

Spectral Polarization Imager with Dual-angle and Enhanced Resolution (SPIDER): Design, Calibration and In-orbit Evaluation

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To address the need for high-spatial-resolution and fine-scale monitoring of black carbon and terrestrial absorbing aerosol components, this study introduces a polar-orbiting commercial cube-sat mission based on Division-of-focal-plane (DoFP) spectropolarimetric technology. Conventional polarization detection methods often struggle to achieve high spatial resolution while maintaining a lightweight design and multispectral observation capability[1,2]. The DoFP spectropolarimetric technique, which highly integrates micropolarizer arrays with image sensors and couples strip filters, enables compact, lightweight, and high-spatial-resolution multispectral polarization imaging within a single optical system.

To meet the objective of high-resolution black carbon aerosol detection, we have developed the DoFP-type Spectral Polarization Imager with Dual-angle and Enhanced Resolution (SPIDER). The sensor will be onboard the "Jiuzhang-1" satellite, which is scheduled for launch in August 2026. The satellite will operate in a sun-synchronous orbit at an altitude of approximately 520 km, with a descending node local time of 10:30 am. SPIDER adopts the DoFP polarization detection scheme and features five spectral channels, dual-angle observation capability, and on-board polarimetric calibration.

Building on an overview of the SPIDER payload development, this report systematically presents its parametric polarization calibration method, high-precision spatial resolution reconstruction algorithm, and in-orbit data preprocessing algorithm, and introduces the preliminary in-orbit performance tests and evaluation results after launch. The sub-hundred-meter resolution of SPIDER is expected to reduce pixel-mixing effects, significantly improving the retrieval capability for fine-scale black carbon aerosol characteristics across diverse environments.

References

- [1] Dubovik O., Li Z., Mishchenko, M. I., *et al.*, 2019: Polarimetric remote sensing of atmospheric aerosols: Instruments, methodologies, results, and perspectives. *J. Quant. Spectrosc. Radiat. Transf.* **224**, 474-511.
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