Homework 9 Due by 5:00 PM on Tuesday, 7 April 2015

1. (10) **Achromat thin-lens design** (Geary ch. 16)
Follow Geary's ch. 16 homework steps to design a thin-lens achromatic doublet having f_e = 400 mm for the F, d, C spectral range, using BK7 glass for the front element and SF2 glass for the rear element. Make a table showing your lens element focal lengths and surface curvatures.

2. (10) **Achromat Zemax design** (Geary ch. 17)
Referring to Geary's ch. 17 discussion as a guide, insert your design into Zemax and show that the thin-lens design satisfies the achromatic condition. Add lens thicknesses and use Zemax to optimize your doublet at fields of 0°, 3.5°, and 5°. Use Zemax to determine the "secondary color" (discussed in Geary ch. 18). In your design report, be sure to show a chromatic focal shift plot to verify proper achromatic performance.

3. (10) **Doublet in Code V**
Repeat problem 2 using Code V.

4. (30 points) **Catalog Lens Analysis**:

a. After exploring some of the commercial lenses available in the Zemax lens catalogs, load the Thorlabs LA1251 singlet made of BK7 glass (nominally f_e = 100 mm, f/4.4). Orient the lens for optimal imaging with an object at infinity and use Zemax "quick focus" to focus the lens for best rms wavefront.

   Set field angles = 0°, 1.4°, 2.0° and wavelengths = f, D, c (visible).

   Use wave-fan and ray-fan plots to identify the dominant aberration(s).

   Discuss how these aberrations are shown in the spot diagrams.

   Use a chromatic focal shift plot to determine the f-c lateral chromatic aberration.

b. Repeat this analysis for a Thorlabs AC254-100-A doublet (f_e = 100 mm, f/4.4). Also look at a chromatic focal shift plot and determine the approximate secondary chromatic aberration for this doublet.

c. Repeat this analysis for the Cooke triplet design provided by me via email (f_e = 100 mm, f/4).

5. (10 points) **MTF Analysis**
For the doublet and triplet lenses, determine the spatial frequency below which the MTF remains above 10% modulation. What spatial resolution on the ground does this imply if you used this lens for airborne imaging from an altitude of 1000 m?