OPTI 415 Homework 3 Due: March 3, 2022

1. The image below is of the Big Dipper (The original is on the website). Estimate the PSF of the imaging system used. If all of the stars are point sources, why are some stars bigger than others?

2. Suppose we have a wavefront error $W(\rho_x, \rho_y) = W_{222} h^2 \rho^2 \cos^2 \psi + W_{131} h \rho^3 \cos \psi$. What are the components of the transverse ray error ε_x and ε_y? Create 500 random values of $-1 \le \rho_x \le 1$ and $-1 \le \rho_y \le 1$. Exclude any points where $\rho_x^2 + \rho_y^2 > 1$. Plot ρ_x vs. ρ_y to see how random your random number generator truly is. Create a spot diagram by plotting ε_x vs. ε_y for these random pupil coordinates. Assume h = 1, $W_{222} = -0.001$ mm, $W_{131} = 0.001$ mm, reference sphere radius R = 100 mm and the exit pupil diameter is 20 mm.

3. Calculate the Percent Distortion in the image below (original available on line). HINT: In class, we defined %Distortion= $\frac{y' - y'_p}{y'_p}$, where $y' - y'_p = \varepsilon_y$ (i.e. the transverse ray error for distortion) and y'_p = paraxial image height. The original image has a 4:3 aspect ratio and $h = 1$ along the diagonal of the image.

4. Write a program to remove the distortion from the image in question 3. Show your resulting image. Don't just download a distortion correction software from the web, but create and implement your own algorithm.