Developments on LLNL's High Contrast Testbed and Lick/ShaneAO

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Abstract

Lawrence Livermore National Laboratory (LLNL) has recently setup a High Contrast Testbed (HCT) for adaptive optics (AO) and high contrast exoplanet imaging technology development. We present the various technologies currently under development and testing on HCT, including (1) a Wynne corrector, (2) Linear Quadratic Gaussian (LQG) multi-wavefront sensor (WFS) control, and (3) in-house photonic lantern design, fabrication, and testing. A Wynne corrector has long been proposed as a method to increase the spectral bandwidth for focal plane wavefront sensors, and is particularly important for high-speed focal plane wavefront sensing of residual atmospheric turbulence; we present HCT testing results of a first Wynne corrector prototype with a self-coherent camera (SCC). We present updates on development efforts to apply LQG multi-WFS control to our SCC and Shack Hartmann WFS (SHWFS) setup that share a common-path DM, leveraging the unique benefits of LQG control to increase the AO system bandwidth (e.g., by updating the DM faster than the AO loop rate). We also present in-house efforts to fabricate and test photonic lanterns, which can share a similar multi-WFS control configuration to our SHWFS + SCC setup, thus enabling similar multi-WFS LQG control solutions. Lastly, we present plans for REDWOODS, a project to deploy these technologies (and a non-modulated pyramid WFS) on-sky on a sub-bench of the Shane AO system at Lick Observatory. This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. This document number is LLNL-ABS-865399.

Keywords: high contrast imaging, focal plane wavefront sensing

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