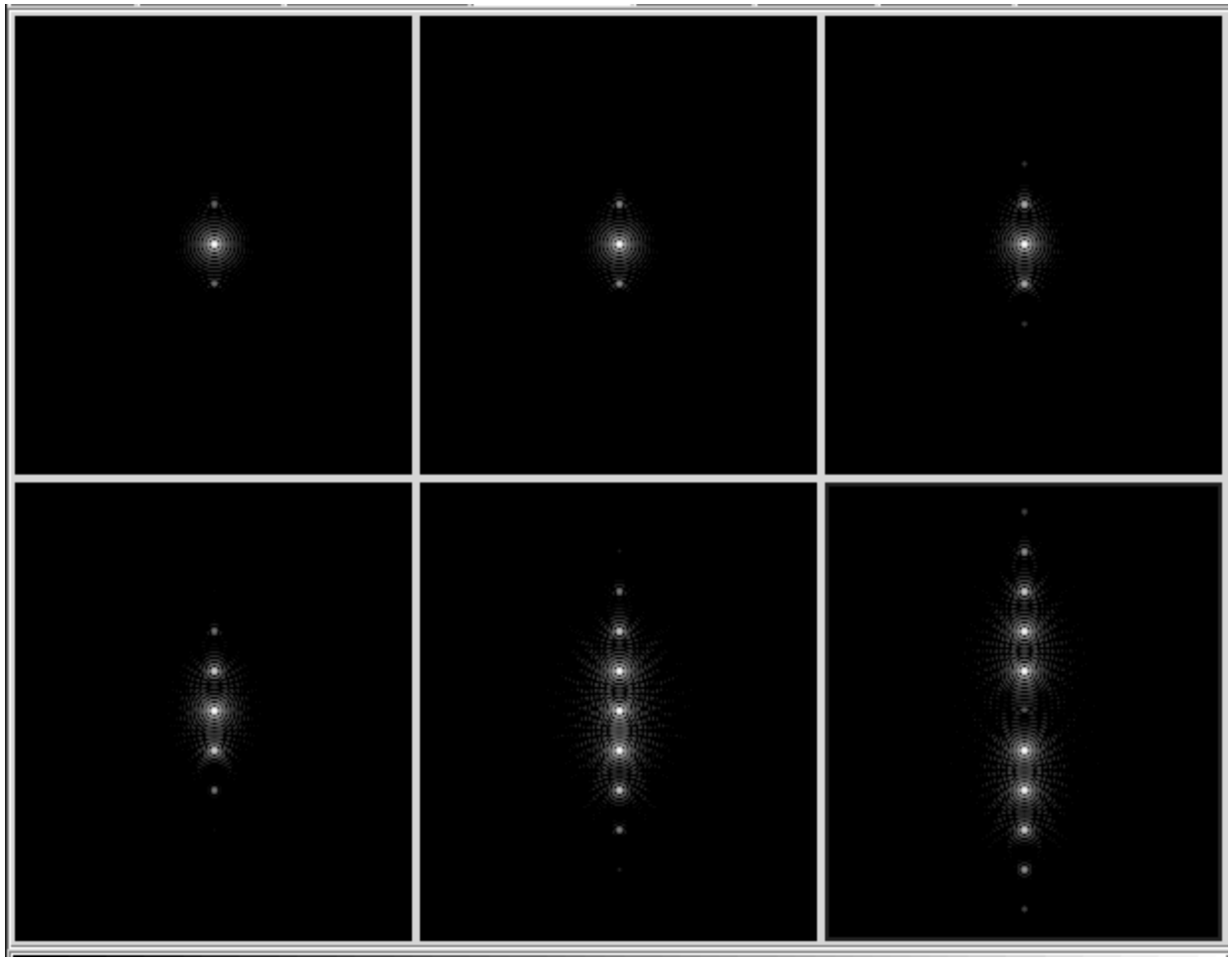
Phase aberrations in cycles per diameter

Think Fourier

Sine wave aberration is a pair of delta functions in its 'Fourier transform domain'

At small amplitudes this corresponds to pair of bright spots in the PSF:
pupil: $\exp(i\phi) \sim 1 + i\phi$
image: $\delta(0)$ + FT(sine)

As size of aberration increases, $\exp(i\phi)$ expansion gets higher order terms. Quadratic terms produce spots at twice the separation...



