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## Simulating a Wavefront Sensing Hybrid Mode-Selective Photonic Lantern

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The use of photonic alternatives to conventional optical trains in telescope instrumentation offers key advantages in satisfying near-impossible tasks demanded by astrophysics (such as imaging Earth-sized exoplanets within the habitable zone of their host star or their formation within a proto-planetary disc).

Current imaging instruments using adaptive optics account for atmospheric seeing conditions by using a Wavefront Sensor (WFS) to measure the aberrated wavefront and apply correction by a Deformable Mirror (DM). Pupil-plane WFS are the most common, but make optimal wavefront correction difficult due to non-common path aberrations with the focal plane, and the inability to detect modes such as low wind effect and petal modes. An effective focal-plane WFS would address these issues.

In recent years the Photonic Lantern (PL), used primarily in telecommunications, has become a promising photonic device with applications in astrophysics for ground-based telescopes to act as a focal-plane WFS and achieve this task. The PL is a device that encodes the phase and amplitude of the aberrated wavefront into the intensities of single-mode fibres at the output, meaning that one could tailor a PL for wavefront sensing and place it within the same focal plane as seen by the CCD/instrument. Furthermore, the PL can be itself used for the main science light injection (using a hybrid mode-selective PL), eliminating non-common-path aberrations entirely.

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