V(WF)^{2}S: Very Wide Field WaveFront Sensor for GLAO

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Abstract

Adaptive optics is an advanced technique developed for large telescopes. It turns out to be challenging for smaller telescopes (0.5_˜2m) due to the small isoplanatic angle, small subapertures and high correction speeds needed at visible wavelengths, requiring bright stars for guiding, severely limiting the sky coverage. Natural guide star (NGS) SCAO is ideal for planetary objects but remains limited for general purpose observing. The approach we propose is a compromise between image quality gain and sky coverage: our proposition is that it is better to partially improve the image quality anywhere in the sky than to be limited by diffraction around a few thousand bright stars. We therefore propose a new solution based on multiple fundamental AO concepts brought together to enable a whole new field of application: The principle is based on a rotating Foucault test, like the first AO concept proposed by Horace Babcock in 1953, on the Ground Layer Adaptive Optics (GLAO), proposed by Rigaut and Tokovinin in the early 2000s, and on the idea of Layer-oriented MCAO and the pupil-plane wave surface analysis by Roberto Ragazzoni. We propose to combine these techniques to use all the light available in a large field to measure the ground layer turbulence and enable the high angular resolution imaging of regions of the sky (e.g. nebulas, galaxies) inaccessible to traditional SCAO systems. The motivation to develop compact and robust AO system for small telescopes is two-fold: On the one hand, schools and universities often have access to small telescopes as part of their education programs. Also, researchers in countries with fewer resources could also benefit from well-engineered and reliable adaptive optics on smaller telescopes for research and education purposes. On the other hand, amateur astronomers and enthusiasts want improved image quality for visual observation and astrophotography. Implementing readily accessible adaptive optics in astronomy clubs would also likely have a significant impact on citizen science.

Keywords: Wavefront sensing, optical differentiation, GLAO

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