Part II - PSF theory

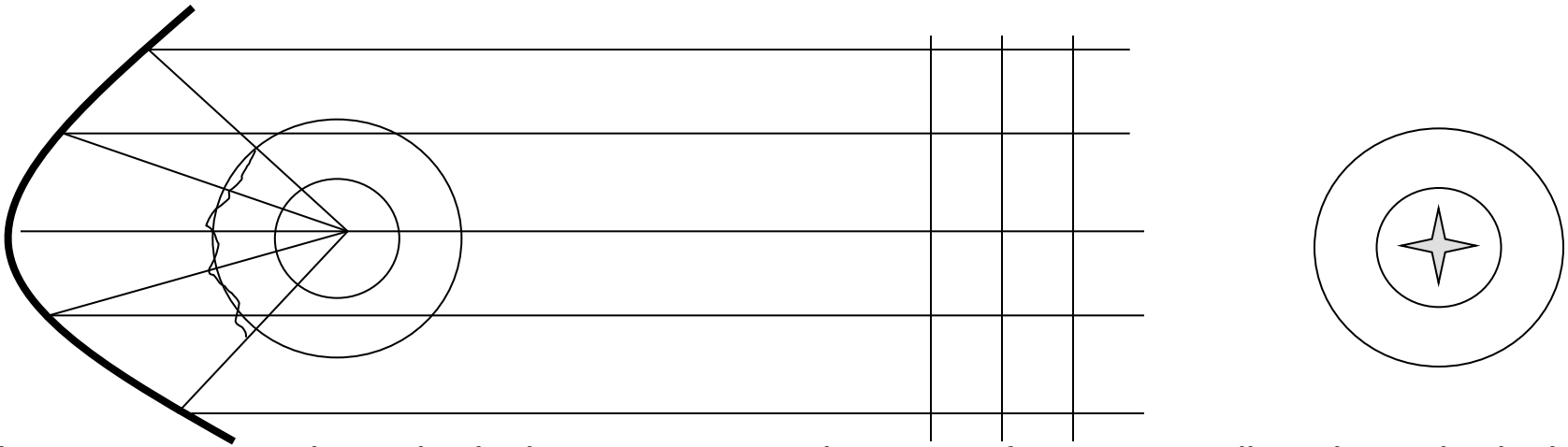
Optical Path Difference
This is the deviation of the wavefront from 'perfect'… when talking of an image being formed by a converging wavefront,

THE DEVIATION OF THE WAVEFRONT FROM THE
PERFECT SPHERICAL CONVERGING WAVE

is the optical path difference.

