Architecting, Implementing and Observing with a Metasurface vector Zernike wavefront sensor on the Keck Telescope

James Wallace*[1], Tobias Wenger[1], Jeff Jewell[1], Maissa Salama[2], Charlotte E. Guthery[3], Vincent Chambouleyron[2], Maaike Van Kooten[4], Jacques Robert Delorme[3], Sam Ragland[3], Rebecca Jensen-Clem[2], Peter Wizinowich[3], Dimitri Mawet[5], and Nemanja Jovanovic[5]

[1]Jet Propulsion Laboratory – United States
[2]Department of Astronomy and Astrophysics [Univ California Santa Cruz] – United States
[3]W.M. Keck Observatory – United States
[4]NRC Herzberg Astronomy and Astrophysics – Canada
[5]Caltech Department of Astronomy [Pasadena] – United States

Abstract

The Zernike wavefront sensor is a member of the diffraction-limited wavefront sensor family with a few attractive properties. It is simple, robust, and easy to implement, at the expense of limited dynamic range. Here we extend previous demonstrations of the Zernike wavefront sensor in the follow ways: we implement a vector Zernike wavefront sensor in order to extend the otherwise limited dynamic range, and we demonstrate this vZWFS on sky. The vector Zernike dimple itself is made using metasurfaces – an optical surface comprised of sub-wavelength optical features. Here, we describe how this sensor is implemented on the Keck Telescope, in particular: 1) the optical design that enables the implementation, 2) the design and fabrication of the metasurface focal plane mask, 3) operations of the sensor on the bench and on sky. We will discuss how this work compares with performance models, and will describe implications of this work on future segmented aperture systems.

Keywords: wavefront sensor, segmented aperture, phasing

*Speaker