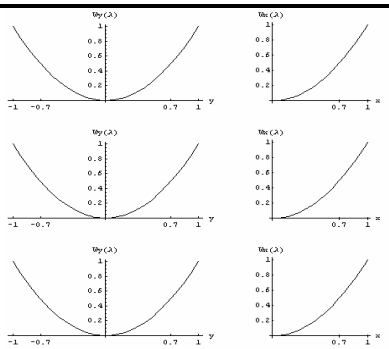
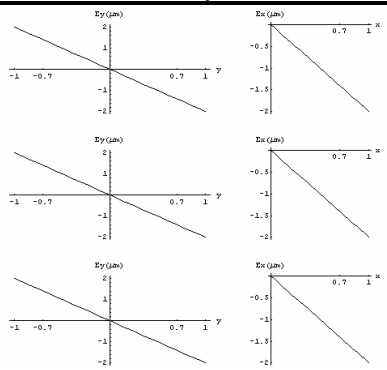
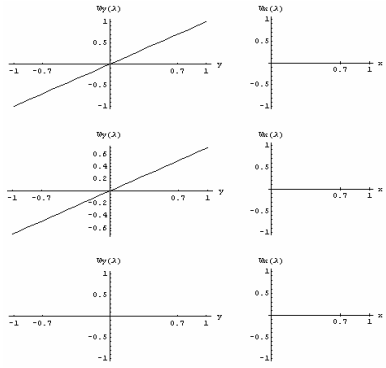
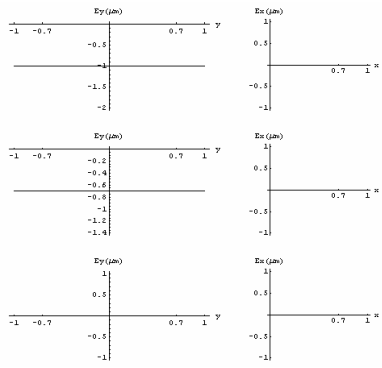
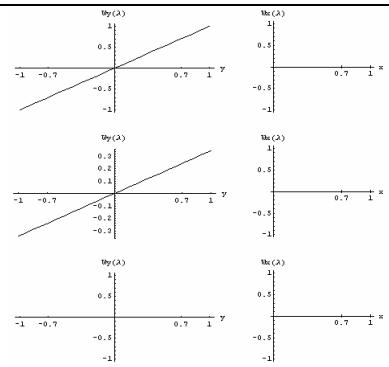
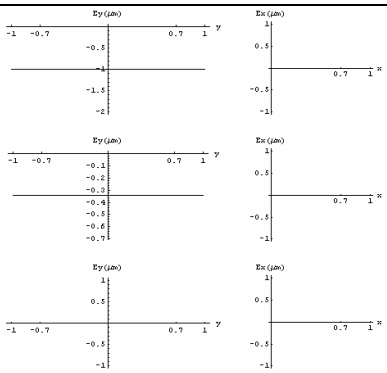
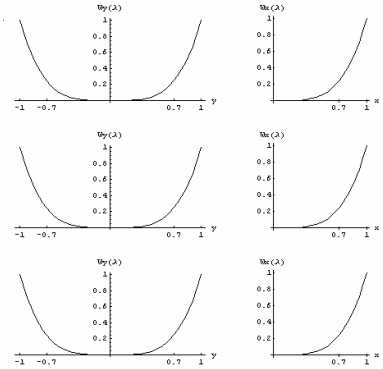
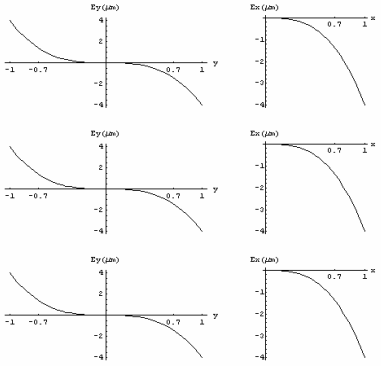
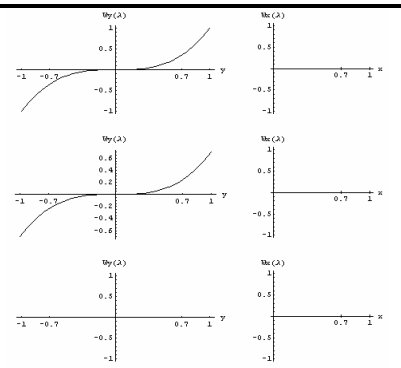
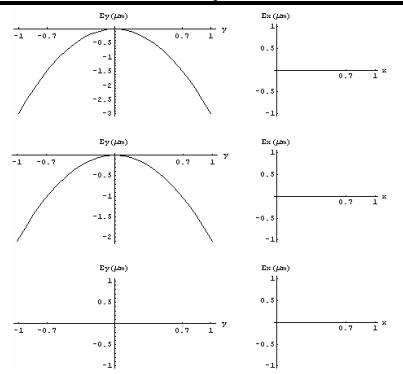
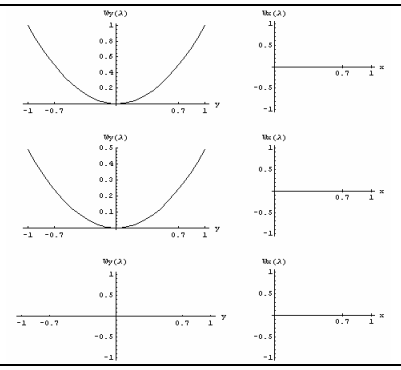
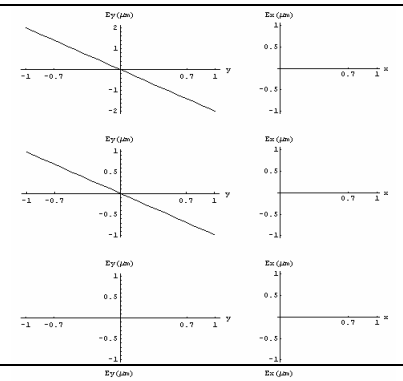
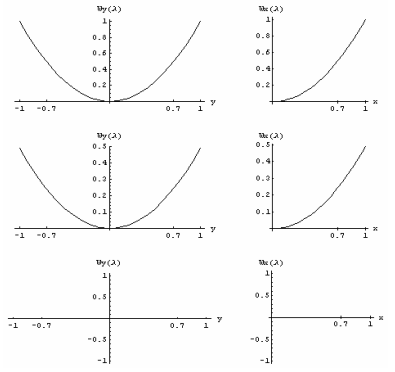
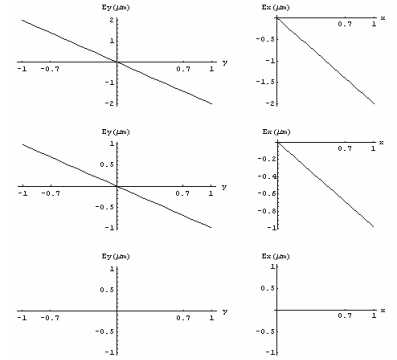
Table A1. Third Order Ray and Fourth Order Wave (OPD) Plots. §