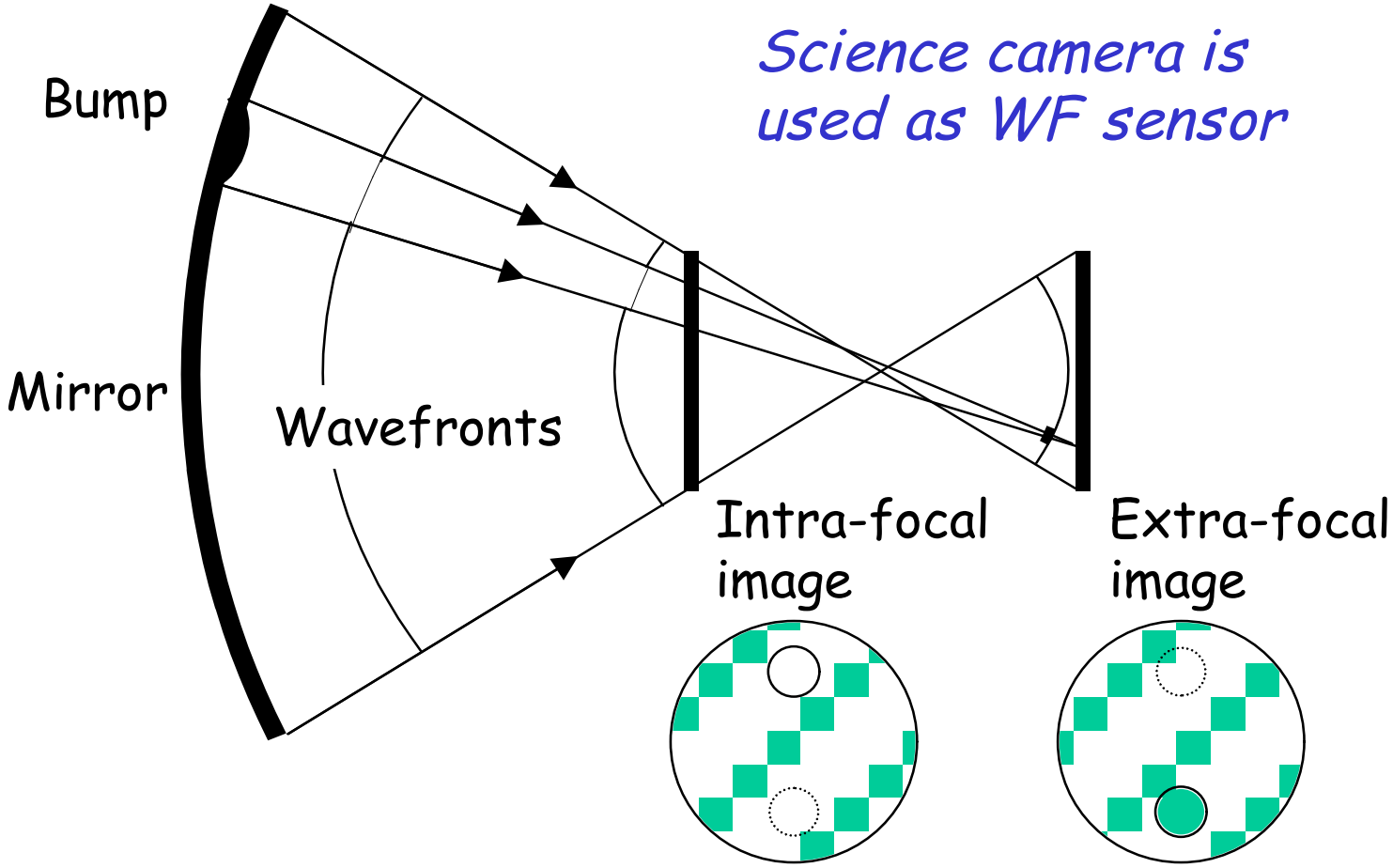
In a collimated beam such as an interferometer, the deviation of a wavefront from the perfect, flat wavefront is the OPD.

