UDC 681.7.067.23

SWIR CATADIOPTRIC LENSES FOR CUBESAT SATELLITE

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CubeSat satellites are widely used to conduct science experiments, test different instruments, provide commercial applications, and support educational projects. To enable research in geology and agriculture, CubeSat optics should operate in different spectral ranges, including short-wave infrared (SWIR) wavelengths. For this purpose, the catadioptric systems are more perspective than pure lens systems, because they can deliver high image quality and have long focal lengths enabling high spatial resolution.

In this research, a set of SWIR catadioptric systems was developed with the optical design software PODIL. The optical design task was carried out practically in the automatic mode by applying a modified modern evolution algorithm.

As a numerical example, an optical schematic diagram of the 350-mm F/4 SWIR lens designed for a nanosatellite is shown in Fig.1. It is intended to operate within the spectral range of 0.4 to 1.8 micrometers.

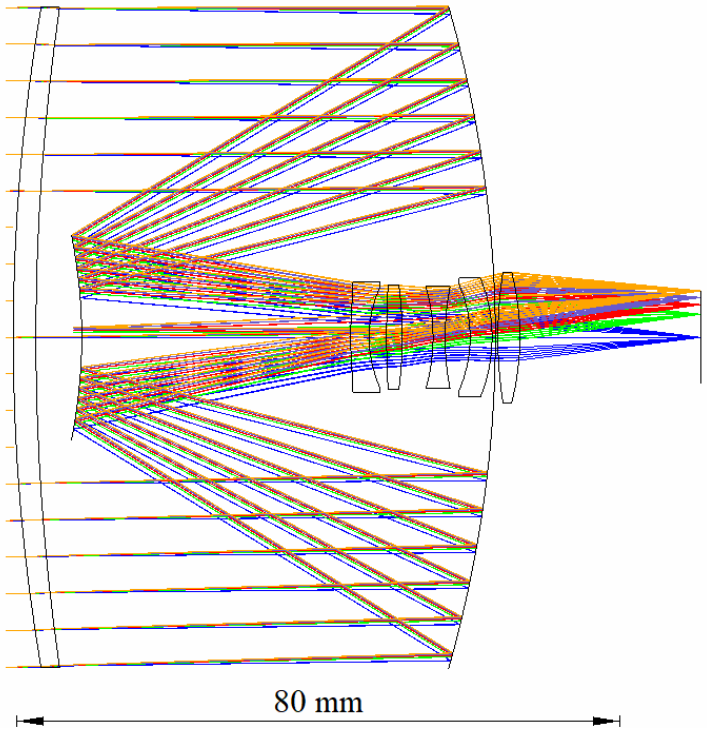

Fig. 1. Schematic optical diagram of the developed 350-mm F/4 SWIR catadioptric lens having angular field of view of 2 degrees

The considered catadioptric lens contains a front meniscus lens, two second-order aspheric mirrors, and a five-lens aberration corrector.

The optical system has an effective focal length of 350 mm and an entrance pupil diameter of 87,5 mm. The angular field of view is 2º, and the image circle diameter is 12.2 mm. The total track (i.e., the axial distance from the external lens surface to the image plane) does not exceed 93 mm.

The polychromatic RMS spot radius is 1 µm on the optical axis and 2 µm at the image periphery.

Fig. 2 illustrates the polychromatic diffraction MTF charts evaluated for different field points. The maximum relative distortion is 1 %.

The report presents the design results for a set of SWIR catadioptric lenses with different focal lengths. It may be interesting for nanosatellite developers and optical designers.

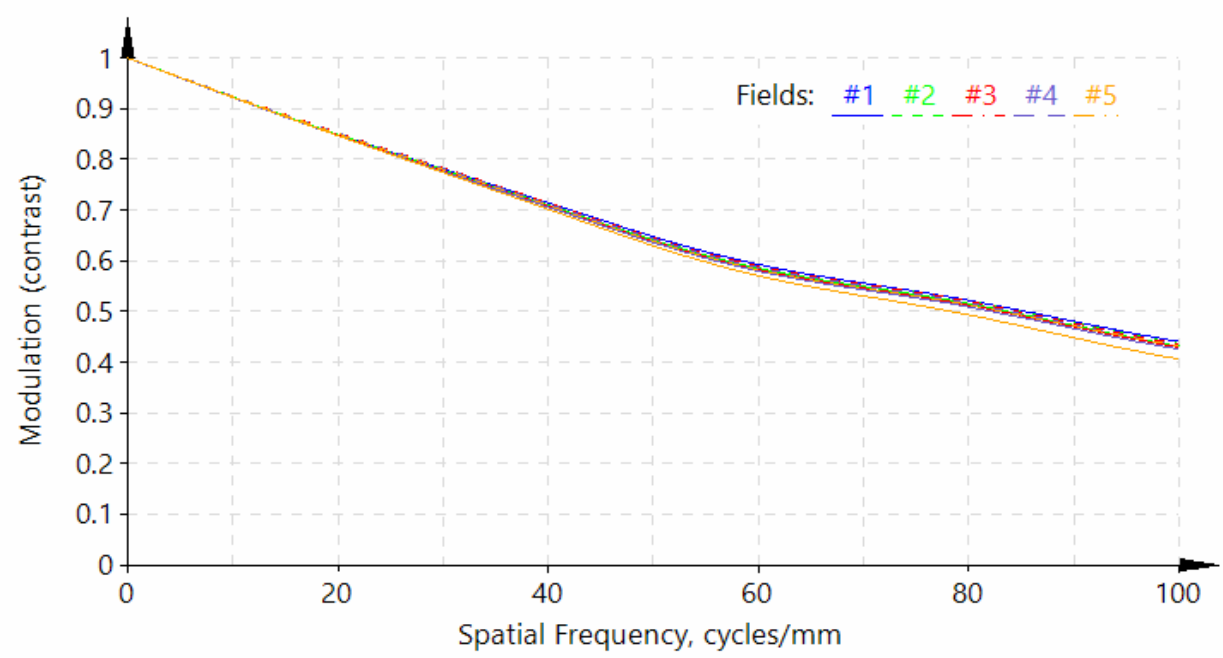

Fig. 2. Polychromatic diffraction MTFs of the developed 320-mm F/4 SWIR catadioptric lens: field numbers #1 to #5 correspond to field angles 0°, 0.5°, 0.71°, 0.86°, and 1°, respectively

Keywords: SWIR, CubeSat, nanosatellite, catadioptric lens, mirror, second-order aspheric, MTF.