OPTI 600B Homework 1 Due: September 7, 2018

1. Design two thin achromats with a focal length of 100 mm. For the first one, use N-BK7 and N-PSK53A for the two glasses. For the second one, use N-BK7 and F2 for the glasses.

a) What are the required powers of the two elements for each of the achromats?
b) While a solution exists for both cases, why is one solution a bad design choice and the other is a good design choice? What is the driving factor affecting the bad design choice?

2. Through similar arguments made for the three element apochromat in the notes, we can try to make a two element apochromat. The matrix equation for this case looks like

$$\begin{pmatrix} 1 & 1 \\ 1/\nu_1 & 1/\nu_2 \\ P_{1\lambda F}/\nu_1 & P_{2\lambda F}/\nu_2 \end{pmatrix} \begin{pmatrix} \phi_{1d} \\ \phi_{2d} \end{pmatrix} = \begin{pmatrix} \phi_d \\ 0 \end{pmatrix}.$$

Now we have three equations and two unknowns. The only hope for a unique solution is that one of the rows is linearly dependent upon the other rows. We already know from the achromat case that the element powers go to infinity when $\nu_1 = \nu_2$. What condition is required for row 1 and row 3 to be linearly dependent assuming $\nu_1 \neq \nu_2$? What condition is required for row 2 and row 3 to be linearly dependent assuming $\nu_1 \neq \nu_2$?

3. Calculate the Mueller matrix for a $\lambda/2$ plate by combining the Mueller matrices for two $\lambda/4$ plates with their fast axes aligned. Verify that the resultant matrix converts left circularly polarized light to right circularly polarized light, and vice versa.