

Diffraction Analysis of Apodized Pupil Mapping Systems

Robert J. Vanderbei

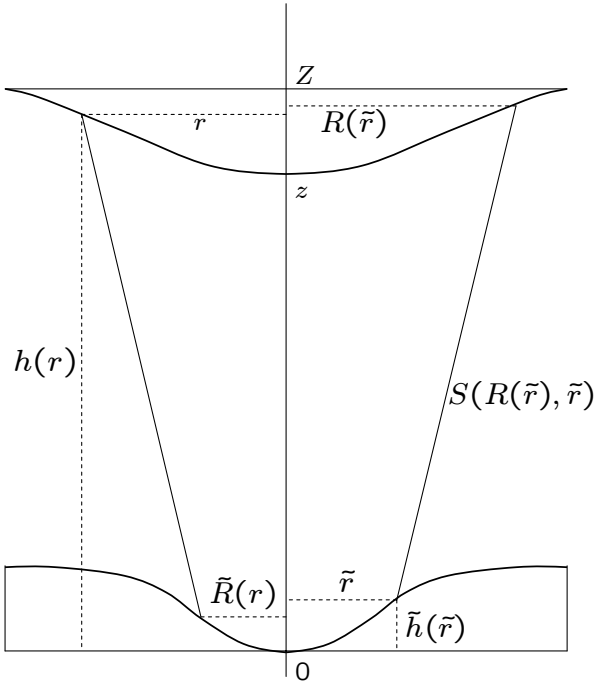
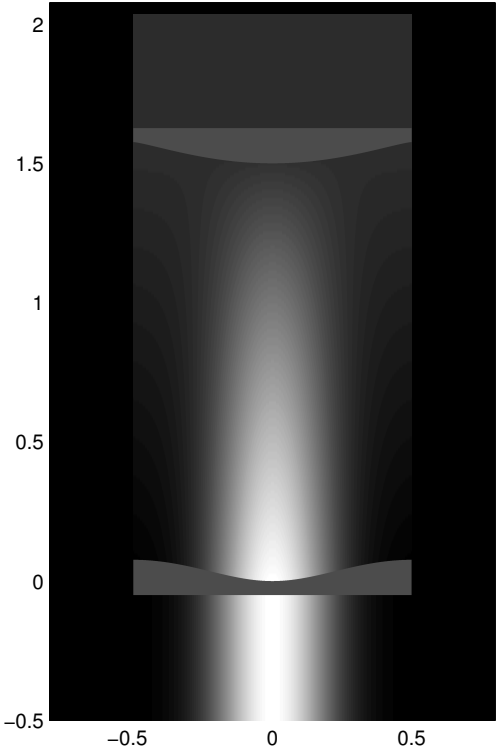
Joint with
Rus Belikov and N. Jeremy Kasdin

April 26, 2006

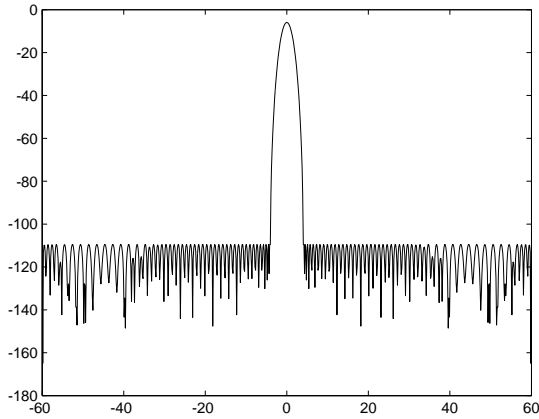
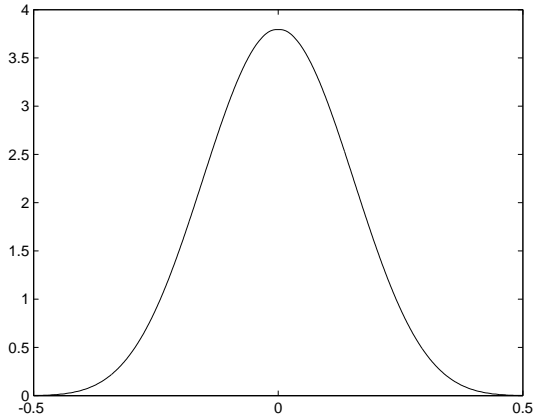
Summary

