Astronomical Observing Techniques 2018: Exercises on Optics (Due on 19 February 2018 at 11:00)

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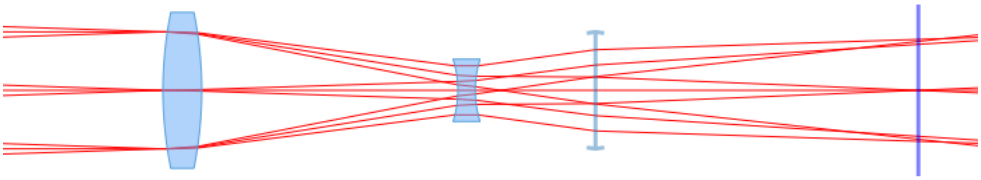
1 Spherical Aberration

For a single, biconvex lens that images an object at infinity on the optical axis, show that the transverse spherical aberration is roughly proportional to F^{-3}, where F is the f-number, and is independent of the field location.

Use the TOD optical design software at `home.strw.leidenuniv.nl/ keller/TOD/tod.min.html` to 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, see figure above) and determine its performance regarding the field of view and chromatic aberrations.

Use a paraxial surface (an ideal optical lens without any aberrations) to simulate the eye; the paraxial surface will not introduce any additional aberrations. Use the rms spot diameter as the performance metric and define the field of view as the field angle at which the rms spot radius doubles as compared to the rms spot radius in the center of the field. For the chromatic aberration, check the rms spot radius for wavelengths of 400, 550, and 700 nm without moving the image plane.

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.