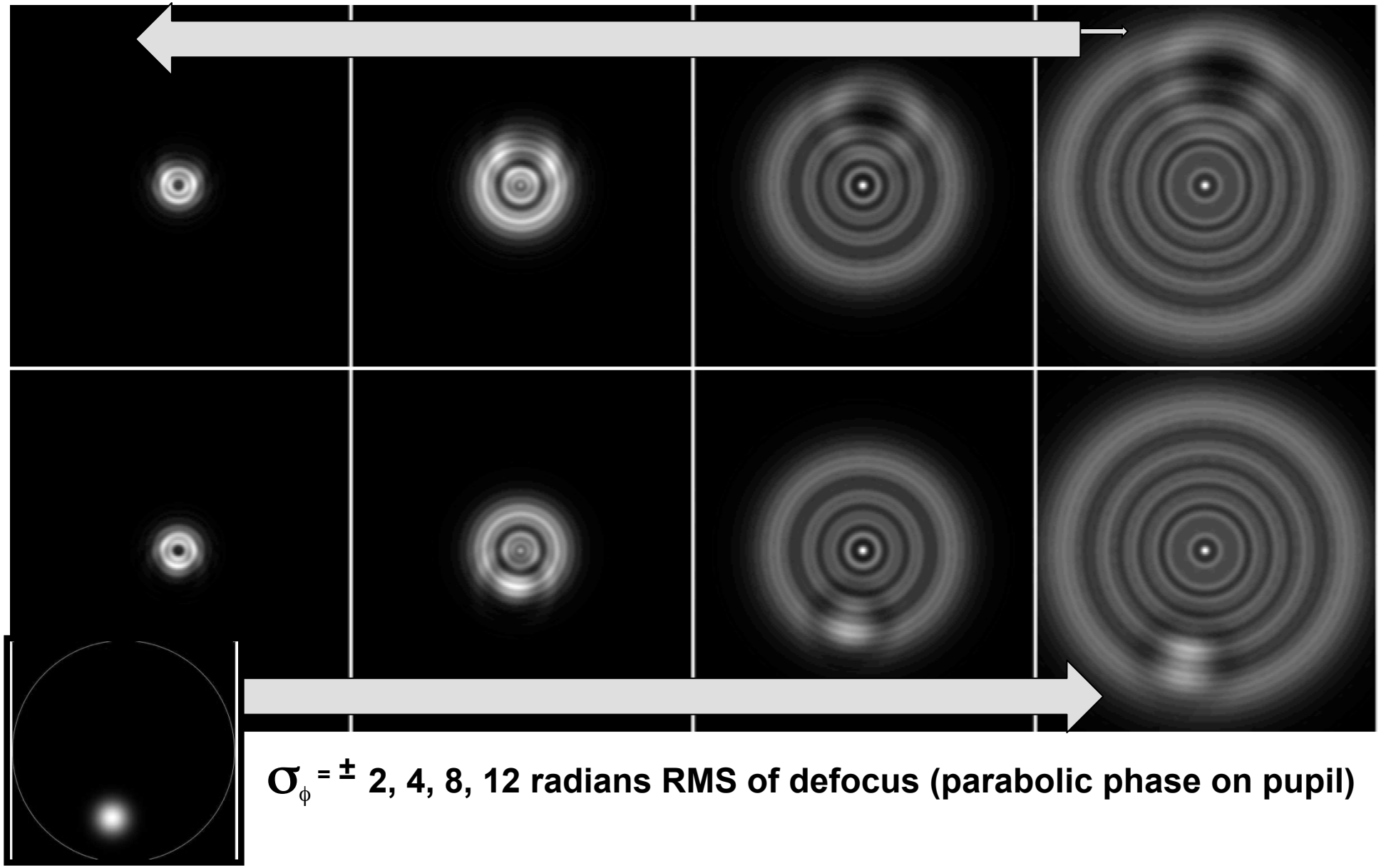
OPD(x,y) is a real function in 'pupil space', dimensions of LENGTH usually
At wavelength it is expressed in RADIANS of PHASE: $\phi(x,y) = (2\pi / \lambda)OPD(x,y)$



