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The 2-Meter Telescope of the National Astronomical Observatory Rozhen: Opportunities for GAIA-FUN-SSO

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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. Images can be obtained with two spatial scales: 0.25 arcsec/px or 0.89 arcsec/px. High signal-to-noise, high resolution (up to 35000) spectra are obtained with the Coudé spectrograph. Upgrades of the 2 meter telescope performed in the last years are presented: autoguiding system in 2007, recoating of the optics in 2008, installation of a new telescope control system in 2009. The performance of the 2-m telescope after these upgrades will be illustrated by a sample of observations and the capabilities for observations of Gaia follow-up of SSO will be discussed. Some of the characteristics of the telescope presented here and many more, can be found on the web-site of the National Observatory: www.nao-rozhen.org.

1. The 2-meter telescope : main modi of observations

1.1 Imaging in the Ritchey-Chretien focus

The focal length of the 2-meter telescope at the Ritchey-Chretien focus is 16 m. The optically corrected field in this focus is 1 degree². This relatively wide field was used extensively for large scale imaging for more than ten years after commissioning of the telescope in 1981, during the era of astronomical photographic plates. Presently a LN₂ cooled CCD camera VersArray 1300B is used, having 1340 x 1300 pixel, each of size 20 μ m which yields a spatial scale of 0.25 arcsec/px. The field of view is 5.5 arcmin. Today, the smaller field of view is partially compensated with the faster detector. Following parameters describe the photometric precision of the imaging mode: in an exposure of 120 s., a star of R-magnitude 20, at seeing 1.2 arcsec has a S/N of approx. 100.

1.2 The 2-channel focal reducer

The 2-channel Focal Reducer Rozhen (FoReRo2) is mounted in the Ritchey-Chretien focus. It is a multimode instrument which allows simultaneous observations in the red and blue spectral range in following modes: broadband imaging, narrow-band imaging, long-slit spectroscopy, Fabry-Perot imaging, and imaging polarimetry. It makes the 2-meter telescope faster by changing its focal ratio from f/8 to f/2.8 and thus making the instrument an excellent device for observations of low surface brightness objects. 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). Recent results obtained with FoReRo2 by using broadband 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) derived the chemical composition and reddening of the continuum in

comet 8P/Tuttle. Similar research based on low-dispersion spectra of comet C/2007 N3 Lulin was made by Borisov (2010).

An example of cometary observations obtained in the narrow-band mode of FoReRo2 is shown on Fig.1. This sequence of images illustrates the process of revealing of faint plasma structures in the near nucleus region of a comet.

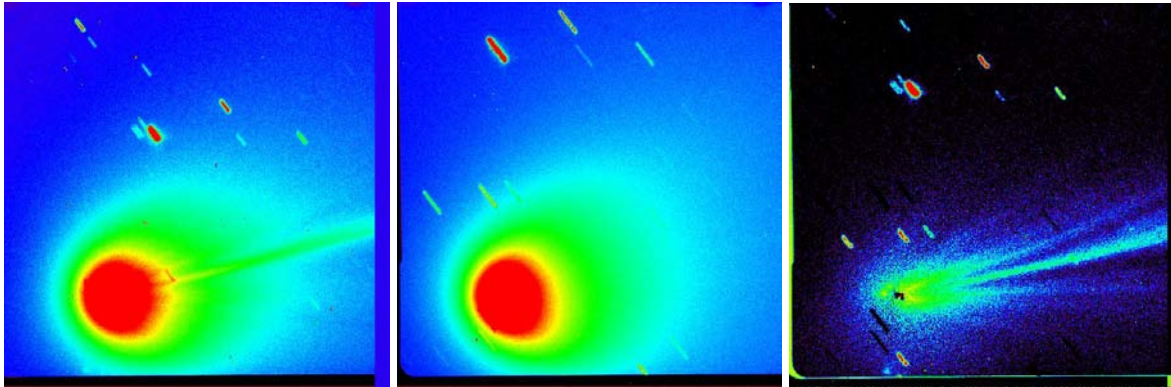


Fig. 1 – Images of comet Q4 (NEAT) obtained with the 2-channel focal reducer on May 26, 2004. Left: image obtained with a narrow –band filter centered at 616 nm (molecular lines of H₂O⁺ and continuum). Middle: image obtained at 642 nm – a well defined continuum window in cometary spectra. Right: The difference (Left – $k \cdot \text{Middle}$) removes the continuum and reveals the spatial distribution of the ions in the near nucleus region.

1.3 The coude-spectrograph

The resolving power of the coude-spectrograph is going up to 35000. The spectrograph is used predominantly for high dispersion spectroscopy of stars: symbiotic, cataclysmic, chemically peculiar, different kinds of binaries, etc. Only occasionally spectra of solar system objects are obtained, for example spectra of comets which are bright enough and allow resolving the rotational lines in their vibrational emission bands. One recent example (the resolved rotational lines of CN at 387 nm in the spectrum of comet C/2009 R1 (McNaught)) can be seen on the web-site of the National observatory: www.nao-rozhen.org, in the rubric “Observations”.

2. Recent upgrades of the 2-meter telescope

2.1 Autoguiding system

The autoguiding system of the Rozhen 2-meter telescope was designed in 2006. It uses the image of a star outside of the observed field of view. The system consists of an optomechanical 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 arcsec), 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, especially in the cases of fainter objects and correspondingly longer exposures. Details of the autoguiding system are described in Bonev et al. (2006).

