
First on-sky demonstration of a three-sided reflective pyramid wavefront sensor using the 3-meter Shane Telescope

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Abstract

The pyramid wavefront sensor (PWFS) is a prime candidate to be implemented into the next generation of extremely large telescopes for low order wavefront sensing. There are a few PWFS designs, however, they are all transmissive and must be optimized for their intended wavefront sensing wavelength. Furthermore, fabricating these four-sided glass prisms is difficult and more expensive, which has led to the development of the double-roof PWFS configuration. To mitigate these challenges, we propose a three-sided reflective pyramid wavefront sensor (3-RPWFS) as a possible alternative to existing PWFS designs. In this paper, we present the first on-sky demonstration of a 3-RPWFS using the Shane Telescope's adaptive optics system (ShaneAO) on Mount Hamilton, California. To implement the R-PWFS on ShaneAO we developed a hybrid transmissive/reflective design to fit in the available space. This includes a novel spinning glass wedge to implement the modulation. Both the reflective pyramid and the transmissive wedge are unique aspects of this implementation that may be useful for future pyramid designs. On-sky closed loop operation is performed using natural guide stars for a performance comparison with the current Shack-Hartmann wavefront sensor (SHWFS) in ShaneAO. The on-sky closed loop results demonstrate proof of concept and this sensor will be further optimized to effectively assess performance.

Keywords: wavefront sensor, reflective, pyramid, three sided, adaptive optics, wedge

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