- Pure pupil mapping (aka PIAA) is similar to apodization.
- Advantages:
 - Ideally 100% throughput (vs. about 10% for apodization).
 - Very small inner working angle (vs. about $4\lambda/D$ for apodization).
- Disadvantages:
 - Doesn't achieve 10^{-10} contrast.
 - Not an imaging system.
 - Hard to manufacture?
- Apodized Pupil Mapping (aka hybrid PIAA) resolves first disadvantage.
- Star occulter with reversed system resolves second disadvantage.
- Sensitivity to Zernike perturbations are shown.

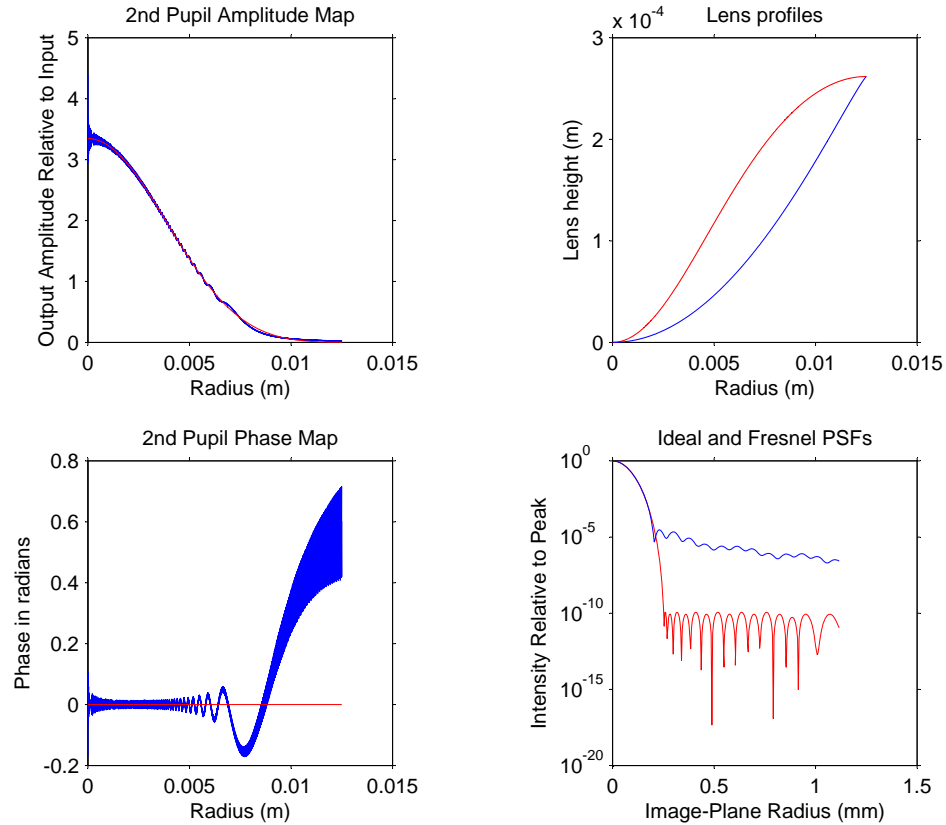
Pupil Mapping via Ray Optics



High-Contrast Amplitude Profiles

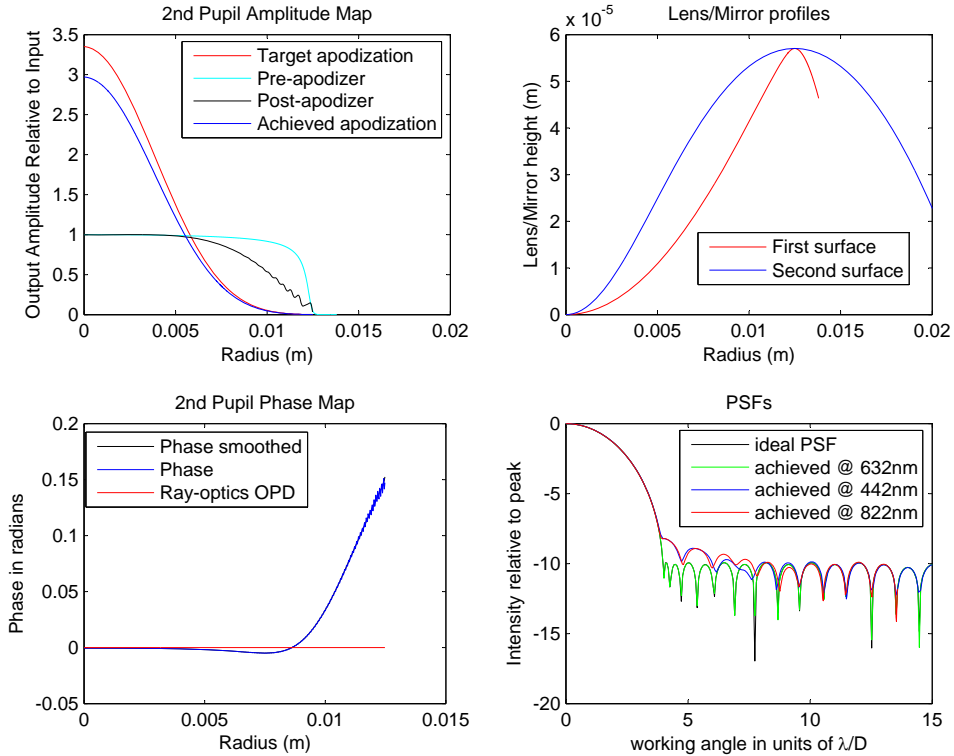


Diffraction Analysis: Pupil Mapping



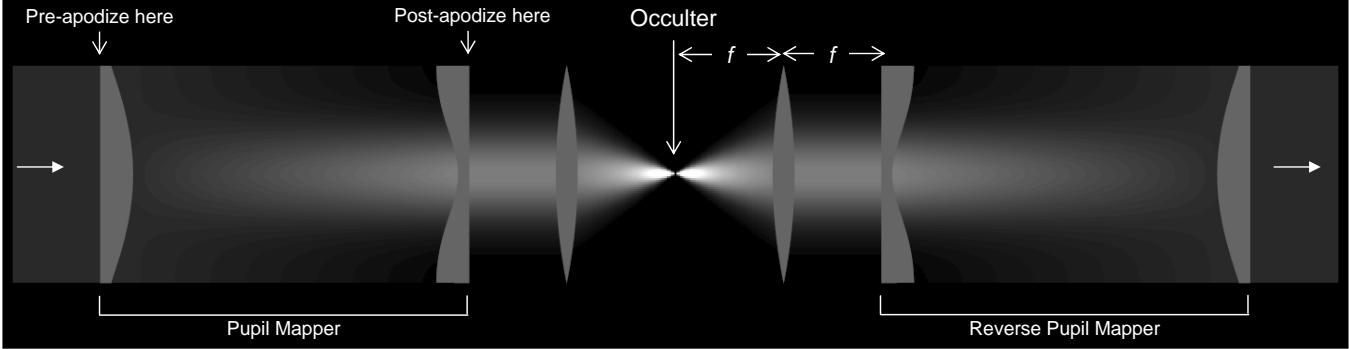
Yikes!! Contrast lost.

