Astro 500 Homework #3

Due Thursday 14 April 2011, 10:45 AM

1. For a spectrograph fed with an f/3.32 beam, and with an f/1.33 camera, what is the magnification factor of the entrance slit at the detector focal plane (larger or smaller)?

2. For the above spectrograph, how big is a 300 micron entrance-slit (in width) at the detector? Give your answer in units of microns and 15-micron pixels.

3. If the above spectrograph has a 115 mm diameter collimated beam (for each field-point) what are the focal lengths, f_1 and f_2 of the collimator and camera, respectively?

The following questions all assume the above spectrograph and detector.

4. If the spectrograph has a camera-collimator angle of 100 deg, and is used with a Littrow transmission grating (e.g., a VPHg), how many l/mm are needed to make the central wavelength 653 nm?

5. What is the angular dispersion of the grating in the configuration defined in (4)? Identify the units of your answer.

6. What is the linear dispersion at the detector (angstroms/pix) for this configuration (4)?

7. What is the anamorphic demagnification of the system (4)?

8. What is the spectral resolution of the system (4)?

9. (a) How many pixels sample the resolution element? (b) Does this number have an impact on the delivered instrumental spectral resolution? (c) How much (if at all) would you bin your CCD?

And now for the hard part:

10. Suppose you replace the Littrow grating above with a VPH grating with fringes tilted by ϕ = +5 deg, but you are forced to keep the camera-collimator angle fixed at 100 deg. (Hint - see lectures notes; Burgh et al. 2007, PASP, 119, 1069; and Bershady 2010 "3D Spectroscopy in Astronomy, a copy of which will be linked to the web page).

a. How do α and β change in order to stay on-blaze (what are their values)?
b. What is the new blaze wavelength?
c. To what would you need to change the grating frequency (l/mm) to keep 653 nm on-blaze?

Consider this blazed grating with revised (if necessary) line frequency:

d. What is the new linear dispersion?
e. What is the anamorphic demagnification?
f. How many more spectral resolution elements have you fit on your detector compared to the unblazed case?
g. What is the delivered spectral resolution?
h. How many pixels are there now per resolution element?