

# Astronomical Telescopes and Instruments 2020: Exercises on Spectrographs (Due on 24 November 2020 at 14:15)

M.A. Kenworthy

November 11, 2020

## 1 Prism spectrograph

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.

1. How wide is the slit in mm?
2. 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.
3. The focal ratio of the camera for the spectrograph is  $f/2$ . What is the slit width on the detector?
4. The detector is a CCD with 512 pixels to a side and 20 micron pixel size. Is the CCD adequately sampling the slit?
5. What is the spectral resolution of the spectrograph at 656nm?
6. What is the estimated bandwidth of the spectrograph?
7. Why can you only estimate the bandwidth?

## 2 Diffraction grating

The James Webb Space Telescope has a diameter of 6.5m and a focal length of 130m.

1. What is the size of the Airy disk at the telescope focus for a wavelength of 2.2 microns?
2. What is the width of the spectrograph entrance slit that matches this diffraction limit?
3. 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?
4. What is the number of illuminated grooves needed for this spectral resolution?
5. What is the full length of the grating?
6. What is the diameter of the collimated beam and its focal length?