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Spectroscopic instrumentation of 1-m class telescopes for ground support of the space mission WSO-UV

M. Sachkov[1], V. Panchuk[2], V. Klochkova[2], S. Sichevsky[1], E. Kanev[1] and A. Kartashova[1]

[1] *Institute of Astronomy RAS, Russia, (E-mail: msachkov@inasan.ru)*
[2] *Special Astrophysical Observatory RAS, Russia*

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Abstract. The World Space Observatory Ultraviolet (WSO - UV), an international mission with Russia and Spain as the main contributors, consists of a 1.7 m telescope with an imaging camera, two spectrographs in the range of 115–176 and 174–310 nm with a resolution of R = 50,000 for high resolution spectral observations and a long-slit-spectrograph for R=1,000 observations. Some of astrophysical studies require both Ultraviolet orbital observations with the WSO-UV as well as observations with ground based instrumentations in visual wavelengths. In this paper we will discuss spectroscopic instrumentations of 1-m class telescopes to be used as project ground support. We also discuss astrophysical studies that require both ground base and orbital observations.

Key words: ultraviolet – space mission – ground support

1. Introduction

The WSO-UV observatory (Shustov et al. (2018)) includes a 170 cm aperture telescope with WUVS (WSO-UV Spectrographs) and FCU (Field Camera Unit) instruments. The launch date is 2025. Many astrophysical tasks of the mission Core program require high resolution spectroscopic observations (R = 50000) in UV wavelengths (115 – 300 nm) as well as in the visual range (300–700 nm) (Boyarchuk et al. (2016)). This means that observations with space based instrumentation should be complemented with ground support spectroscopic observations in the spectral domain of 300-1000 nm. For these purposes we plan to install new spectrographs on 1–m telescopes of SAO RAS and Simeiz Observatory of INASAN and to a 2–m telescope of the Terscol observatory. Here we present detailed information on such instrumentation and our recent achievements.

2. WSO-UV spectrographs

The WUVS instrument consists of a set of three spectrographs (Sachkov et al. (2014)): the far UV high resolution spectrograph (VUVES) that will permit to carry out echelle spectroscopy with the resolution of about 50000 in the 115–176 nm range; the near UV high resolution spectrograph (UVES) to carry out echelle spectroscopy with the resolution of about 50 000 in the 174–310 nm range; the Long Slit Spectrograph (LSS) that will provide the low resolution (R=1000), long slit spectroscopy in the 115–305 nm range. The spatial resolution will be 0.5 arcsec. All spectrographs will be equipped with a CCD cooled to minus $100^o\,C$ (Shugarov et al. (2014)).

3. Ground based spectrographs

For monitoring programs we plan to use 1–m telescopes of SAO RAS and INASAN. The INASAN 1–m telescope will be fully occupied with ground support observations of WSO–UV during its operation on orbit. The 1–m SAO RAS telescope will be equipped with CAES (Panchuk et al. (2018)). The 1–m INASAN telescope will be equipped with a similar spectrograph that is under construction now. Connection of a high resolution spectrograph and a telescope with the help of a fiber fed allows to reach high positioning accuracy with light loose in the fiber and with stabilisation of the spectrograph housing.

Many astronomical tasks require such approach with a classical slit. They are: radial velocity of gas movement in atomic and ion lines in different parts of planetary nebulae; absorbtion cell radial velocity measurements; observation of faint objects to take into account sky background; visual binary star Doppler measurements when one needs to register both component spectra (see Gorynya et al. (1996)); in survey observations of magnetic stars where one does not need precise Zeeman measurements.

For ground base ultraviolet observations (300 – 400 nm) light loose in a fiber is very significant hence the design of the spectrograph should exclude the fiber. For this spectral range we will install a spectrograph to the 2–m Terscol telescope. The optical scheme of this spectrograph will be similar to WUVS high resolution spectrographs (see Fig. 1, Panchuk et al. (2014)).

4. Conclusions

The WSO–UV project is an efficient multipurpose orbital observatory for high and low resolution spectroscopy, high sensitivity imaging and slitless spectroscopy in the ultraviolet. The imaging instrument FCU onboard WSO–UV will be the first UV camera to be flown to a geosynchronous orbit. The WUVS spectrographs will deliver spectroscopic performance on a range of astronomical sources, combining high sensitivity, low background and high resolution at FUV and NUV wavelengths. According to the current Roscosmos plans, WSO–UV will be launched in 2025. Up to date information on the WSO–UV mission can be found on the web site of the Joint Centre of Ultraviolet Astronomy: http://jcuva.space.

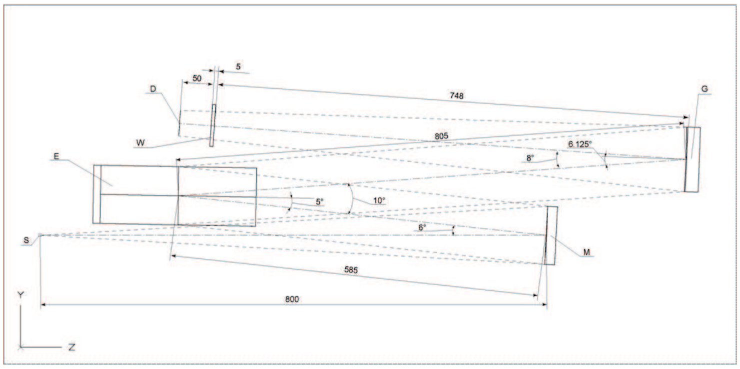

Figure 1. The UVES spectrograph optical layout. S - a slit, M1 - a collimator, E - an echelle grating, G - a cross disperser and camera mirror, W - a detector window, D - a detector.

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