Adaptive optics for high contrast and very large array optical interferometry without WFSs and DMs using integrated photonics devices and a digital signal modulated satellite beacon

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Abstract

For high contrast imaging, atmospheric turbulence may be sensed and corrected at very high bandwidth without WFS or deformable mirrors using phase correcting integrated photonics devices and advanced signal processing. This method employs a satellite loitering near a science object to send a time-coded reference laser to telescopes on the ground. It permits coherently combining arrays of optical telescopes to give unprecedented micro-arcsecond resolution in the near infrared to obtain image and spectral data cubes of extrasolar planets. The method is also useful for satellite communications. The overall system employs radio astronomy techniques developed for clock distribution, to sense and correct phase, and radio interferometry procedures to produce high resolution images. One of the tallest poles in high-contrast AO is the frame rate. Our simulation models estimate correction bandwidth might be 1-2 orders of magnitude faster than current high contrast AO. We have designed and measured a 32 channel astrophotonics phase sensing and correcting device, which is low-cost and compact due to its telecommunications heritage. We are developing a prototype AO system to test the concept, first on a lab bench and then using a telescope pointed at sources on a tower. We present simulations and prototype testing and what we have learned about limitations that merit continued technology developments.

Keywords: integrated photonics, satellite beacons, high contrast, optical interferometry

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