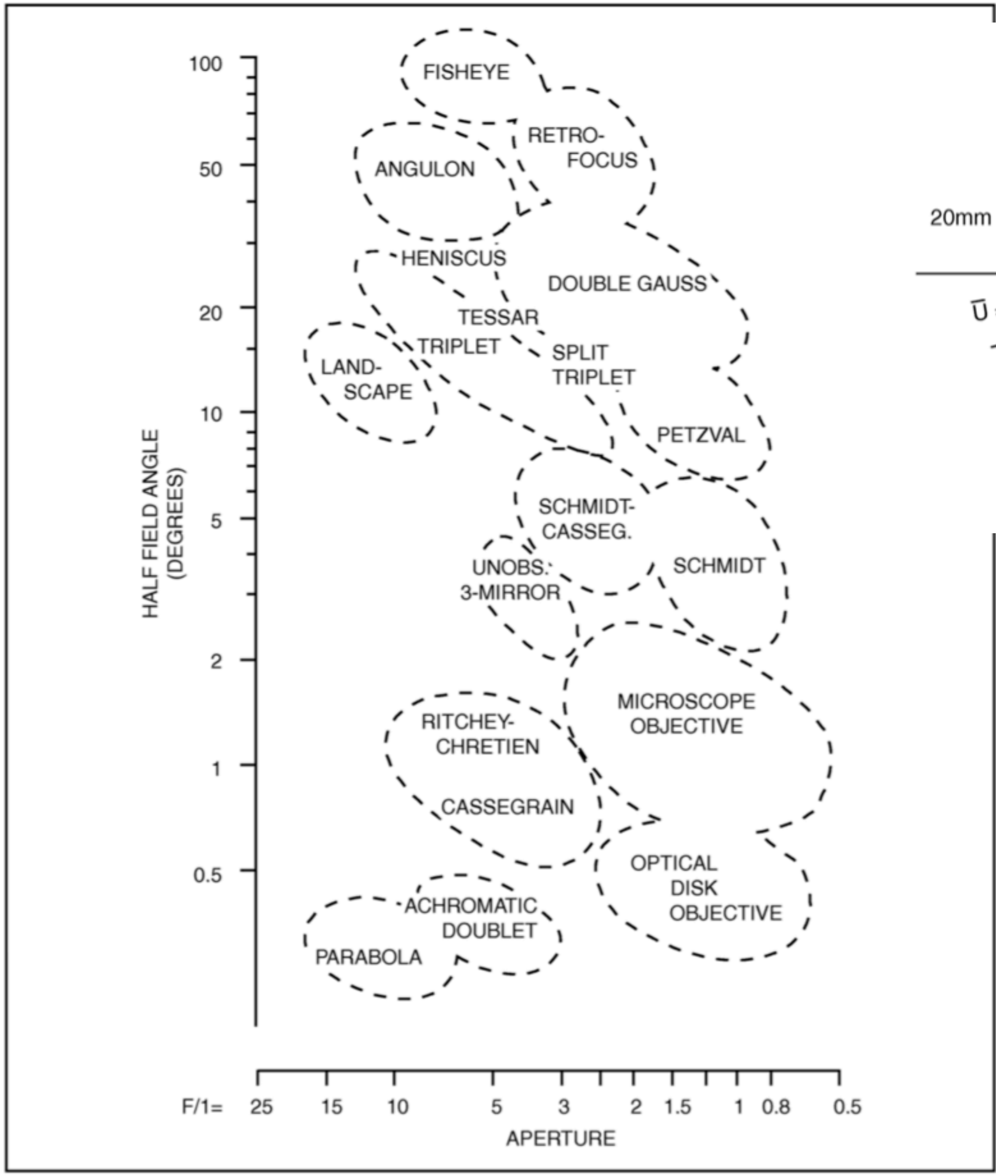


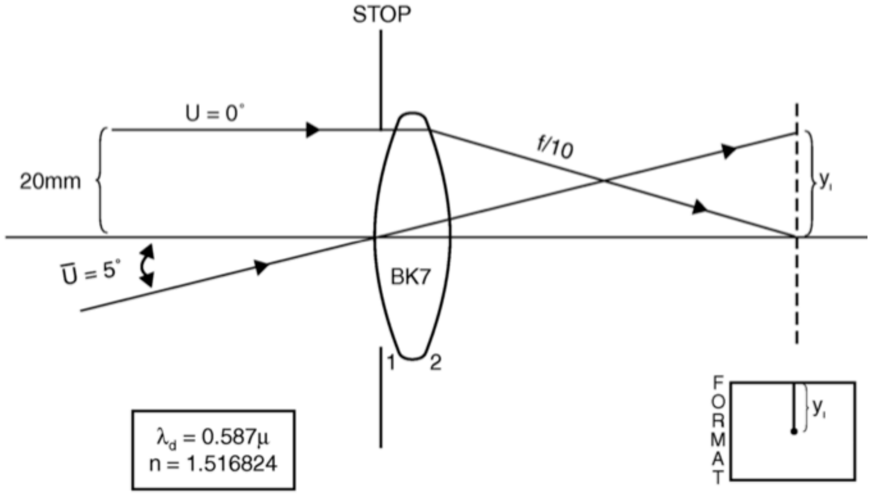
