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PERFORMANCE CHARACTERIZATION OF THE LIFE SIGNATURE DETECTION POLARIMETER (LSDPOL)

Abstract

We present the performance characterization of the Life Signature Detection polarimeter (LSDpol), a prototype instrument designed to identify life on Earth and derive the integrated signal of Earth-as-an-exoplanet through global polarization measurements from the Airbus Bartolomeo platform on the International Space Station (ISS). LSDpol is optimized for the measurement of an unambiguous biomarker exhibited by chlorophyll and other bio-pigments: homochirality. The instrument is very sensitive to small

signals in circular polarization induced by this preference in handedness found in biological molecules. LSDpol has the capability of measuring full Stokes parameters as a function of wavelength while containing no moving parts and a compact design suitable for SmallSats. The point-and-shoot configuration of this instrument uses a patterned liquid crystal spatial polarization modulator at the slit followed by a quarter wave retarder and a liquid crystal polarization grating. This combination fully decouples the faint circular and strong linear polarization signals through spatial modulation making it insensitive to cross-talk. In this paper we present detailed simulations and results from the performance characterization of LSDpol. We discuss the sensitivity of the instrument and the impact of the flat field and distortions based on optical simulations of the modulation. LSDpol is also compared against the performance of another prototype instrument, TreePol, optimized for vegetation polarization measurements on ground. Our study looks at both instruments' capabilities outdoors and in the laboratory. Abiotic data from artificial vegetation and sand are used as a control against the leaf measurements of interest. Additionally, we show designs including a microlens array used as an integral field unit to achieve imaging capability. This versatile instrument concept is ideally suited for remote sensing of homochirality, enabling vegetation health monitoring on Earth and detection of biotic signatures on icy moons.