Segment piston estimation using sequential phase retrieval

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Abstract

The Giant Magellan Telescope (GMT) consists of seven 8.4-m diameter circular segments in a petal pattern to create a telescope with an effective diameter of 25.4 m. The Laser Tomography Adaptive Optics system for the GMT uses a Shack-Hartmann Wavefront Sensor guiding on six laser guide stars (LGSs) to measure high-order wavefront aberrations. LGS-based adaptive optics systems also require one or more tip-tilt sensors, since the LGSs affected by tip-tilt errors on the uplink. The wavefront errors also contain segment piston, which can be induced by the atmosphere or the telescope. If the tip-tilt sensor is a Nyquist sampled imager, we can use phase retrieval to measure discontinuities in the wavefront at the full frame rate of the tip-tilt sensor. Two existing algorithms, Gerchberg-Saxton and the Fast & Furious algorithms, are adapted for this purpose. We describe both algorithms in detail, and demonstrate using end-to-end simulations that phase retrieval can be used to measure segment piston and thus improve the delivered image quality over a range of operating conditions.

Keywords: phase retrieval, segment phasing, Gerchberg, Saxton, Fast & Furious, Giant Magellan Telescope, laser tomography adaptive optics

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