The development and metrology of the heliospheric Lyman-α photometer IMAP/GLOWS

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The heliosphere is a region in interstellar medium dominated by the solar wind plasma outflow. The neutral component of surrounding interstellar medium, mostly atomic hydrogen and helium, penetrates freely inside the heliosphere and interacts with the solar corpuscular and radiative environment. As a result, a 3D pattern of the density of interstellar hydrogen is created, which bears imprints of the latitudinal structure of the solar wind. The hydrogen atoms are resonantly excited by the solar Lyman-α emission, and as a result of the subsequent de-excitation, the heliospheric backscatter glow is produced. The distribution of the intensity of this emission in the sky bears imprints of the latitudinal structure of the solar wind. Thus, systematic observations of the helioglow emission allow to establish the latitudinal structure of the solar wind and its evolution during the solar activity cycle.

Such observations are planned for GLOWS (GLObal solar Wind Structure), one of experiments on a NASA mission IMAP, scheduled for launch in 2025 [1]. GLOWS is a non-imaging single-pixel Lyman-α photometer, effectively a photon counting instrument. It is conceptually based on the TWINS/LaD photometer, originally designed to observe the georoconal Lyman-α glow [2]. The instrument includes a collimator with a baffle, a spectral filter, and a channeltron (CEM) detector connected to the electronics block. The instrument is designed and assembled in the Space Research Centre PAS (CBK PAN), and its development is performed in collaboration with PTB.

Successful observations require suppression of solar straylight and the UV spectral background. This is accomplished by special design of the entrance system with a collimator and baffle and a narrow-band optical filter. The suppression of straylight is obtained, among others, by application of a special coating. Verification of the suppression/transmission properties of the entrance system requires preforming complex calibration measurements using a well-calibrated UV source.

Optical characterization of the GLOWS entrance system was a multi-tier effort that involved: measuring the spectral transmission band of the optical filter, determining the BRDF function of the black coating, measuring the quantum efficiencies of the channeltron detectors, and determining the PSF functions of the collimator and the entire optical stack. These measurements were performed at PTB Berlin within a Polish-German scientific collaboration.

[1] McComas, D.J. et al., 2018, Space Science Reviews **214**:116, **1(2)**, 10.1007/s11214-018-0550-1.

[2] Nass, H.U., Zoennchen, J.H., Lay, G., Fahr, H.J., 2006, ASTRA **2**, 27