Astronomical Observing Techniques 2016: Exercises on Optics (Due on 21 March 2016 at 11:15)

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1 Spherical Aberration

For a single, biconvex lens that images an object at infinity on the optical axis, show that the transverse spherical aberration is about proportional to F^{-3}, where F is the f-number, and is independent of the field location. Use the optical design software and determine the rms spot size in the best focus for a number of different beam diameters illuminating a single lens with a fixed focal length. Note that the location of best focus depends on the beam diameter, even if the lens has a constant focal length.

2 Galileo Telescopes

Design a refractor according to Galileo (large biconvex and small biconcave lens). Determine the field of view and the chromatic aberrations. Use the rms spot diameter as the performance metric. Hint: use a single lens with a long focal length to simulate the eye; the long focal length will make sure that the aberrations induced by that lens can be neglected with respect to the aberrations of the telescopes that you design.

3 Diffraction-Limited Sampling

Determine the pixel size (in arcsec) needed for the 2.4-m Hubble Space Telescope to make images at a wavelength of 0.5μm without loosing spatial information.