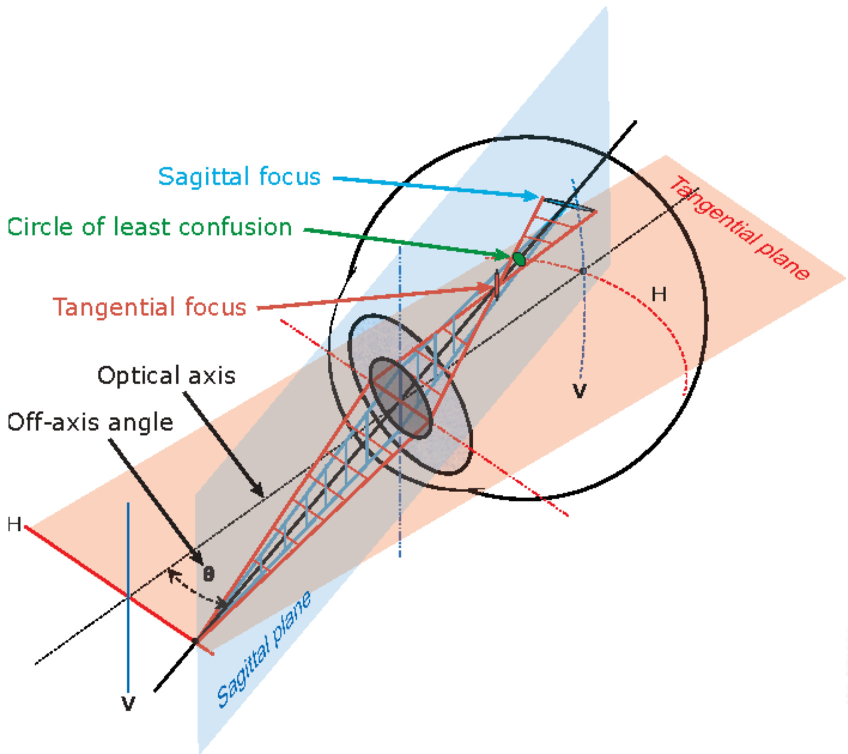
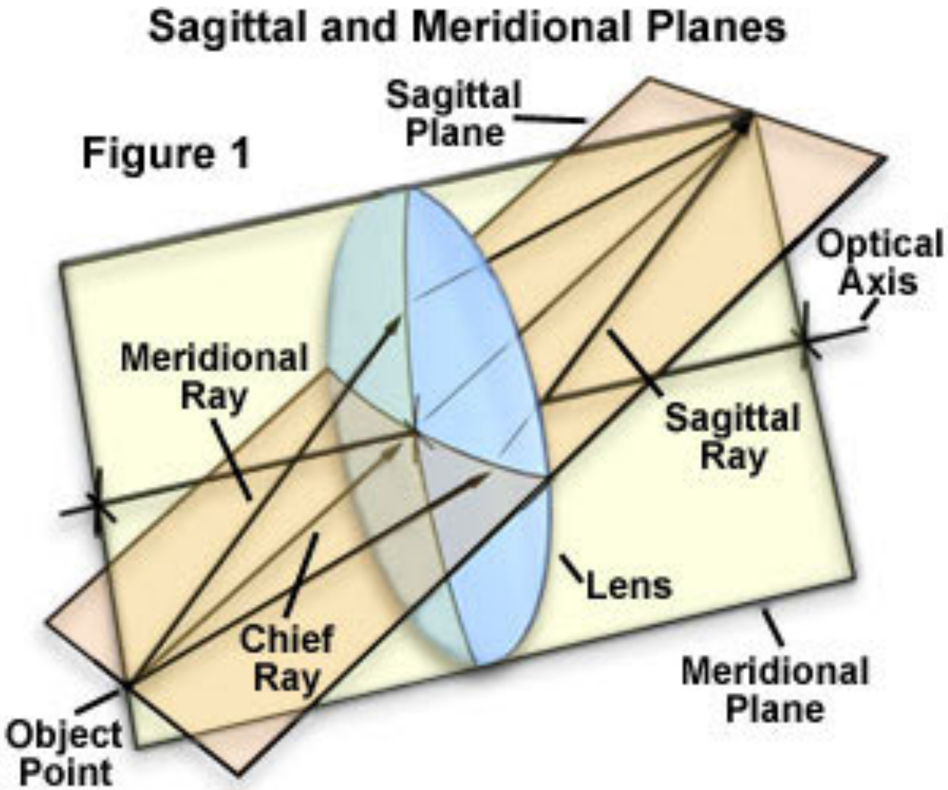


