UCA Department of Physics and Astronomy

PHYS 3345: OPTICS

An interesting selection of achromats

Chapter 06: Chromatic Aberration
Design Your Own Achromat

Attached are several spec sheets for different optical glasses, two crowns and a flint, Using the data provided, design a simple Fraunhofer cemented achromat with a focal length of 75cm.

1. Choose a crown and a flint to work with.

Lens 1 (crown): N-BK7

$n_{1C} = 1.51432$

$n_{1F} = 1.52238$

$n_{1d} = 1.51680$

$$V_{1d} = \frac{n_{1d} - 1}{n_{1F} - n_{1C}}$$

$$V_{1d} = \frac{1.51680 - 1}{1.52238 - 1.51432}$$

$V_{1d} = 64.12$

Lens 2 (flint): SF66

$n_{2C} = 1.91033$

$n_{2F} = 1.95452$

$n_{2d} = 1.92286$

$$V_{2d} = \frac{n_{2d} - 1}{n_{2F} - n_{2C}}$$

$$V_{2d} = \frac{1.92286 - 1}{1.95452 - 1.91033}$$

$V_{2d} = 20.88$

2. Find the power of each lens.

$$D_1 = \frac{1}{f_{1d}} = \frac{V_{1d}}{f_d\left(V_{1d} - V_{2d}\right)}$$

$$D_1 = \frac{64.12}{(0.75\text{m})(64.12 - 20.88)}$$

$D_1 = +1.976\text{m}^{-1}$

$$D_2 = \frac{1}{f_{2d}} = \frac{V_{2d}}{f_d\left(V_{2d} - V_{1d}\right)}$$

$$D_2 = \frac{20.88}{(0.75\text{m})(20.88 - 64.12)}$$

$D_2 = -0.643\text{m}^{-1}$

3. Assume that the crown is equi-convex.

$$\rho_1 = \frac{1}{R_1} - \frac{1}{R_2} = \frac{1}{R_1} - \frac{1}{(-R_1)}$$

$$\rho_1 = \frac{2}{R_1} = \frac{D_1}{n_{1d} - 1}$$

$$R_1 = \frac{2(n_{1d} - 1)}{D_1}$$

$$R_1 = \frac{2(1.51680 - 1)}{1.976}$$

$R_1 = 0.523\text{m}$

4. Assume that R_1 of the flint matches the crown, but don't assume that R_2 will be infinity.

$$\rho_2 = \frac{1}{R_1} - \frac{1}{R_2} = \frac{D_2}{n_{2d} - 1}$$

$$\frac{1}{R_2} = \frac{1}{R_1} - \frac{D_2}{n_{2d} - 1}$$

$$\frac{1}{R_2} = \frac{1}{(-0.523)} - \frac{-0.643}{(1.92286 - 1)}$$

$R_2 = -0.823\text{m}$

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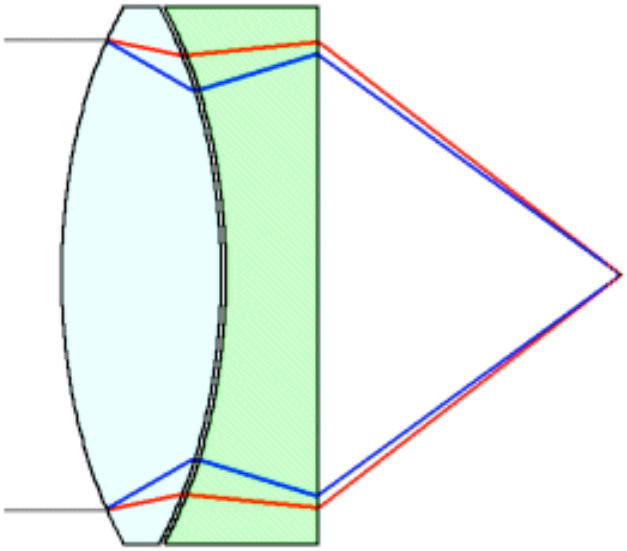

$$D_2 = \frac{1}{f_{2d}} = \frac{V_{2d}}{f_d\left(V_{2d} - V_{1d}\right)}$$

$$D_2 = \frac{20.88}{(0.75\text{m})(20.88 - 95.02)}$$

$$D_2 = -0.376\text{m}^{-1}$$

1. Choose a crown and a flint to work with.

Lens 1 (crown): N-FK56

$$n_{1C} = 1.43285$$
$$n_{1F} = 1.43742$$
$$n_{1d} = 1.43425$$
$$V_{1d} = \frac{n_{1d} - 1}{n_{1F} - n_{1C}}$$
$$V_{1d} = \frac{1.43425 - 1}{1.43742 - 1.43285}$$
$$V_{1d} = 95.02$$

Lens 2 (flint): SF66

$$n_{2C} = 1.91033$$
$$n_{2F} = 1.95452$$
$$n_{2d} = 1.92286$$
$$V_{2d} = \frac{n_{2d} - 1}{n_{2F} - n_{2C}}$$
$$V_{2d} = \frac{1.92286 - 1}{1.95452 - 1.91033}$$
$$V_{2d} = 20.88$$

2. Find the power of each lens.

$$D_1 = \frac{1}{f_{1d}} = \frac{V_{1d}}{f_d\left(V_{1d} - V_{2d}\right)}$$

$$D_1 = \frac{95.02}{(0.75\text{m})(95.02 - 20.88)}$$

$$D_1 = +1.709\text{m}^{-1}$$

3. Assume that the crown is equi-convex.

$$R_1 = \frac{2(n_{1d} - 1)}{D_1}$$

$$R_1 = \frac{2(1.43425 - 1)}{1.709}$$

$$R_1 = 0.508\text{m}$$

4. Assume that R_1 of the flint matches the crown, but don't assume that R_2 will be infinity.

$$\frac{1}{R_2} = \frac{1}{(-0.508)} - \frac{-0.376}{(1.92286 - 1)}$$

$$R_2 = -0.641\text{m}$$