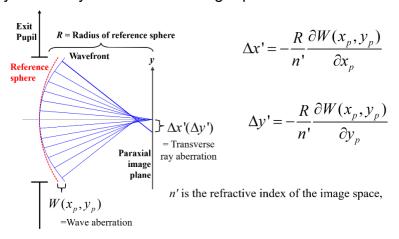
## Homework 3

## Introduction to Computational Optics, Lecturer: Zexin Feng

1. Prove that the (transverse) ray aberrations and wave aberrations are commonly related by means of following equations shown in this figure.



 Read "Chapter 8, Wavefront Aberrations, in Voelz, David George, Computational Fourier optics: a MATLAB tutorial, 2011" and finish Exercise 8.4.

Parabolic Mirror: A mirror with a parabolic curvature has a diffractionlimited PSF for an incident plane wave at zero field angle (traveling down the optical axis). Figure 8.10 shows a ray trace diagram from ZEMAX of an f/5 parabolic mirror arrangement. In practice, the converging light is usually directed out of the incoming beam with a second mirror, for example, a small flat mirror at a 45-deg angle, but that issue is ignored here. The mirror parameters are f=200 mm, diameter = 40 mm, and the maximum image height is 3.5 mm. The Seidel aberration coefficients are shown in Table 8.3 for the He–Ne laser wavelength 0.633 µm (a common wavelength for component testing). Alter the lens\_psfmtf script to model this mirror. Use M = 1024 and L = $0.1 \times 10^{-3}$  m. Generate the PSF and MTF for the following image position coordinates  $(u_0, v_0)$ : (0, 0), (0, 1), and (0.707, 0.707).

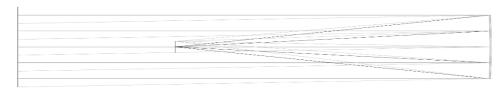


Figure 8.10 ZEMAX ray trace layout for f /5 parabolic mirror. Focal length (effective) =200 mm, pupil diameter = 40 mm. Incident field angles are 0 and 1 deg, corresponding to image plane heights of 0 and 3.5 mm.

**Table 8.3** Seidel coefficient values for f/5 parabolic mirror (ZEMAX).

Coefficient	Value <sup>a</sup>
$W_d$	0
$W_{040}$	0
$W_{131}$	$-1.3792\lambda$
$W_{222}$	$0.4815\lambda$
$W_{222} = W_{220}^{b}$	0
$W_{311}$	0

<sup>&</sup>lt;sup>a</sup>  $\lambda = 0.633 \ \mu m$ .

Please kindly submit both the Matlab (or Octave, or Python) code and the corresponding resulting word (or pdf) files to Nanshun Jiang (姜南顺) (Email: jnswangyi@163.com or through ibit)

Due: 2024/12/08

<sup>&</sup>lt;sup>b</sup> Sagittal field curvature.