Implementing the LIFT algorithm on Keck I adaptive optic system

Mojtaba Taheri*[1,2], Sam Ragland[2], Arseniy Kuznetsov[3], Benoit Neichel[1], Peter Wizinowich[2], Carlos Correia[1], and Cedric Plantet[4]

[1]Laboratoire d'Astrophysique de Marseille – Aix Marseille Université, Institut National des Sciences de l'Univers, Centre National d'Études Spatiales [Toulouse], Centre National de la Recherche Scientifique – France

[2]W.M. Keck Observatory – United States

[3]European Southern Observatory – Germany

[4]INAF - Osservatorio Astrofisico di Arcetri – Italy

Abstract

Current applications of adaptive optic systems for astronomy are heavily dependent on wavefront measurements gathered by observing Laser Guide Stars (LGSs). These artificial, relatively bright stars provide high signal-to-noise high-order wavefront information where no appropriate Natural Guide Star (NGS) exists in the vicinity of the science target. However, the significant caveat of LGS wavefront measurements is the lack of low-order information such as tilt, tip, and focus, particularly due to the sodium layer altitude fluctuation. To resolve this issue, simultaneous observation of at least one natural guide star (NGS) remains essential. Traditionally, a Low-order Shack-Hartman sensor is dedicated to this task, typically working in the visible spectrum. A major upgrade to this architecture, both in terms of sensitivity optimization and sky coverage, is the use of a focal plane wavefront sensor in infrared bands. LIFT is a noise-effective, low-order focal-plane sensor algorithm that is designed for this application. We used the Keck I adaptive optics facility to study the feasibility and efficiency of replacing the low-order Shack Hartman sensor with LIFT and the TRICK IR focal plane detector. The result of this study is a milestone in the Keck All-Sky Precision Adaptive Optic system (KAPA) project as well as paving the way for improving the design of future adaptive optic systems in terms of sky coverage, efficiency, and reducing overall physical bench size.

Keywords: Keck, LIFT, Focal plane wavefront sensing, Infra red wavefront sensing

*Speaker