Course Notes

SPIE Education Services

SC1272
Mirror System Design with Freeform Surfaces

José Sasián
Wyant College of Optical Sciences
University of Arizona

SPIE.
SPIE.org

Table of aberrations of a plane symmetric systems

Aberration terms of a plane symmetric system	
First group	
W_{00000}	Piston
Second group	
$W_{01001}\vec{i}\cdot\vec{\rho}$	Field displacement
$W_{10010}\vec{i}\cdot\vec{H}$	Linear Piston
$W_{02000}\vec{\rho}\cdot\vec{\rho}$	Defocus
$W_{11100}\vec{H}\cdot\vec{\rho}$	Magnification
$W_{20000}\vec{H}\cdot\vec{H}$	Quadratic Piston
Third group	
$W_{02002}\left(\vec{i}\cdot\vec{\rho}\right)^2$	Uniform astigmatism
$W_{11011}\left(\vec{i}\cdot\vec{H}\right)\left(\vec{i}\cdot\vec{\rho}\right)$	Anamorphic distortion
$W_{20020}\left(\vec{i}\cdot\vec{H}\right)^2$	Quadratic piston
$W_{03001}\left(\vec{i}\cdot\vec{\rho}\right)\left(\vec{\rho}\cdot\vec{\rho}\right)$	Uniform coma
$W_{12101}\left(\vec{i}\cdot\vec{\rho}\right)\left(\vec{H}\cdot\vec{\rho}\right)$	Linear astigmatism
$W_{12010}\left(\vec{i}\cdot\vec{H}\right)\left(\vec{\rho}\cdot\vec{\rho}\right)$	Field tilt
$W_{21001}\left(\vec{i}\cdot\vec{\rho}\right)\left(\vec{H}\cdot\vec{H}\right)$	Quadratic distortion I
$W_{21110}\left(\vec{i}\cdot\vec{H}\right)\left(\vec{H}\cdot\vec{\rho}\right)$	Quadratic distortion II
$W_{30010}\left(\vec{i}\cdot\vec{H}\right)\left(\vec{H}\cdot\vec{H}\right)$	Cubic piston
$W_{04000}\left(\vec{\rho}\cdot\vec{\rho}\right)^2$	Spherical aberration
$W_{13100}\left(\vec{H}\cdot\vec{\rho}\right)\left(\vec{\rho}\cdot\vec{\rho}\right)$	Linear coma
$W_{22200}\left(\vec{H}\cdot\vec{\rho}\right)^2$	Quadratic astigmatism
$W_{22000}\left(\vec{H}\cdot\vec{H}\right)\left(\vec{\rho}\cdot\vec{\rho}\right)$	Field curvature
$W_{31100}\left(\vec{H}\cdot\vec{H}\right)\left(\vec{H}\cdot\vec{\rho}\right)$	Cubic distortion
$W_{40000}\left(\vec{H}\cdot\vec{H}\right)^2$	Quartic piston

$$W\left(\vec{i},\vec{H},\vec{\rho}\right)=$$

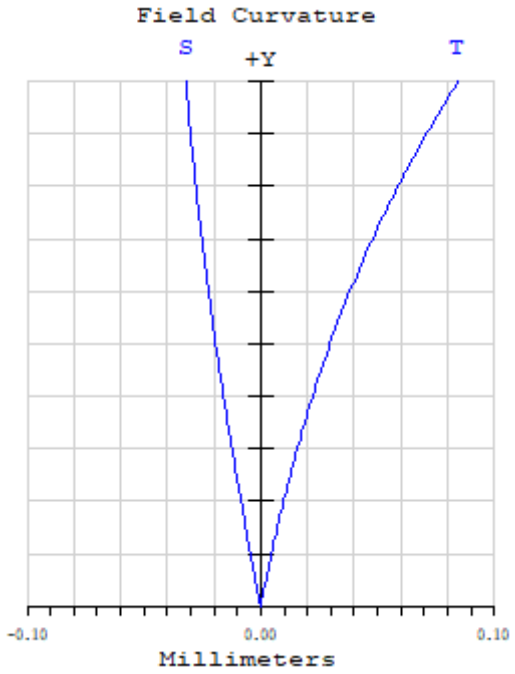
$$\sum_{k,m,n,p,q}^{\infty} W_{\substack{2k+n+p,\\ 2m+n+q,\\ n,p,q}} \left(\vec{H}\cdot\vec{H}\right)^k \left(\vec{\rho}\cdot\vec{\rho}\right)^m \left(\vec{H}\cdot\vec{\rho}\right)^n \left(\vec{i}\cdot\vec{H}\right)^p \left(\vec{i}\cdot\vec{\rho}\right)^q$$

