

Astronomical Telescopes and Instruments 2017:

Exercises on Spectrographs

(Due on 22 November 2017 at 13:30)

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1. The MMT telescope has a diameter of 6.5m and a Cassegrain focal ratio of $f/15$. A spectrograph at the Cassegrain focus has an entrance slit set to match the typical seeing of 0.75 arcseconds.
 - (a) How wide is the slit in mm?
 - (b) The diameter of the collimator is 300mm, and it projects onto a glass prism made of F2 glass with a base length $B = 200\text{mm}$. What is the dispersion A in radians per nm at the Hydrogen alpha line? You can assume $dn/d\lambda = 0.06\mu\text{m}^{-1}$ at a wavelength of 0.656 microns and the prism is set up in minimum deviation.
 - (c) The focal ratio of the camera for the spectrograph is $f/2$. What is the slit width on the detector?
 - (d) The detector is a CCD with 512 pixels to a side and 20 micron pixel size. Is the CCD adequately sampling the slit?
 - (e) What is the spectral resolution of the spectrograph at 656nm?
 - (f) What is the estimated bandwidth of the spectrograph?
 - (g) Why can you only estimate the bandwidth?
2. The James Webb Space Telescope has a diameter of 6.5m and a focal length of 130m.
 - (a) What is the size of the Airy disk at the telescope focus for a wavelength of 2.2 microns?
 - (b) What is the width of the spectrograph entrance slit that matches this diffraction limit?
 - (c) Studying the dynamics of globular clusters requires a spectral resolution of 60000. A diffraction grating with 100 lines/mm is provided for the spectrograph. If the diffraction grating is used in 8th order in a Littrow configuration, what is the incident angle on the grating?
 - (d) What is the number of illuminated grooves needed for this spectral resolution?
 - (e) What is the full length of the grating?
 - (f) What is the diameter of the collimated beam and its focal length?