2.7 Achromatism

Since achromatism is a first-order property, achromatic balance can be determined through the application of thin-lens equations.

2.7.1 Primary achromatism

For a series of thin lenses in close contact, the longitudinal chromatic aberration is given by

$$\Delta l = -f^2\left(\frac{\Phi_1}{V_1}+\frac{\Phi_2}{V_2}\right) \tag{2.20}$$

for a thin-lens doublet where

$$V = \frac{(n_M - 1)}{(n_S - n_L)}, \tag{2.21}$$

$$\Phi = 1/f, \tag{2.22}$$

and n_M, n_S, and n_L are the mid-, short-, and long-wavelength indices of refraction. For a thin-lens achromatic doublet, two wavelengths will come to focus when

$$f_a = f\left(\frac{V_a - V_b}{V_a}\right)$$

and

$$f_b = f\left(\frac{V_b - V_a}{V_b}\right). \tag{2.23}$$

To make a positive achromat, combine a positive low-dispersion element with a negative high-dispersion element:

3 to 5 µm: silicon is low dispersion (V = 250)
germanium is high dispersion (V = 107)
f = 100: f_a = 57.2, f_b = –133.6

8 to 12 µm: germanium is low dispersion (V = 1073)
zinc selenide is high dispersion (V = 58)
f = 100: f_a = 94.6, f_b = –1750.