Spectroastrometry and Imaging Science with Photonic Lanterns on Extremely Large Telescopes

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Abstract

Photonic Lanterns (PLs) are tapered waveguides that gradually transition from a multi-mode fiber geometry to a bundle of single-mode fibers. In astronomical applications, PLs can efficiently couple multi-mode telescope light into a multi-mode fiber entrance and convert it into multiple single-mode beams. The output beams are highly stable and suitable for feeding into high-resolution spectrographs or photonic chip beam combiners. For instance, by using relative intensities in the output cores as a function of wavelength, PLs can be utilized for spectroastrometry. In addition, by interfering beams in the output cores with a beam combiner in the backend, PLs can be used for high-throughput interferometric imaging. When used on an Extremely Large Telescope (ELT), with its increased sensitivity and angular resolution, the imaging and spectroastrometric capabilities of PLs will be extended to higher contrast and angular regimes. We study the potential spectroastrometry and imaging science cases of PLs on an ELT, including study of close-in extrasolar planetary systems, exomoons, and broad line regions of quasars, and examine the requirements for PL system design.

Keywords: photonic lanterns, spectroastrometry, coherent imaging, high angular resolution, high spectral resolution, photonics

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