Aberration	OPD	Ray	Field
DEFOCUS = $W_{020}\,\rho^2$ **OPD:** Curvature @ origin $W_y = W_{020} y_p^2$ $W_x = W_{020} x_p^2$ **Ray:** Same slope $\varepsilon_y = -2\left(\frac{R}{r_p}\right) W_{020}\rho Cos\theta = -2\left(\frac{R}{r_p}\right)\Delta W_{20} y_p$ $\varepsilon_x = -2\left(\frac{R}{r_p}\right) W_{020}\rho Sin\theta = -2\left(\frac{R}{r_p}\right)\Delta W_{20} x_p$			H=1 H=0.7 H=0
TILT = $W_{111}\,H\rho Cos\theta$ **OPD:** Different slope increasing with field (linearly) $W_y = W_{111} H y_p$ $W_x = 0$ **Ray:** Distance from origin increases with field $\varepsilon_y = -\left(\frac{R}{r_p}\right) W_{111} H = -\left(\frac{R}{r_p}\right)\Delta W_{11} H$ $\varepsilon_x = 0$			H=1 H=0.7 H=0
DIST = $W_{311}\,H^3\rho Cos\theta$ **OPD:** Different slope increasing with field (cubically) $W_y = W_{311} H^3 y_p$ $W_x = 0$ **Ray:** Distance from origin increases with field $\varepsilon_y = -\left(\frac{R}{r_p}\right) W_{311} H^3$ $\varepsilon_x = 0$			H=1 H=0.7 H=0
SA = $W_{040}\,\rho^4$ **OPD:** No curvature @ origin; $W_y = W_{040} y_p^4$ $W_x = W_{040} x_p^4$ **Ray:** $\varepsilon_y = -4\left(\frac{R}{r_p}\right) W_{040}\rho^3 Cos\theta = -4\left(\frac{R}{r_p}\right) W_{040} y_p^3$ $\varepsilon_x = -4\left(\frac{R}{r_p}\right) W_{040}\rho^3 Sin\theta = -4\left(\frac{R}{r_p}\right) W_{040} x_p^3$			H=1 H=0.7 H=0

§ See below **Table A2** for explanation.