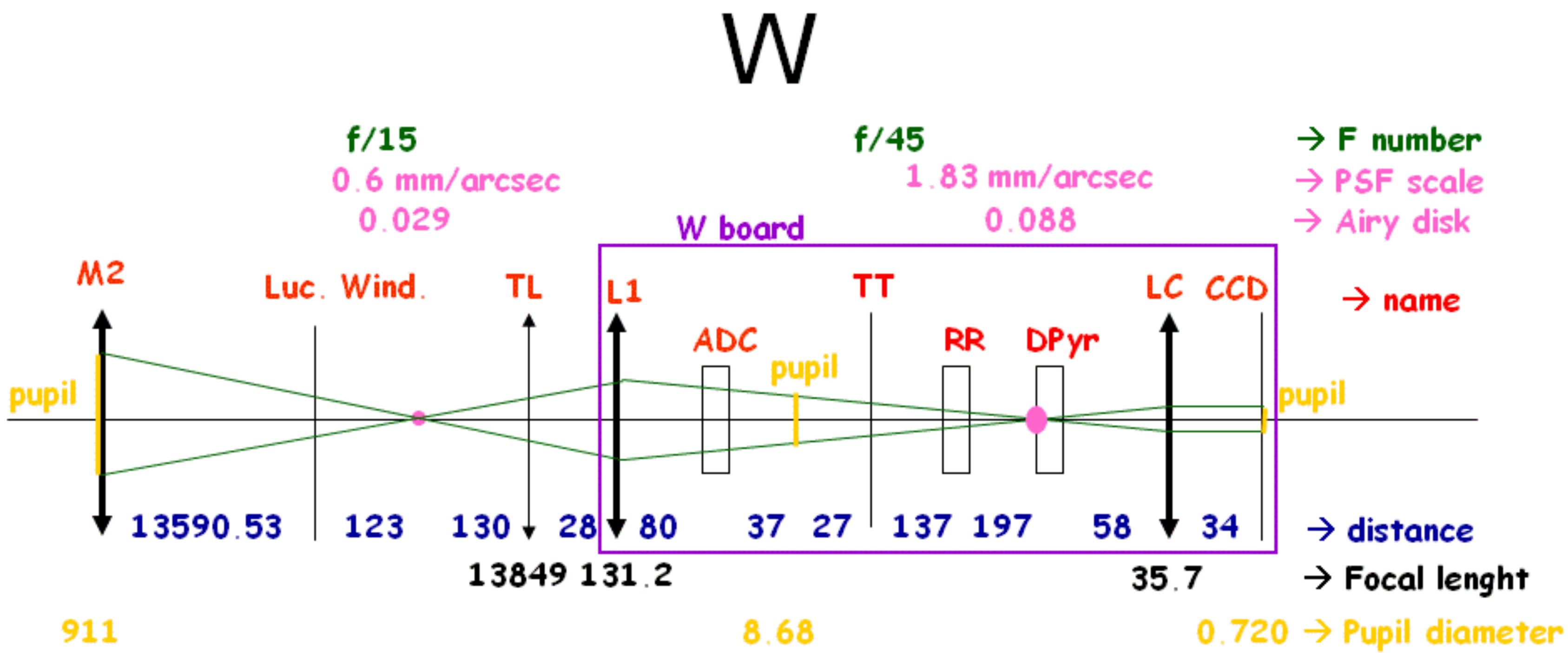
Fig. 1.6 *Map showing the design types which are commonly used for various combinations of aperture and field of view. (From W. Smith,* Modern Lens Design *(McGraw-Hill, 1992). Reprinted with permission of the McGraw-Hill Companies.)*