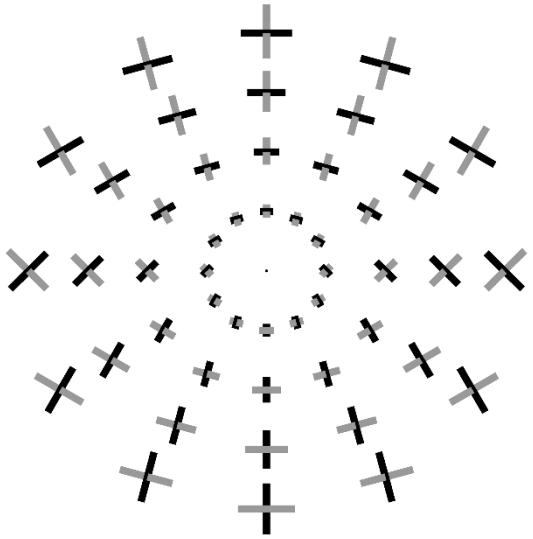
$$\left(\vec{H}\cdot\vec{H}\right)\quad\left(\vec{H}\cdot\vec{\rho}\right)\quad\left(\vec{\rho}\cdot\vec{\rho}\right)$$

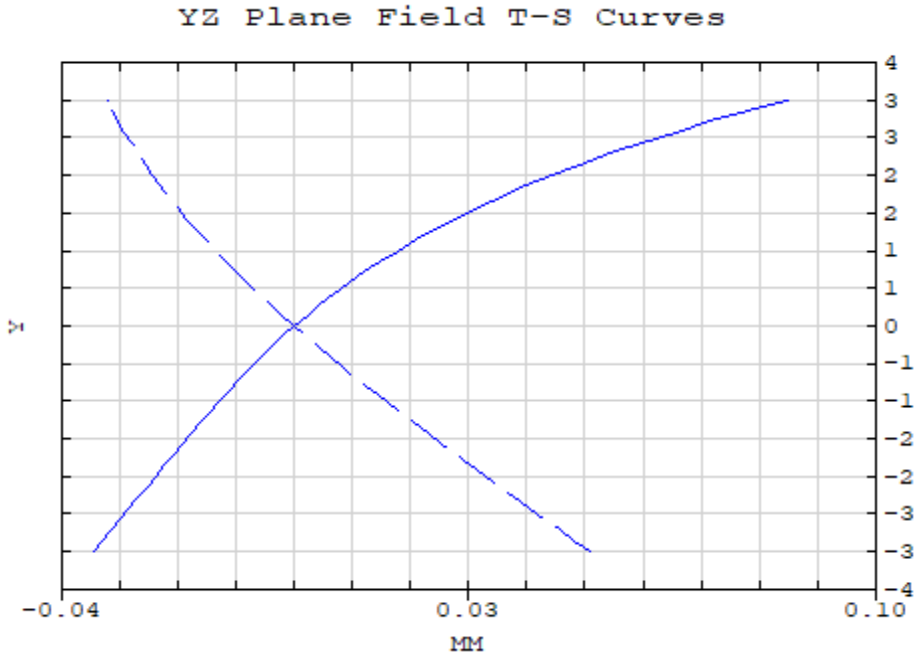
$$\left(\vec{i}\cdot\vec{H}\right)^2\quad\left(\vec{i}\cdot\vec{\rho}\right)^2\quad\left(\vec{i}\cdot\vec{H}\right)\left(\vec{i}\cdot\vec{\rho}\right)$$