Apodized Pupil Mapping

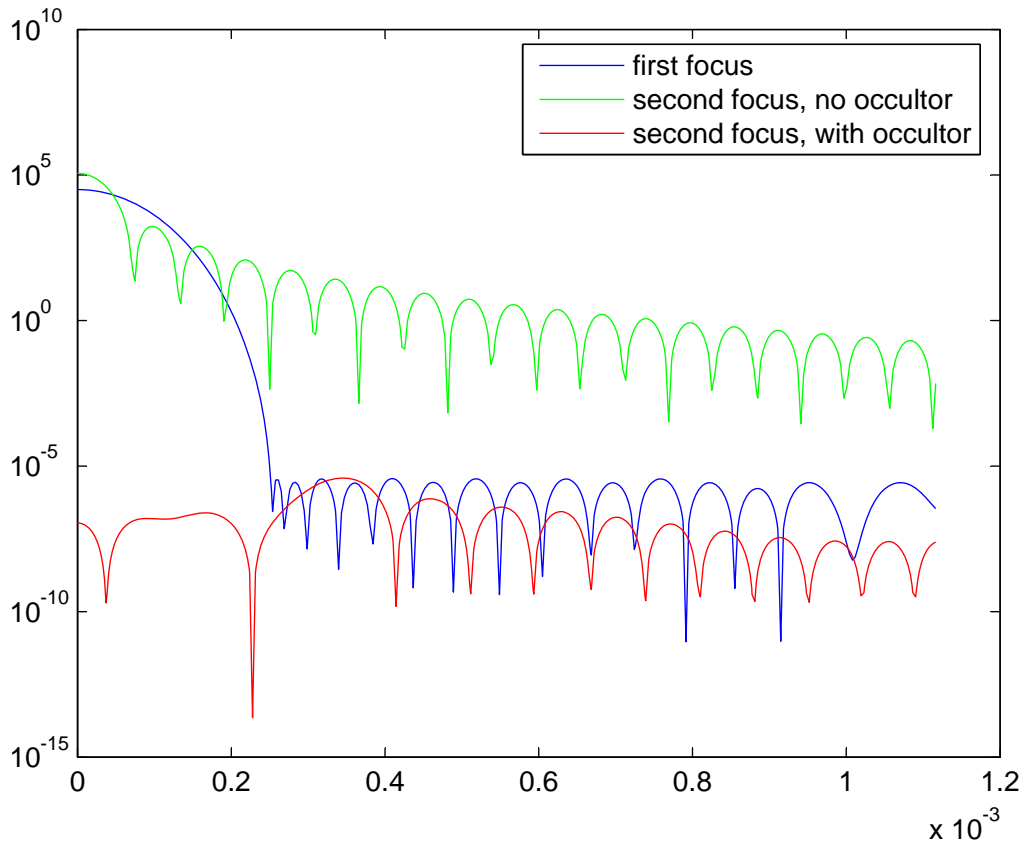


Contrast regained. Slightly chromatic.