Piani sagittali e tangenziali (o meridionali)





Schemi ottici



the hidden, terrible equations...

2 f/# λ 1.22 = Airy disk ("PSF dimension")

1/f = 1/p + 1/q

1 october 2008

Dimensions are mm

Sag

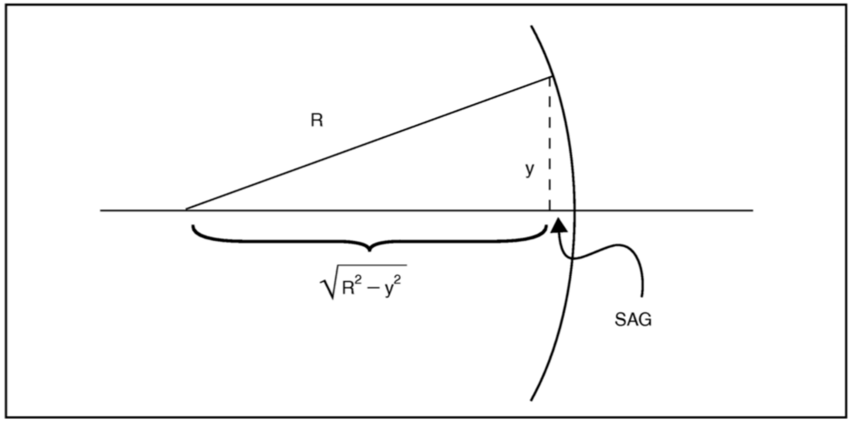


Fig. 3.3 *Illustration of surface sag.*

After taking a binomial expansion and keeping the first two terms:

$$\text{sag} \cong R - R\left[1 - \frac{y^2}{2R^2}\right] \tag{3.4}$$

$$\text{sag} \cong R - R + \frac{y^2}{2R}$$

$$\text{sag} \cong \frac{y^2}{2R} \tag{3.5}$$

Conic constant

Table 3.1
Conic constant associated with different surface types.