$$\left(\vec{i}\cdot\vec{H}\right)\quad\left(\vec{i}\cdot\vec{\rho}\right)$$

Linear Astigmatism





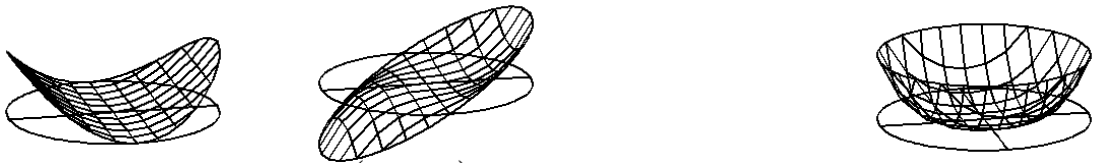


Ad-hoc freeform surface

Sag(X,Y)=Conic+polynomial

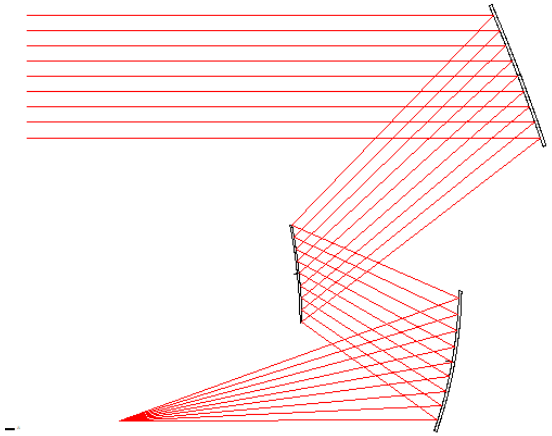
Polynomial aspheric coefficients directly relate to aberration correction

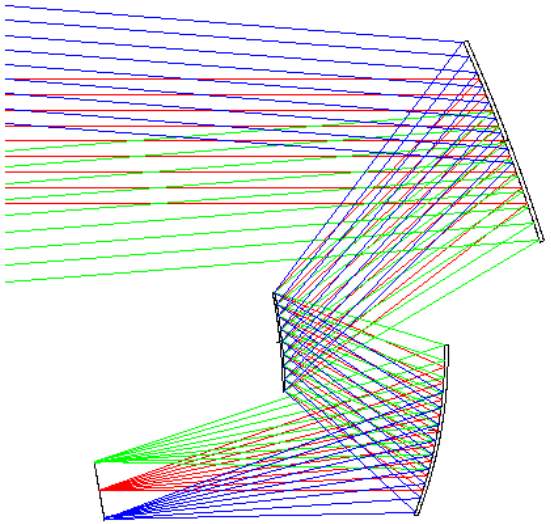
$$z(x,y) = A_1 y^2 + A_2 x^2 y + A_3 y^3 + A_4 x^4 + A_5 x^2 y^2 + A_6 y^4 \ldots$$

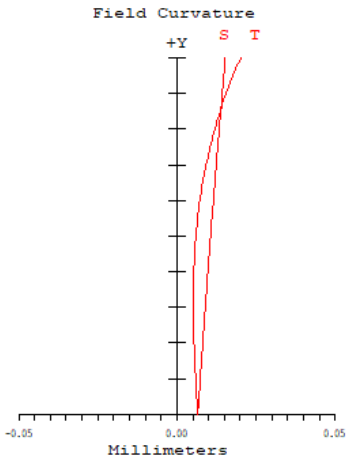


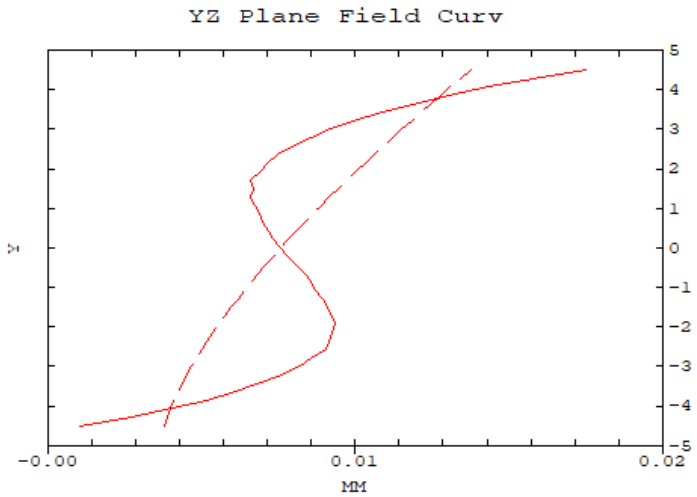
Astigmatism, coma, spherical aberration

Three mirror anastigmatic system I









Tri-nodal astigmatism

Three mirror anastigmatic system II