proper star for the guiding process. The position of the selected star in the focal plane is calculated by a dedicated software. With a guide star of magnitude about 12, under mediocre seeing conditions (about $3''$), the integration time needed for reliable derivation of the star's center of weight is about 15 seconds. With the commissioning of the autoguider the quality of the images obtained in the RC-focus of the 2-m telescope was substantially increased.

The autoguider of the 2-meter telescope was commissioned in the fall of 2006. Details of the autoguiding system are described in Bonev et al. (2006).

5. IMPROVEMENTS OF THE OPTICAL SYSTEM

The 2-meter mirror was coated in 1999. After 9 years, in 2008 the reflectance of the mirror was strongly reduced, the reflective layer of the mirror was far from uniform, on several areas no reflective layer could be seen at all. This situation had not only negative influence on the effectivity of the observations, it was dangerous for the optical surface of the mirror which was not more protected by a reflective layer.

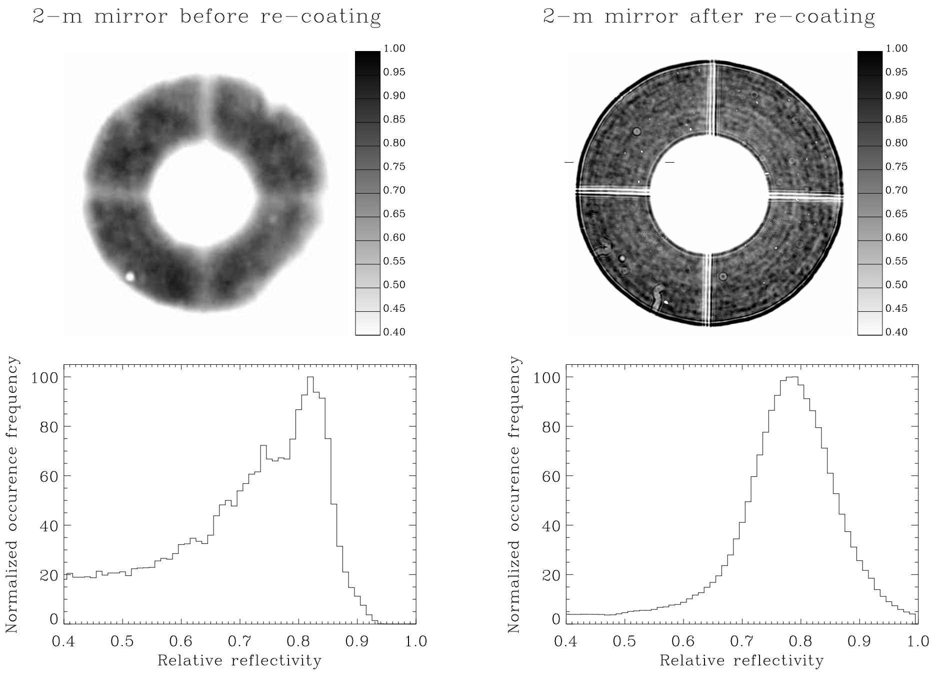

Figure 1: Upper panels: Map of the reflectivity of the 2-meter mirror before (left) and after (right) the re-coating in the summer of 2008. Lower panels: Histogram of the reflectivity. Note: The reflectivity is in relative units. Thus, there is internal consistency in the maps and histogram, but no absolute comparison can be made between the data before and after the re-coating.

The recoating of the mirrors was performed in August 2008. End of July, the main mirror and the first flat mirror deflecting the light beam to the coude spectrograph were demounted and transported to Jena, Germany. The re-coating of the mirrors was performed by the company 4H-Jena engineering (www.4h-jena.de). The reflective coating is aluminum covered by a thin protective layer MgF_2. The renewed mirrors were mounted in the telecope by the mid of September 2008.

The maximum reflectance of the mirrors after the re-coating was 90.45% at 550 nm. The first observations with the new optic showed an increase of the efficiency by a factor of about 2. This efficiency increase is reached thanks to both, the increased maximum of reflectance and the highly uniform distribution of the reflectance, achieved after the re-coating (see Fig. 1). Markov et al. (2010) analysed spectra obtained with the coude spectrograph and found that the signal-to-noise ratio has increased from about 50 before to 100-120 after the re-coating. The increased S/N allowed to derive and measure features in the observed spectral lines and to identify new lines in the spectra of the eclipsing binary UU Cas.

Another improvement of the imaging quality of the 2-m telescope was performed in 2009. Additional diaphragms were mounted in the baffle of the primary mirror and in the filter module of the telescope. This diaphragms removed the existing inconsistency between the large scale shape of the flat fields and the science images. Detailed description of this improvement is given in Ovcharov et al. (2010).

6. NEW CONTROL SYSTEM

The 2-meter telescope was commissioned in 1979. During the next 30 years the telescope has been operational with its original electronic control system. Due to natural aging of its components, the old control system has often failed in the last years. In order to make the telescope more reliable and to boost the overall efficiency of the observations, an extensive upgrade was undertaken in 2009, the old control system was exchanged by a new one.

On March 26, 2009, a contract was signed between the Institute of Astronomy (www.astro.bas.bg) and the company Projectsof (www.projectsoft.cz) for the design and manufacturing of a new control system for the 2-meter telescope. The new system is based on Siemens industry controllers. All the drives, sensors, user interface, etc. are replaced with state-of-the art technologycal solutions, which is a guarantee for high reliability of the new system. After several months preparation of the new system in the labs and workshops of Projectsoft, the mounting of the new system started on site begin of August, 2009. By the end of August the telescope was already operational with the new system. The first results showed an excellent improvement of the telescope pointing accuracy, after application of the TPOINT model (http://www.nao-rozhen.org/news/fr9_en.htm). The telescope tracking quality was initially subject to several periodical fluctuations which were related to the mechanical coupling of the sensors. After analysis of the fluctuations (Bonev and Dimitrov (2010)) they were removed by modifications of the mechanical coupling of the sensors and finally by changes in the algorithm of the control system code. Since the end of 2009 the 2-m telescope is fully operational with the new control system.

Acknowledgments

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