Table A2. Third Order Ray and Fourth Order Wave (OPD) Plots. §

Aberration	OPD	Ray	Field
COMA = W_{131} $H\rho^3 Cos\theta$ **OPD:** $W_y = W_{131} H y_p^3$ $W_x = 0$ **Ray:** Quadratic $\varepsilon_y = -\left(\frac{R}{r_p}\right) W_{131} H\rho^2 (2 + Cos2\theta) = -3\left(\frac{R}{r_p}\right) W_{131} H y_p^2$ $\varepsilon_x = -\left(\frac{R}{r_p}\right) W_{131} H\rho^2 Sin2\theta = 0$ (when $x_p = 0$)			H=1 H=0.7 H=0
ASTIG = W_{222} $H^2\rho^2 Cos^2\theta$ **OPD:** Different curvature with field $W_y = W_{222} H^2 y_p^2$ $W_x = 0$ **Ray:** Different slope increases with field $\varepsilon_y = -2\left(\frac{R}{r_p}\right) W_{222} H^2 \rho Cos\theta = -2\left(\frac{R}{r_p}\right) W_{222} H^2 y_p$ $\varepsilon_x = 0$			H=1 H=0.7 H=0
FC = W_{220} $H^2\rho^2$ **OPD:** $W_y = W_{220} H^2 y_p^2$ $W_x = W_{220} H^2 x_p^2$ **Ray:** Different slope increases with field $\varepsilon_y = -2\left(\frac{R}{r_p}\right) W_{220} H^2 \rho Cos\theta = -2\left(\frac{R}{r_p}\right) W_{220} H^2 y_p$ $\varepsilon_x = -2\left(\frac{R}{r_p}\right) W_{220} H^2 \rho Sin\theta = -2\left(\frac{R}{r_p}\right) W_{220} H^2 x_p$			H=1 H=0.7 H=0

§ Represented plots: Tangential on left (x_p=0) and Sagittal on right (y_p=0). OPD axes: W vs. y_p & W vs x_p and Ray axes: ε_y vs. y_p & ε_x vs. x_p. R = radius of reference sphere, r_p = radius of pupil, y_p = aperture, H = field, $\left(\frac{R}{r_p}\right) \approx 2F/\#$,

$y_p = \rho Cos\theta$, $x_p = \rho Sin\theta$, $\rho^2 = x_p^2 + y_p^2$. Ray Fan plots: $\varepsilon_y = -\frac{R}{r_p}\frac{\partial W}{\partial y_p}$ and $\varepsilon_x = -\frac{R}{r_p}\frac{\partial W}{\partial x_p}$

Combined equations for plotting OPD and Ray Fans with multiple aberrations present: (For plots F/1, λ = 0.5μm and $W_{aberration}$ = 1)

$$W_y = W_{020} y^2 + W_{111} H y + W_{311} H^3 y + W_{040} y^4 + W_{131} H y^3 + W_{222} H^2 y^2 + W_{220} H^2 y^2$$

$$W_x = W_{020} x^2 + W_{040} x^4 + W_{220} H^2 x^2$$

$$\varepsilon_y = -\frac{R}{r_p}\left[2W_{020} y + W_{111} H + W_{311} H^3 + 4W_{040} y^3 + 3W_{131} H y^2 + 2W_{222} H^2 y + 2W_{220} H^2 y\right]$$

$$\varepsilon_x = -\frac{R}{r_p}\left[2W_{020} x + 4W_{040} x^3 + 2W_{220} H^2 x\right]$$

Table A3. Wavefront Maps (3 waves of aberration).