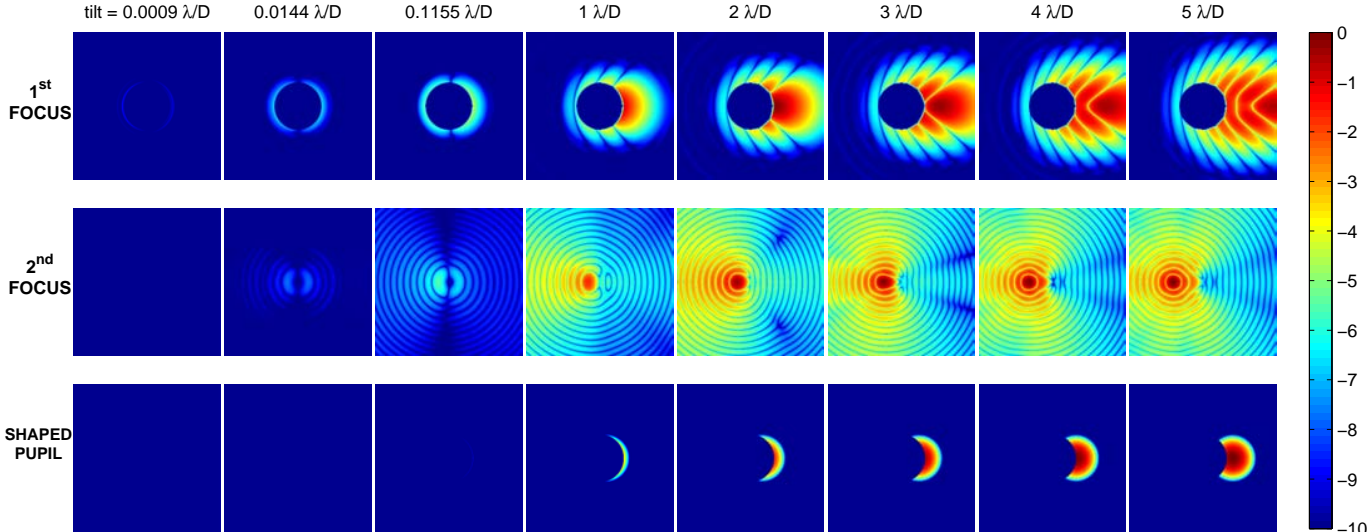
Occulter and Wavefront Reconstruction



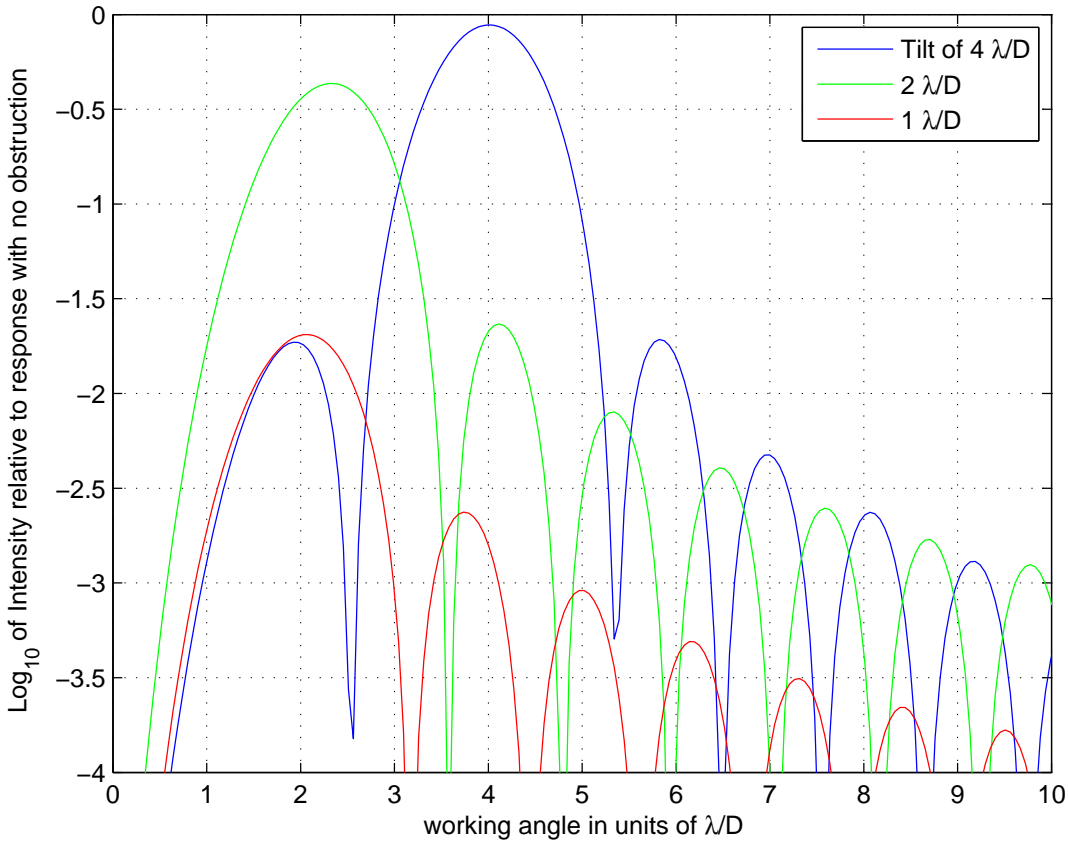
On-Axis PSF at First and Second Focus



