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The Palomar Kernel Phase Experiment

At present, the principal limitation on the resolution and contrast of astronomical imaging instruments comes from aberrations in the optical path, which may be imposed by the Earth's turbulent atmosphere or by variations in the alignment and shape of the telescope optics. These errors can be corrected physically, with active and adaptive optics, and in post-processing of the resulting image. A recently-developed adaptive optics post-processing technique, called kernel phase interferometry, uses linear combinations of phases that are self-calibrating with respect to small errors, with the goal of constructing observables that are robust against the residual optical aberrations in otherwise well-corrected imaging systems. This method has not previously been used to perform astronomical observations from the ground. Here we present a direct comparison between kernel phase and the more established competing techniques, aperture masking interferometry, point spread function (PSF) fitting and bispectral analysis. We resolve the alpha Ophiuchi binary system near periastron, using the Palomar 200-Inch Telescope. This is the first case in which kernel phase has been used to resolve a system close to the diffraction limit with ground-based extreme adaptive optics observations. Excellent agreement in astrometric quantities is found between kernel phase and masking, and kernel phase significantly outperforms PSF fitting and bispectral analysis, demonstrating its viability as an alternative to conventional non-redundant masking under appropriate conditions.