Ray optics converging spherical plane wavefronts diverging spherical

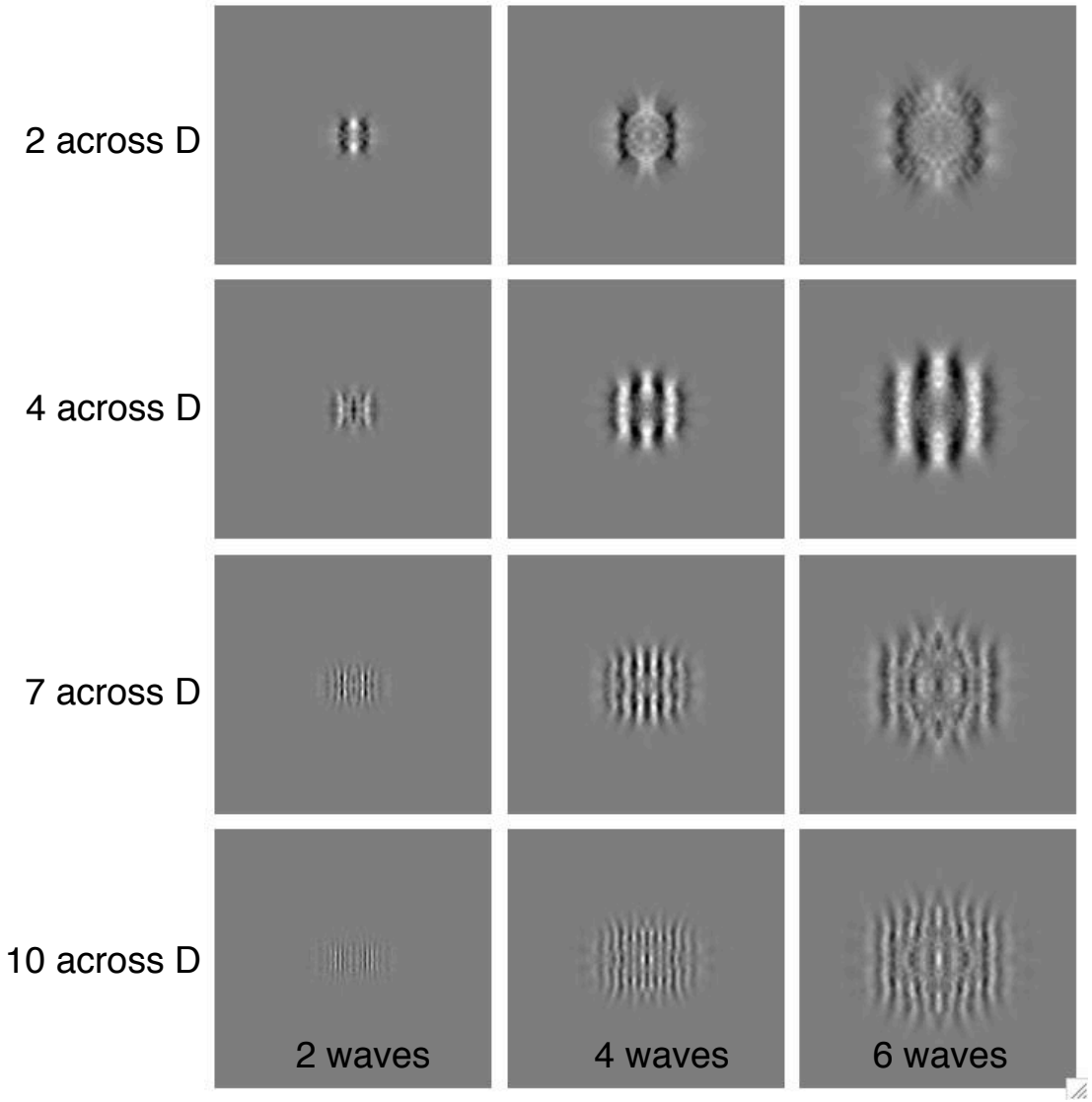
Unfocussed images measure the mirrors





$\sigma_\phi = \pm$ 2, 4, 8, 12 radians RMS of defocus (parabolic phase on pupil)

