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Imaging Spectroscopy IV (M. R. Descour and S. S. Shen, Chairs)

Title

A Compact, Low-Distortion Imaging Spectrometer for Remote Sensing Applications

Author listing:

Pantazis Mouroulis and David A. Thomas
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive, MS 306-336
Pasadena, CA 91109

Tel: (81 8) 393-2599, Fax: (818) 393-9567
email: pantazis.mouroulis@jpl.nasa.gov

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Abstract Text

We describe a pushbroom imaging spectrometer having a number of attractive features for remote sensing applications. Based on the Offner relay with a convex diffraction grating at the secondary mirror, it is an order of magnitude more compact than conventional grating-based design forms. It can be used at low F-numbers and over wide slit widths with near diffraction limited image quality. It can be designed to present undetectable levels of spatial and spectral distortion, or "smile", which is considered critical in producing data free of significant spectral calibration errors. It can be adapted for use over a wide range of wavelengths - from the ultraviolet through the thermal infrared. Practical implementation of the design is enabled by the use of electron-beam lithography to fabricate the diffraction grating. We describe the unique characteristics of these gratings, that permit the practical realization of these low distortion values. These include the ability to produce true blazed designs on a convex substrate as well as to control the shape of the pupil anodization resulting from multipanel grating designs. Experimental results are given that show how these new e-beam gratings outperform versions made by conventional ruling and holographic means in all respects - wavefront, diffraction efficiency, and scatter. Finally, a specific imaging spectrometer design is evaluated in the laboratory. It covers a spectral band from 380 to 1000 nm with 3 nm spectral resolution and has 800 spatial elements (13 microns in size) across the entrance slit (limited by the detector size). Details of an alignment method designed to minimize residual distortions while optimizing image quality are given. Experimental results are described that show the extent to which the theoretical optical performance can be approached in practice for this novel spectrometer design form.

Key Words Imaging spectrometer, optical design, diffractive elements

Brief Biography Pantazis Mouroulis is a Member of Technical Staff in the Imaging and Spectrometry Systems Section of JPL. Prior to joining JPL he was an Associate Professor at the Center for Imaging Science, Rochester Institute of Technology. He has authored several publications in the fields of optical design, fiber optics, and holography, and a book on Geometrical Optics and Optical Design published by Oxford University Press.