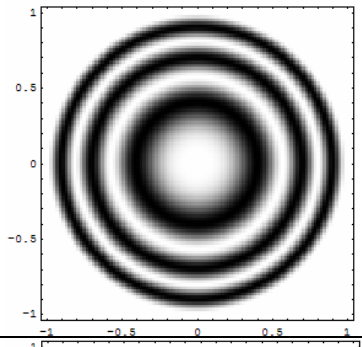
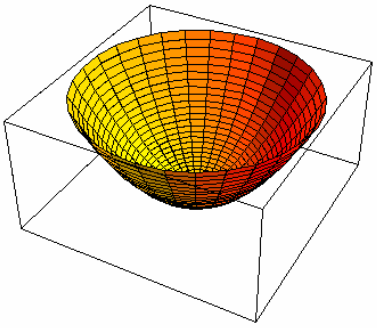
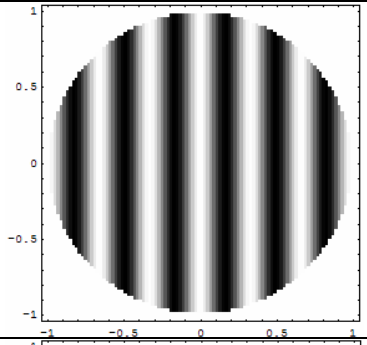
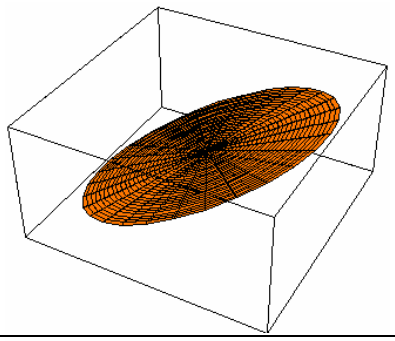
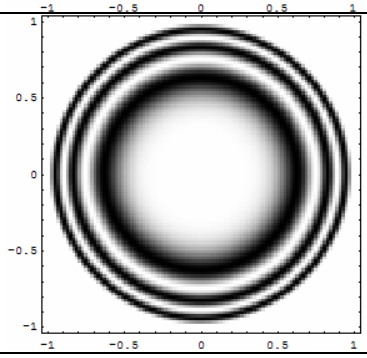
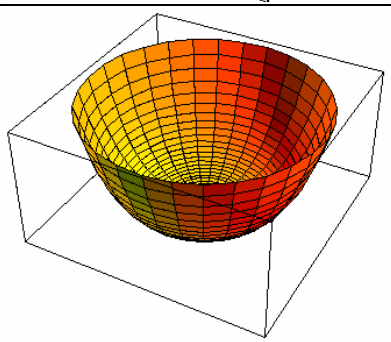
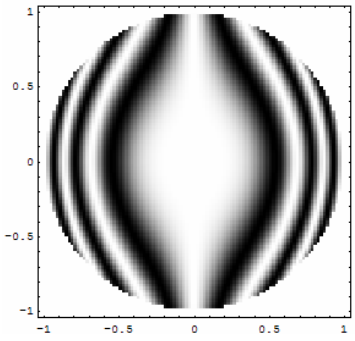
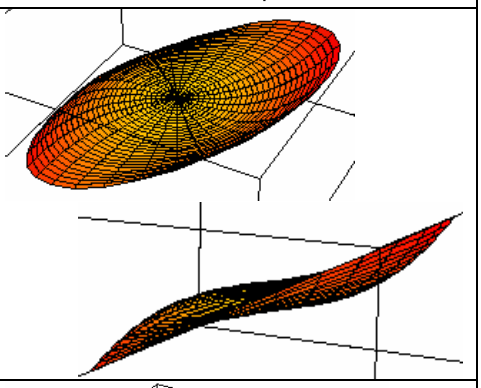
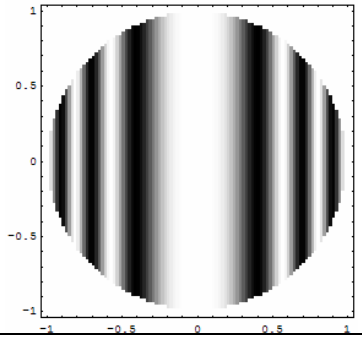
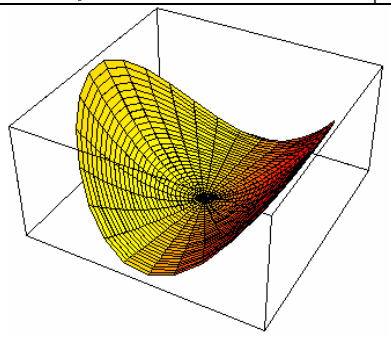
Aberration	Density Plot	Cylindrical 3D Plot
DEFOCUS = $W_{020}\,\rho^2$ $W_y = W_{020} y_p^2$ $W_x = W_{020} x_p^2$		
TILT = $W_{111}\,H\rho\cos\theta$ $W_y = W_{111} H y_p$ $W_x = 0$		
SA = $W_{040}\,\rho^4$ $W_y = W_{040} y_p^4$ $W_x = W_{040} x_p^4$		
COMA = $W_{131}\,H\rho^3\cos\theta$ $W_y = W_{131} H y_p^3$ $W_x = 0$		
ASTIG = $W_{222}\,H^2\rho^2\cos^2\theta$ $W_y = W_{222} H^2 y_p^2$ $W_x = 0$		

Table A4. Wavefront Maps for combinations of spherical, coma and astigmatism.