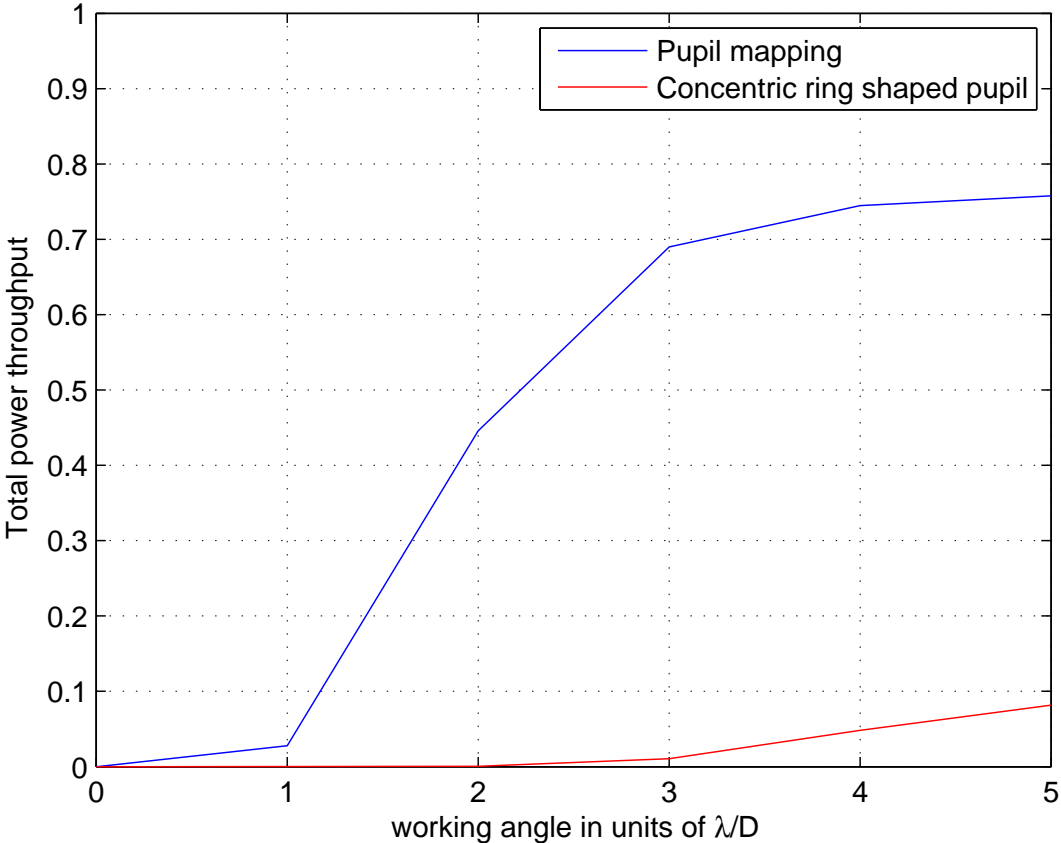
Off-axis Planet Images



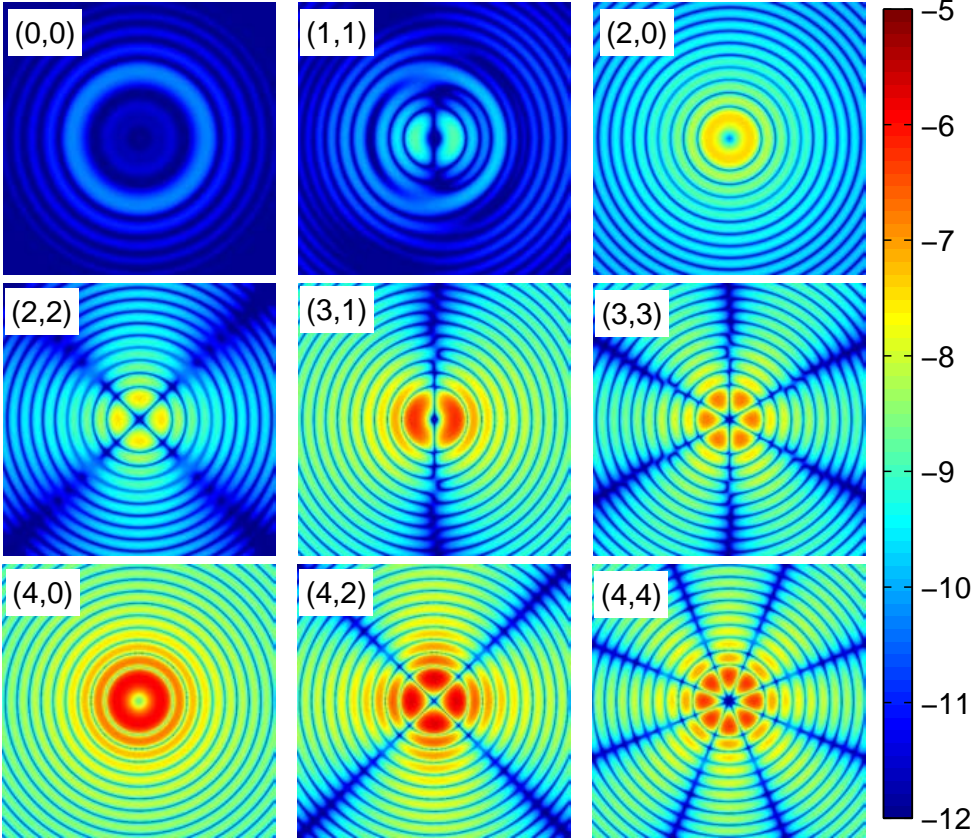
Cross-Sectional Plots