Choosing the amount of defocus



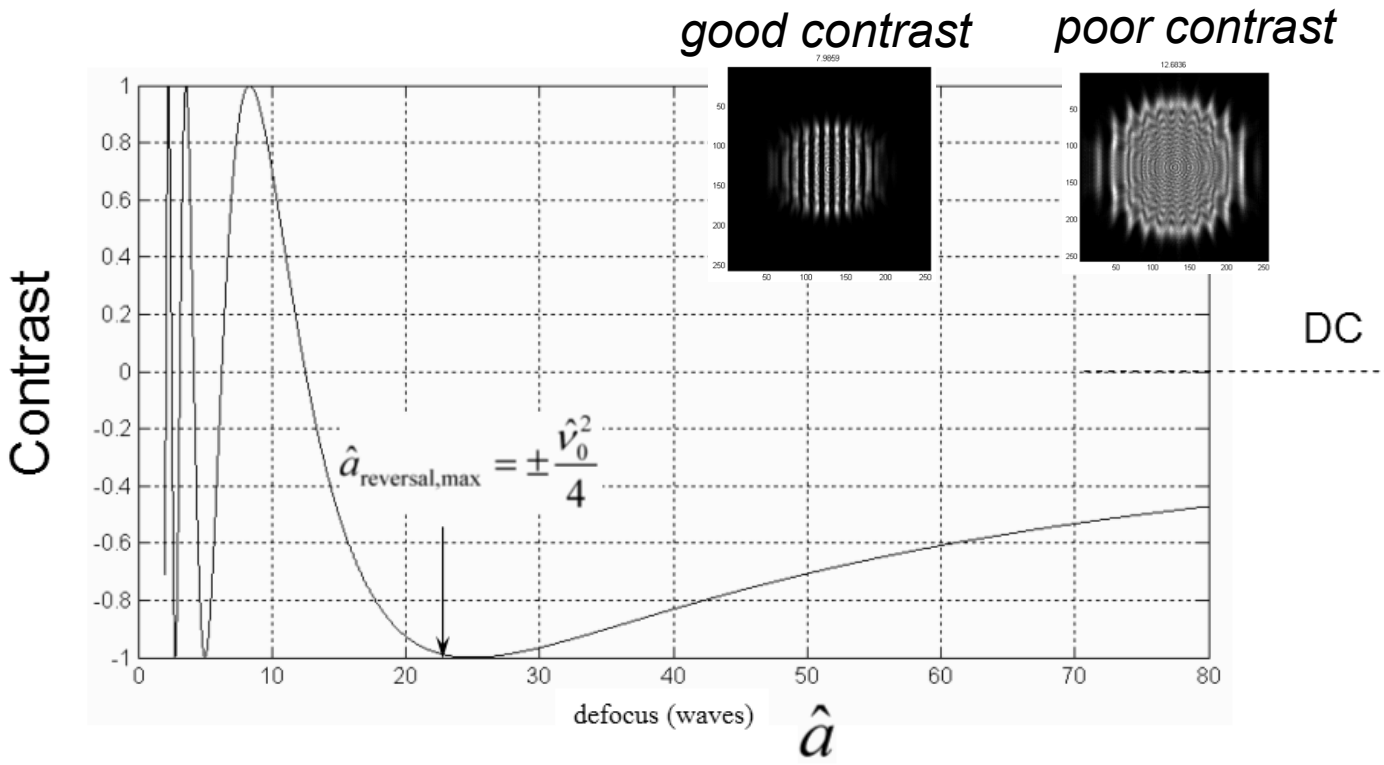
Numerical experiment

Place a sinusoidal phase aberration over the pupil and try three different amounts of defocus.

pre-focus image
-
rotated post-focus image
=
signal

What is the best defocus to use?

Signal strength for given spatial frequency of aberration (number of ripples across mirror) is periodic in 1/defocus



B. Dean, C. Bowers, "Diversity Selection for Phase-Diverse-Phase-Retrieval," JOSA, 20(8), 2003, pp. 1490-1504