2.1 *Re-coating of the optics*

The main mirror of the 2-meter telescope and the first plane mirror deflecting the light to the coude-spectrograph were re-coated in 2008. The comparison of observations obtained before and after the re-coating shows an increase of the performance of the telescope by a factor of two.

2.1 *New control system*

In 2009 the more than 30 years old control system of the telescope was replaced by a new one. The new system is based on Siemens industry controllers. All the drives, sensors, user interface, etc. are replaced with state-of-the-art technological solutions, which is a guarantee for high reliability of the new system. Incorporation of the TPOINT model takes account for the various kinds of errors: misalignment of the polar axis, non-perpendicularity of the hour and declination axes, bending of the tube, and many more. The very first results showed an enormous improvement of the telescope pointing accuracy after application of the TPOINT model, as can be seen on fig. 2.

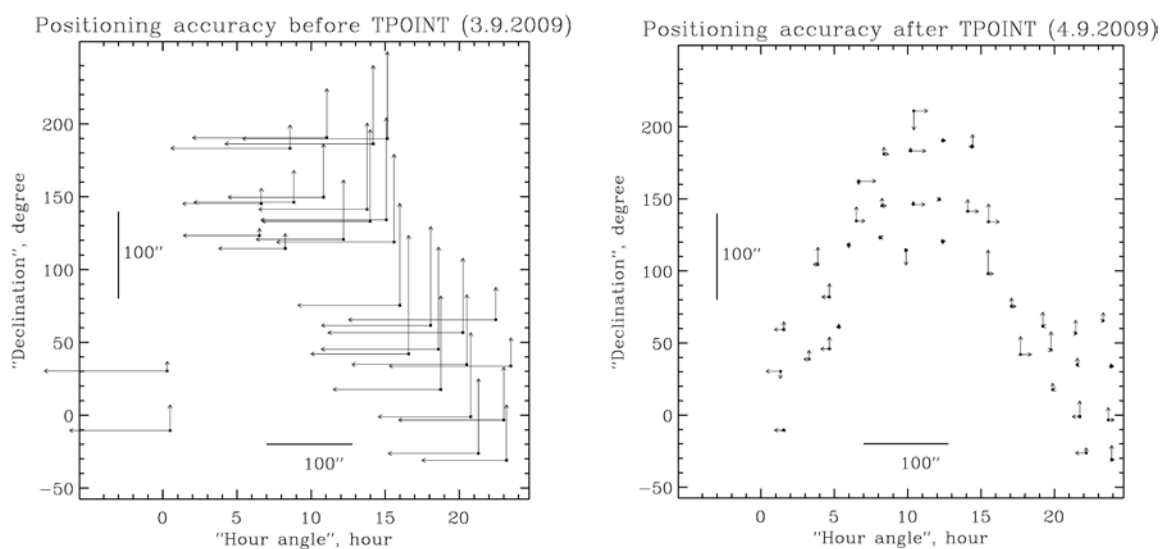


Fig. 2 – Left: pointing of the 2-meter telescope before application of the TPOINT model.
Right: Pointing of the telescope after application of the model feeded
with measured pointing errors of only 28 stars.

Conclusion

The 2-meter telescope of the National astronomical observatory can be an effective member of GAIA-FUN-SSO. It can be used for: photometry, astrometry, broad-band and narrow-band imaging of extended objects (comets), and polarimetric imaging of asteroids and comets. The telescope is equipped for observations useful for determination of the physical state and chemical composition of solar system objects, but it can be effectively used also for astrometric measurements of Solar system objects discovered by Gaia. The author thanks for a grant provided by the organizers of the GAIA-FUN-SSO workshop allowing him to present these data at the meeting. Partial support for participation at the workshop was provided by the National Science Fund in Bulgaria under contract DO 02-85.

References

- Bonev, T., Lukarski, H., Parov, I., Neykov, S., Marinkov, V., and Yaramov, K. : 2006 , Autoguiding system for the 2-m RCC telescope of the Rozhen National Astronomical Observatory, *Bulgarian Astronomical Journal* 8, 201-208
- Bonev, T., Boehnhardt H., and Borisov G.: 2008, Broadband imaging and narrowband polarimetry of comet 73P/Schwassmann-Wachmann 3, components B and C, on 3, 4, 8, and 9 May 2006, *Astronomy & Astrophysics* 480, 277-287
- Borisov, G. , Waniak, W., Bonev, T., Czart, K., and Drahus, M.: 2008, Low dispersion spectroscopy of the comet 8P/Tuttle, *Bulgarian Astronomical Journal* 10, 59-66
- Borisov, G.B.: 2010, Observations of the Comet C/2007 N3 (Lulin) during its Closest Approach to the Earth, *Publications de l'Observatoire Astronomique de Beograd* 90, 19-23
- Jockers, K., Credner, T., Bonev, T., Kiselev, V. N., Korsun, P., Kulyk, I., Rosenbush, V., Andrienko, A., Karpov, N., Sergeev, A., Tarady, V.: 2000. Exploration of the solar system with the Two-Channel Focal Reducer at the 2m-RCC telescope of Pik Terskol, Observatory. *Kinematika i Fizika Nebesnykh Tel Supplement* 3, 13–18
- Waniak, W., Borisov, G., Drahus, M., Bonev, T., Czart K., Kueppers, M.: 2009, Rotation of the Nucleus, Gas Kinematics and Emission Pattern of Comet 8P/Tuttle: Preliminary Results from Optical Imaging of the CN Coma, *Earth Moon Planet* 105, 327–342