Astronomy 3130  
Problem Set 3 – Spring 2017  
Due Thursday March 2

You are welcome and encouraged (i.e. somewhat expected) to do the calculations for the quantitative problems below in the form of an iPython notebook, using comments/markdown liberally. Just print the final web page from your browser using the “Print Preview” option in iPython to create a submitable .pdf.

1) Suppose you construct a 20 cm diameter telescope objective from a single piece of FK-5 glass (refractive index curves vs. wavelength for this material can be found fairly easily). If this lens is plano-convex (flat on one side, curved to make it a positive converging lens on the other) with a radius of curvature of 2000 mm on the convex face:

   a) Calculate the focal length of this lens at 400 nm wavelength.

   b) What is the platescale in mm/arcsec for this telescope?

   c) Calculate the image blur (diameter of the out of focus image) at a wavelength of 500 nm in arcseconds due to chromatic aberration assuming the focal plane is in focus for a wavelength of 400 nm.

   d) How does this chromatic aberration at 400 nm compare to the diffraction-limited image size for this telescope?

   e) What will the pixel scale of an Andor iXon 888 CCD camera be if placed at the focal plane of this one lens telescope? What is the field-of-view of this camera? Is this pixel scale a good match to typical seeing? To the diffraction limit?

   f) In order to solve the chromatic aberration issue you decide to construct a reflecting telescope with the same focal length. What is the required radius of curvature of the telescope mirror to create system with identical focal length?

2) Consider an 8.4-meter diameter telescope aperture (one of the primary mirrors on the Large Binocular Telescope). Given the rule that 1” seeing corresponds to an $r_0$ of 10 centimeters at a wavelength of 500nm estimate the approximate number of actuators required (the number of $r_0$’s in the aperture) to correct at the infrared “H” band at 1600 nm when the 500 nm seeing is 0.6”. Compare this number to the actual number of actuators on the LBT secondary mirrors (which you will need to dig up and reference).

3) The course home page has a variety of exposure time calculators listed in the tools section. Explore these in order to answer the question, “How long do you have to expose on the 31” telescope at Fan Mountain to detect a 21st magnitude star at SNR=10 through an R-band filter.” The path to the answer requires that you make some assumptions. Make any that are reasonable, but be sure to be explicit about those assumptions in your answer. Ask questions...