Poke: An open-source tool for modeling polarization aberrations in next-generation ground and space telescopes

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Abstract

Next-generation ground and space-based observatories aim to directly image and characterize Earthlike exoplanets in reflected light. This task requires tight constraints on the optical performance to maintain contrasts below 1e-7 in the infrared for the Extremely Large Telescopes (ELTs) and 1e-10 in the visible for a Habitable Worlds Observatory (HWO). A significant source of error for high-contrast imaging instruments on these telescopes are the aberrations induced by polarization. Polarization aberrations are a burgeoning issue for the astronomical community. However, we lack an open-source platform with which to study the polarization aberrations of next-generation observatories. Poke is an open-source polarization ray tracing (PRT) Python package that utilizes the Zemax OpticStudio API (ZOS-API) to compute polarization aberrations from ray traces of optical systems. We present a brief overview of Poke's simulation capabilities, including: Jones pupil computation from PRT data, multilayer thin film stacks, and interfacing with existing physical optics packages (POPPY, HCIPy). Poke has most recently been used in a study to analyze the polarization aberrations of the ELTs, where we quantified the degradation of coronagraphic performance due to polarization.

Keywords: polarization aberrations, open source, physical optics, python, zemax

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