Surface Type	**Conic constant (K)**	$P = 1 + K$
Circle	0	1
Parabola	–1	0
Hyperbola	< –1	< 0
Prolate Ellipse	–1 < K < 0	0 < P < 1
Oblate Ellipse	> 0	> 1

$$z_{-} = \left(\frac{R}{P}\right)\left[1 - \sqrt{1 - P\left(\frac{y}{R}\right)^2}\right] \quad \textbf{(3.10)}$$

Using the binomial expansion on the square root, and letting z_A replace z_{-}:

$$z_A \sim \left(\frac{R}{P}\right)\left\{1 - \left[1 - \left(\frac{P}{2}\right)\left(\frac{y}{R}\right)^2 - \left(\frac{P^2}{8}\right)\left(\frac{y}{R}\right)^4 - \left(\frac{P^3}{16}\right)\left(\frac{y}{R}\right)^6 - \text{etc.}\right]\right\} \quad \textbf{(3.11)}$$

$$z_A \sim \frac{y^2}{2R} + \left(\frac{P}{8}\right)\left(\frac{y^4}{R^3}\right) + \left(\frac{P^2}{16}\right)\left(\frac{y^6}{R^5}\right) + \left(\frac{5P^3}{128}\right)\left(\frac{y^8}{R^7}\right) + \text{etc.} \quad \textbf{(3.12)}$$

Note that the first term is simply the approximate sag of a spherical surface (as per Equation 3.5). The higher order terms represent the aparabolic departure. The particular aspheric associated with various values of the conic constant are shown in Figure 3.5 and tabulated in Table 3.1.

The image of very distant source (e.g., a star) contains spherical aberration

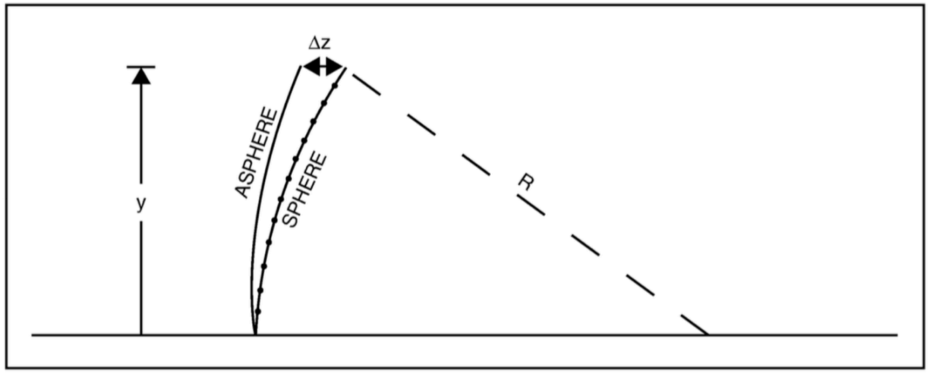


Fig. 3.8 *Departure from sphere.*

$$\Delta z = z_A - z_s \tag{3.14}$$

$$\Delta z \sim \left(\frac{1}{8}\right)(P-1)\left(\frac{y^4}{R^3}\right) + \left(\frac{1}{16}\right)(P^2-1)\left(\frac{y^6}{R^5}\right) + \left(\frac{5}{128}\right)(P^3-1)\left(\frac{y^8}{R^7}\right) + \text{etc.} \tag{3.15}$$

As an example, let's find Δz for a 31.25 cm focal length $f/1.25$ parabola. This means that the parameter values used in Equation 3.15 are: $P = 0$; $y = 12.5$ cm; $R = 62.5$ cm. Calculating the first two terms in Equation 3.15:

$$\Delta z = -0.0125 - 0.00025$$

$$\Delta z = -0.01275 \text{ cm} = -127.5 \text{ microns} = -201\lambda \text{ (for } \lambda = 0.6328)$$

This is a significant departure from sphere and means that a null lens (Chapter 35) would have to be designed to test this parabola interferometrically at its center of curvature.