Off-Axis Source Attenuation

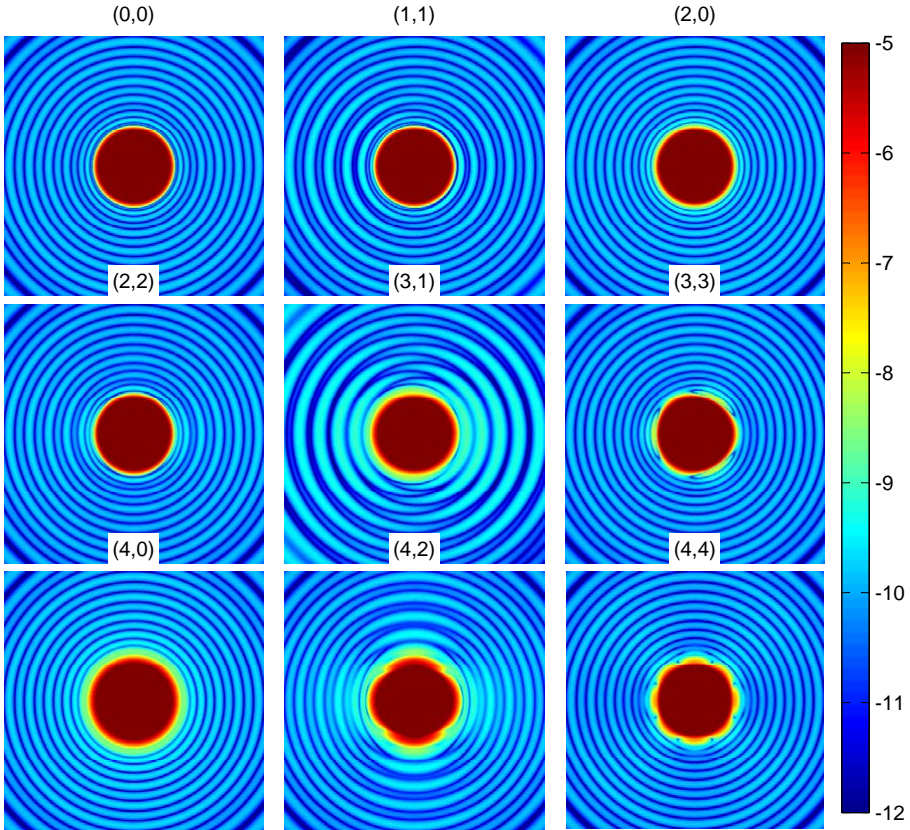


Zernike Sensitivities: Apodized Pupil Mapping

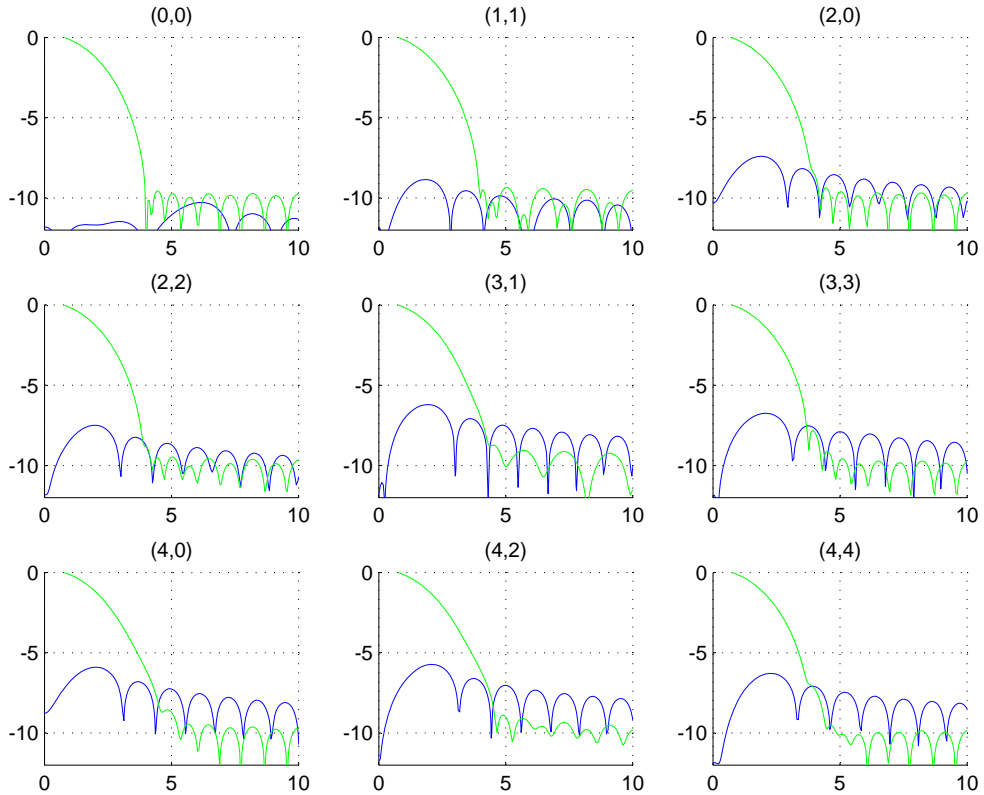


1/100th wave rms

Zernike Sensitivities: Concentric Ring Mask



Radial Profiles from Previous Two Slides



Contrast Degradation vs. RMS Error

